Reprint

from

THE TRANSACTIONS OF

THE ROYAL INSTITUTION OF
NAVAL ARCHITECTS

10 UPPER BELGRAVE STREET · LONDON S.W.1

Reprinted from The Quarterly Transactions of The Royal Institution of Naval Architects, January 1963

THE DEVELOPMENT OF SHIPBUILDING IN CORK HARBOUR

By P. G. Martin* (*Associate-Member*)

Read in Dublin at a Meeting of The Royal Institution of Naval Architects on June 6, 1962, Viscount Simon, C.M.G. (President), in the Chair.

Summary

The history of shipbuilding on the River Lee—connecting the Lower Harbour with the river port of Cork—is briefly reviewed, and it is shown how ship repairing gradually took precedence over newbuilding by the middle of the nineteenth century. Repair work was ultimately focused on the dry-dock at Rushbrooke, which in 1959 became the nucleus for the development of an extensive and modern dockyard for both shipbuilding and repairs. The planning and construction of the new yard is discussed in detail, with particular reference to some of the problems encountered in the process of establishing new industry in a predominantly rural area. The training programme which had to be devised for a completely untrained labour force is described, and particular emphasis is laid on the three-cornered relationship between employer, trade union, and employee. Unrestricted flexibility of labour is stressed as an essential feature of the new establishment. The author shows how the shipbuilding methods and planning systems adopted at the Verolme Cork Dockyard were integrated with centralized technical offices in Holland. An inventory of principal dockyard plant and equipment is given in an Appendix.

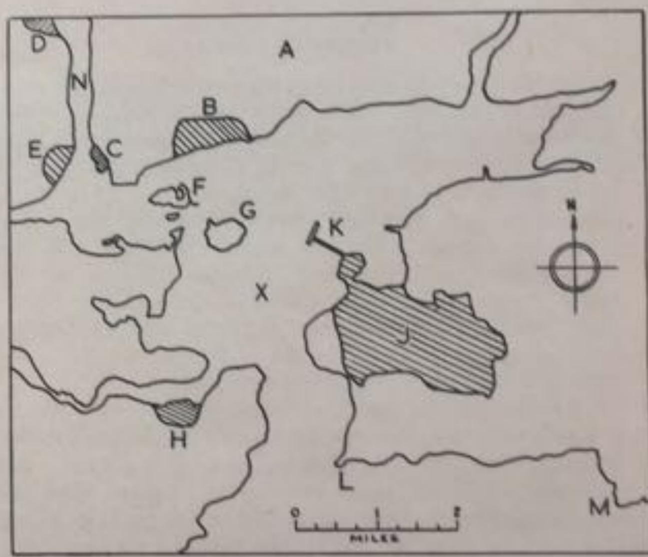
Early History of Shipbuilding in Cork

Historical references exist which refer to a number of Irish ports engaged in building ships of up to 500 tons burden during the latter half of the sixteenth century. The inducement for the Irish owner to build at home apparently declined early in the seventeenth century, when he found it cheaper to hire his tonnage from the Dutch. There appears to have been a temporary revival during the seventeenth century, but by the end of that century shipbuilding had once again almost died out.

Little is known of very early shipbuilding activity in Cork Harbour, but guided by records of an industrious and competent revival during the nineteenth century, we are led to believe that the craft of boat-building, at least, had never entirely died out. Although shipbuilding gave way to ship repairing in Cork Harbour as the century wore on, the first 50 years of it earned Cork a name for first-class ships—many of which made a substantial contribution to the advancement of shipbuilding, and perhaps even more to marine engineering, during the period in which sails were slowly giving way to steam.

Lecky, the Lee shipbuilder, launched H.M. Sloop *Rattler* in 1844, which with 200 hp on a screw propeller, did harm to the paddle-steamers of that period. Although her race with the paddle-driven H.M.S. *Prometheus* (of similar form and power) was rather inconclusive, *Rattler* steaming at 9·89 knots to the 8·89 knots by *Prometheus*, her celebrated tug o' war with H.M. Sloop *Alecto* in 1845 was an important victory for screw propulsion over paddles. The official experiment ended by *Alecto* making 2½ knots sternway, although developing the same power ahead as *Rattler*, and Admiralty cautiously admitted that screw propellers promised to become a better proposition than paddles as auxiliary power to sails!

Sirius—generally conceded to have been the first steamship to cross the North Atlantic in 1838—was Scots-built, but she was commanded on that historic voyage out of Queenstown by



A. Great Island.
B. Cobh (and Atlantic passenger terminal).
C. Verolme Cork Dockyard Ltd.
D. Passage West.
E. Monkstown.
F*. Haulbowline Island.
G. Spike Island.
H. Crosshaven.
J*. Whitegate oil refinery.
K*. Tanker terminal.
L. Roche's Point.
M. Power Head.
N. River Lee (to Port of Cork).
X. Transatlantic liner anchorage.

* Haulbowline Island, formerly a Royal Naval Dockyard, is now the Headquarters of the Irish Naval Service, but the eastern part of the island is occupied by Irish Steel Holdings Limited, whose steelworks are at present being greatly expanded to meet export commitments. The Irish Refining Company's Oil Refinery at Whitegate was opened in May 1959. Up to 40,000 tons of crude oil arrives weekly from Iraq and Saudi Arabia, to meet the country's total requirements of petrol, gas oil, diesel oil, heavy fuels, T.V.O., and aviation jet fuel.

Fig. 1.—Salient features of Cork Harbour

* Naval Architect, Verolme Cork Dockyard Ltd., Rushbrooke, Co. Cork.

Lieutenant Roberts, R.N., of Passage West, and during most of her life was owned and manned from Cork. She became the first ship of the City of Cork Steam Packet Company, and foundered in Ballycotton Bay in 1847.

Lecky also built the *Lee*, the first double-dredger with a bucket-chain port and starboard. She was used for many years to deepen the channel between the Lower Harbour and Cork—the start of an enormous project which the Cork Harbour Commissioners have pursued so that today ships drawing almost 30 ft. can proceed to the City Berths.

Pike, another Cork shipbuilder, designed and built ships of up to nearly 2,000 tons gross; he also built engines, boilers, lifeboats and the entire outfit in the shipyard. That was over 100 years ago, and by contemporary standards he was probably not regarded as unique in this respect.

The first iron-built ship from a Cork yard was the three-masted *Cormorant*, built by Pike. While loading cavalry horses in Portsmouth for the Crimea, Queen Victoria and Prince Albert went on board and were greatly taken by the ship's masts. Informed by the Master that they were built of iron, the Queen insisted on scraping them with the Prince Consort's penknife, and finding that they were indeed not of wood, ordered their scantlings to be recorded for use in the construction of masts for Government ships then building in England.

The last ship of the *Cormorant* class to be built at Pike's yard was the *Ibis*. It was probably the last launching of many that the Cork people had witnessed from the banks of the Lee. Almost exactly a hundred years later the same banks were crowded with spectators to see the 15,000-ton *Irish Rowan* go down the ways at Rushbrooke.

History of Rushbrooke

The history of the ship repairing establishment at Rushbrooke, situated at the point where the River Lee flows into the Upper Harbour, began in 1854. In that year a prosperous Cork shipbuilder, Joseph Wheeler, started building a dry-dock. It was to be 435 ft. long and 60 ft. wide, but only 15 ft. deep. The excavation took over five years, and in 1860 the new graving dock was opened when the Scottish steamer *John Bell* dry-docked for bottom repairs. Wheeler lived in an adjoining mansion—today the Head Office of the Verolme Cork Dockyard. In the same year four shipyards were operating on the Lee, but the last launch in Cork took place within a very short time of the opening of the new dry-dock.

The fluctuations of Rushbrooke's fortunes soon became coupled with the hitherto flourishing shipbuilding industry at Passage West, on the opposite bank of the river. Although shipbreaking is the main industry in Passage West today, it was there that the first steamship to be built in Ireland was launched on June 10, 1815. She was the *City of Cork*, from Hennesseys' yard. William Brown of Passage West had by 1832 completed an ambitious and costly dockyard there, which was opened in that year by Queen Victoria. Up to the time of Wheeler's venture at Rushbrooke, shipbuilding was successfully carried on at Passage West, but before the turn of the century both enterprises had amalgamated under the successive control of no less than three companies. In 1906 a new company (Queenstown Drydocks, Shipbuilding and Engineering Company Limited) was formed to acquire the entire interest. They operated for only three years when one of the directors of this and the previous company bought out the other directors and continued alone. He was O. S. Southwell Piper, and he finally sold the concern to Furness, Withy & Company in 1917. This transaction probably ended the effective combination of interests on both banks of the Lee. These new owners closed the Rushbrooke dry-dock for three years during an extensive modernization programme of ship repair facilities and by 1920 the graving dock had been re-equipped and enlarged to 540 ft. × 70 ft. × 27 ft. and during this time the Passage West yards had practically disappeared.

Furness Withy carried on operations until 1929, when they sold Rushbrooke to William Beardmore & Company of Glasgow. They used the dockyard almost exclusively for dry-docking in connection with their contracts with the Anglo-American Oil Company. This lasted only for about two years, at the end of which they closed and sold privately the dockyard and its equipment.

Throughout the thirties it lay empty. The local inhabitants were largely responsible for ensuring that the dock gate was not allowed to deteriorate beyond repair—a fortuitous regard for the future which had its reward in due time.

The Second World War placed the Republic of Ireland in a critical position as practically all British and foreign tonnage available for importation of essential commodities was withdrawn for war service elsewhere. Ireland was then faced with an immediate need for her own deep-sea ships. Neither the time nor the facilities were available to construct the necessary tonnage, nor did the second-hand market have any sound ships on hand at a time when acceptable standards were depressed. These conditions led to the formation, by the Government, of Irish Shipping Limited, and while it has flourished into the large and prosperous concern necessary to safeguard the country's supplies in any repetition of the circumstances which prevailed in 1940, the company's early days were guided by a small band of courageous men fighting an almost impossible problem.

They bought whatever ships were available, a number of which were, for all practical purposes, worn out. The means necessary to make them seaworthy had to be found or created at home, because repair establishments elsewhere were not in a position to undertake work which in some cases amounted to rebuilding.

At this stage Irish Shipping Limited acquired the run-down establishment at Rushbrooke. Cork Dockyard Limited, which was then formed as a subsidiary of the national shipowners, had the dry-dock and shops re-equipped and made ready for the first of a succession of major refits in ships for which the demand was becoming daily more acute. Liffey Dockyard in Dublin also played a vital part in the establishment of a deep-sea fleet during these difficult times, and so did the Irish coastal and short-sea shipowners, who undertook interim management of the several ships as they entered service under the Irish flag. The problem was reduced as each ship left the dockyards for sea, and in spite of war losses a small fleet of reasonably sound ships was gradually built up to meet the country's needs.

When the war came to an end, the peacetime shipping plans for the future were reviewed. The national requirement for a permanent ocean-going fleet led eventually to a continuous and regular building programme for Irish Shipping Limited, now operating for twenty-one years. The war-time tonnage was sold as the new ships came into service, and as the fleet soon reached proportions exceeding the requirement for Irish trade alone, many ships became engaged in work for other countries and seldom docked in their ports of registry.

The dockyard at Rushbrooke was still owned by Irish Shipping Limited up to the time that it passed into the control of Verolme United Shipyards of Rotterdam early in 1959.

Planning

In planning the new shipyard it was decided to integrate it—but not wholly—with the fully developed Verolme establishments in Holland, which in turn were to be expanded to cope with the technical services demand from Ireland, Norway, and later from South America also. By this means it became possible to undertake in Holland a maximum—not only of research, contract negotiation, design and development, estimating, drawings, etc.—but also of highly skilled office preparation of actual shipbuilding media in the form of optical drawings, and their negatives for direct projection. The principle was developed of doing nothing on the shipbuilding floor which could be done by a highly-trained technical office staff working under conditions of absolute accuracy and good shipbuilding practice. Those familiar with the practical application of optical-marking methods can appreciate that the system is of little value without a perfect degree of accuracy in the preparation, through its various stages, of optical negatives.

The need for flexibility and decentralization was realized during the planning of new yards overseas, and while for a time no provision was contemplated for separate optical drawing-offices in each shipyard, the way was left open for each yard to become technically independent in other respects, as they acquired staff of the required calibre to deal with the work. The optical drawing offices in Alblasserdam and Rozenburg are at present undertaking the entire preparation of projection negatives for all the Verolme yards. Because of their specialized staff and costly equipment this has led to a degree of economical competence which could not immediately be duplicated at each separate yard. The main steelwork plans from which the optical drawings are prepared may come in to the O.D.O. from any source—at present the individual shipyard drawing offices in Holland not only make their own steelwork drawings, but also those for the new Verolme yards elsewhere. Gradually, however, these yards may take over such work and eventually will deal direct with the optical drawing offices in Holland, until such time as their own are functioning.

When shipbuilding operations at Cork Dockyard began in September 1960, the steelwork drawings, optical drawings and negatives, material requisitions and orders, and the outline planning for the first ship, all had been prepared in Holland and forwarded to Rushbrooke. The technical staff at Cork were consequently able to concentrate entirely on detailed planning, material control, and on the actual physical production and erection of the first sectional assemblies. They were, in effect, given the information, the plant, the materials, an unfinished slipway and about 200 men, most of whom were new to shipbuilding. They started to build a ship of 15,000 tons deadweight and by the end of the first year ships totalling 39,000 tons deadweight were laid down, with a further vessel of 30,000 tons deadweight still to lay down.

The accomplishment of the formidable tasks which lay ahead in September 1960 was made possible because of the following factors:—

1. The shipbuilding methods and planning systems adopted.
2. Rational working agreements with trade unions.
3. The type, availability and cost of labour.
4. The training programme devised for skilled trades.
5. Close supervision and quality-control by a competent technical and foreman staff.
6. The morale and co-operation of the men.
7. The lack of precedent.

The constructional methods decided upon at Rushbrooke, based on optical plate-marking, are known and proved, and details of principal plant are to be found elsewhere. However, by transferring much of the skill of shipwright and loftsman into the hands of the optical draughtsman, by providing for an absolute maximum of work under cover, and by doubling the extent of downhand welding, it was established at an early stage that such methods are suitable, indeed obligatory, if an initially inexperienced labour force is to function competitively. The author ventures to suggest that the shipbuilding methods chosen by the Verolme yards, or some other parallel system utilizing, for example, electronic cutting equipment, is today necessary whether the labour force is firmly established or not, if the modern builder of ocean-going tonnage is to survive. The system requires the backing of rapid transport and craneage for turning, moving and erecting heavy prefabricated sections, but above all it demands a type of production planning control without which any such method becomes inefficient. Bad handling of the welding-floor space allocation boards—on which cardboard replicas of the week's sections are fitted like a jigsaw puzzle—can reduce output drastically, and appalling confusion builds up within hours if the day's material requisition orders are issued in the wrong sequence. All plates are stocked flat in a prearranged sequence, and rapid flow to the marking-tower is ensured by a 10-ton magnetic crane and electric roller-conveyor tables.

The selection of plant and machinery at Rushbrooke was largely governed by the adoption of a standard section weight of 40 tons. Although the heavy gantry crane in the shipbuilding shop has one 40-ton and one 20-ton hook, the gantry supporting structure was designed in such a way that a second 40-ton gantry could be fitted later if required, so that sections of up to 80 tons could be handled. Existing berth craneage could lift 80-ton sections without modification, although it is probable, when heavier sections are adopted, that at least one of the three 40-ton crane tracks would be provided with a second crane. A utilization-analysis of 40-ton shop and berth cranes shows that the total number of lifts can be classified as follows:—

1. Sectional assemblies of maximum weight.
2. Sectional assemblies of maximum dimensional size but below maximum weight (e.g. W. T. Bulkheads).
3. Sundry lifts of nominal weight and dimensions (e.g. small steelwork fitted on board separately, welding equipment, etc.)

Under heading (3) above, the proportion of such lifts—marked plates, subsections and semi-sections—is obviously so high in the shipbuilding shop that travelling gantries ranging from 2 tons (twelve) to 10 tons (four) are fitted in addition to the heavy gantry crane to give optimum-utilization of all units. The berth cranes, however, work to maximum capacity over a very limited proportion of total lifts—partly by reason of dimensional limitations on weight, heading (2) above, and partly because a pair of cranes are usually employed for erection-manœuvrability of all large sections.

A comparatively low mean loading-factor for heavy cranes must be accepted, particularly for outside work. This, considered in conjunction with:—

(*a*) The size and type of ship anticipated during the first two years;
(*b*) Limitations imposed by initially inexperienced labour;
(*c*) Provision for future fitting of a second heavy shop gantry;

provides for a safe economical optimum figure of 40 tons, with the proviso that this will probably be increased to 80 tons, as dictated by experience and the type of tonnage offering subsequently, but the maximum lifting capacity of the largest crane will remain at 40 tons. Gantries of various capacities are arranged in the shop to handle efficiently the progressively increasing unit-weight as material moves from the marking-tower through to the berth, but similar versatility is difficult for slipway cranes, especially if they also cover fitting-out berths. Light shipborne elevators or shipside lifts obviate the use of heavy cranes for sundry small loads during fitting-out, and the use of such equipment is being considered at Rushbrooke in conjunction with plans for new fitting-out quays.

No furnace heating is done at Rushbrooke, all plate development, frame bending, etc., being carried out in "cold" machines.

A Bakker 300-ton electro-hydraulic press caters for practically all shaped platework, and a Scottish Machine Tool Corporation 320-ton electro-hydraulic cold-bending machine is used for frame-turning, working from optically-marked moulds. When the new shipbuilding shop and welding-floor is built in a subsequent phase of development, a 500-ton press will be fitted, together with other units of capacities in excess of existing machines.

It should be observed that while the maximum lifting capacity of heavy cranes is largely dictated by economics and choice of a standard section-weight, it is undoubtedly essential in planning a new shipyard to select cold steelworking machines having maximum capacities which may initially appear rather more than adequate. The extremely heavy scantlings becoming more common in very large tankers and bulk-carriers could well lead to serious production difficulties if such machines were working too near their limit. The capital investment involved in the very heavy machine is recoverable by a faster rate of working, even when the machine is operating below its maximum rating.

The traditional shipyard mould-loft is obviated by optical marking, but a small floor was provided in one corner of the shipbuilding shop at Rushbrooke, to deal with special marking work, alterations, repair work, and for verifying any apparent errors in optical projection. The floor was used so little that it was raised on to a mezzanine deck to release valuable floor space for subsection assembly.

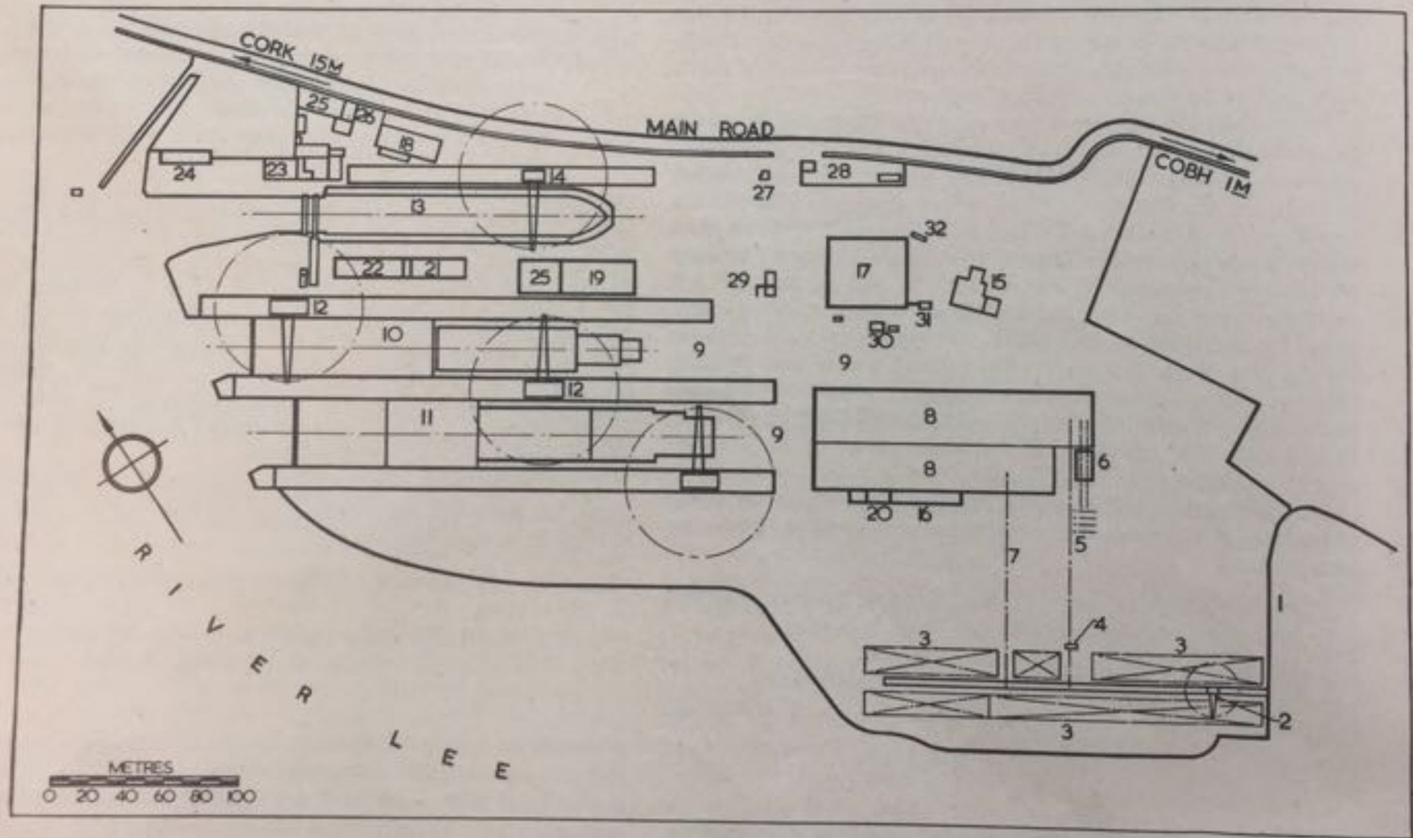
The newbuilding scrap allowance (gross, as a percentage of allocated material) at Rushbrooke varies between 7 per cent and 8 per cent. This is graded into large and small scrap for the purpose of economic disposal.

An inventory of all principal plant and equipment appears in an appendix, and this is adequate to complete an impression of the methods adopted in the new dockyard.

Development

When the existing ship repair establishment at Rushbrooke was acquired by the Verolme concern on January 8, 1959, the facilities available consisted of the 540-ft. graving dock served by mobile steam cranes, and the shops and offices associated with normal dry-docking and survey work.

Before shipbuilding operations could begin it was necessary to reclaim an initial area of 16½ acres from the harbour. This was achieved by the deposition of some 300,000 cubic yards of gravel fill, over a period of 14 months, brought by road from quarries 7 miles from Rushbrooke. Piling of this reclaimed land then began, preparatory to which an extensive programme of soil investigation had been undertaken, involving a total of



1. Steel discharging jetty.
2. 10-ton magnetic travelling crane.
3. Steel stockyard.
4. Plate flattening rolls.
5. Electric roller-conveyor.
6. Optical marking-tower (2 projectors).
7. Railway for bars.
8. Plate-shop and welding floor.
9. Interim storage for completed sections.
10. No. 1 slipway.
11. No. 2 slipway.
12. 40-ton travelling cranes.
13. Dry-dock 540 ft. × 70 ft. × 27 ft.
14. 12-ton travelling crane.
15. Administrative office block.
16. Production office block.
17. Woodworkers', polishers' and painters' shop.
18. Fitters' shop.
19. Pipefitters' shop.
20. Electricians' shop.
21. Repair steelworkers' shop.
22. Shipwrights' and riggers' shop.
23. Blacksmiths' shop.
24. Maintenance shop.
25. Stores.
26. Repair offices and first-aid station.
27. Security office (main gate).
28. Car and bicycle parks.
29. Clocking shelter and time office.
30. Oxy-acetylene station.
31. Exhausting and heating plant.
32. Paint stores.

Fig. 2.—Outline plan of Verolme Cork Dockyard

3,637 ft. of boreholes. Some of these penetrated 84 ft. before reaching bedrock, and about 25 per cent of them had to be made from a drilling barge working in up to 50 ft. of water in strong tides. The original programme of boring covered all offshore drilling necessary for full consideration of all development projects expected to arise in the future.

A standard re-inforced concrete pile, 16 in. square, was adopted for all piling work, and 2,989 of these, varying in length between 12 and 45 ft., were made on the site for preparing the ground for the shipbuilding shops, slipways and crane tracks; 3,380 square yards of corrugated steel sheet piling were also driven, in association with new jetties and slipway piers. The first pile was driven on November 10, 1959; piling in way of the shipbuilding shop began in March 1960; the shipbuilding shop was completed in August 1960; the keel of the first ship was laid down on No. 1 Slipway on October 15, 1960.

At the present stage of development 40,000 cubic yards of concrete, re-inforced with 1,200 tons of steel, have been used—practically all of it in direct association with newbuilding facilities; 1½ miles of drainage were incorporated, using pipe varying in bore between 3 and 12 in.

When reclamation was completed, it was necessary to begin dredging operations to open up the new East Jetty and clean out the river bed in way of the two new slipways. For every two tons of fill used for reclaiming land, over a ton of blue silt had to be dredged and taken in hopper barges over 7 miles for dumping at sea. None of this material was suitable for supplementing the quarried fill used for reclamation. At a critical stage of the dredging programme a large bucket dredger capsized and sank in deep water alongside the main repair jetty, which was rendered unusable until salvage operations concluded with a delicate manœuvre of the still-submerged wreck into the dry-dock for interim repairs.

With the completion of No. 2 Slipway early in 1962, all immediately essential development associated with newbuilding was completed, but space has been reserved to the north of the existing shipbuilding shop for a second similar shop, and not until this is in operation will the dockyard approach the limit of newbuilding development. Plans for other major projects provide for urgently-needed fitting-out berths with suitable cranes, improved berthage for repair-ships, a completely new engine shop, and possibly for a second and bigger graving dock, or alternatively for a wet basin designed to accommodate a large floating dock. It is essential that the development of these extensions goes hand-in-hand with the increased manpower needed to operate them and all planned development at Rushbrooke is phased with due regard to an anticipated manning-rate. Broadly, each phase is completed and in operation before further major projects are initiated, so that capital development may be constantly and prudently channelled to satisfy the most urgent requirement.

The Building Berths

Two building berths have been constructed of re-inforced concrete on reclaimed ground, previously prepared by driving closely-spaced concrete piles down to bedrock. Both slipways consist of four independent sections, and are fitted with water-tight steel gates so that work may proceed in the dry at the after end of ships building, at any state of the tide. The gates also serve as gangways for crossing the slipway ends. They are made tight by rubber-on-steel sealing, and are bodily lifted out prior to launching. Water may be admitted or drained through the doors by means of remote-controlled sluice-valves.

No. 1 Berth, designed for ships of up to about 35,000 tons deadweight, is arranged for single-way launching only, but ships may be launched on either single or double ways from No. 2 Berth, which is intended for ships of up to about 55,000 tons deadweight (based on the usual proportions of tankers and bulk-carriers).

Both slipways are equipped with pipe and cable services carrying oxygen, acetylene, compressed air, fresh water, salt water, alternating and direct current and each is served by two 40-ton travelling cranes.

The forward half-length of both slipways rises well above the standard ground level of the dockyard, and the spaces under have been given over to canteens, kitchens, wash and change rooms, production and foremens' offices, tool and electrode stores, etc. The slipways are swept or hosed down daily to preserve a completely clean and tidy working surface.

Other details are as follows:—

	No. 1 Berth	No. 2 Berth
Length in metres	200·81	227·60
Maximum breadth in metres ..	30·02	34·25
Declivity	1:20	1:21
Number of concrete piles ..	554	917
Weight of concrete piles in tons	1,293	2,139
Total concrete in cubic yards ..	8,000	9,000

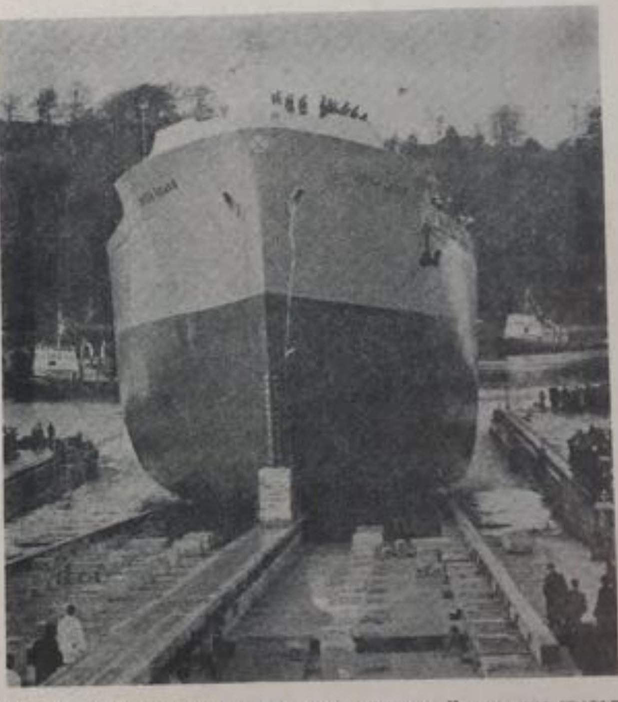


FIG. 3.—LAUNCHING OF M.S. "IRISH ROWAN," SHOWING SINGLE LAUNCHING WAYS

The Training Programme

Apart from a very limited number of boys serving a five years' apprenticeship, all personnel employed for training to a skilled trade are known at Rushbrooke as trainees. This distinction of terminology arises because a trainee is not indentured or bound by articles, but signs an agreement in which he submits to an examination by the dockyard medical staff, agrees to a probationary period of two months, agrees his hourly rate of pay, and guarantees—with his employer—to abide by the terms of the shipbuilding agreement between the dockyard and trade unions.

Various social influences, such as the very high national emigration rate from Ireland, and the possibility of selection for Continental training, considered in conjunction with the economics of local supply and demand of labour, have together led to an optimum intake age of about 25 years. This also means that a proportion of the intake are vocationally prepared for specialized training, though the number of "ready-made" craftsmen is extremely small, and confined almost entirely to woodworkers and fitters. The comparitively advanced age at which trainees start at the dockyard fits in with the slightly less highly-developed degree of personal skill demanded by optical and pre-assembly methods, to result in a training period of three years. This period applies to all skilled trades regardless of how much of it is spent in Holland. Dutch-trained employees, on their return from, say, a year in Holland, spend the balance of their three years as trainees at Rushbrooke. As in all the Verolme yards in Holland, there is a training school at Rushbrooke where classes are in progress for as many of the trainees as practicable, each group of 20 trainees spending two or three half-days per week in the school under the supervision of a foreman-instructor. Instruction is confined to practical shipbuilding, and follows four separate courses. These were developed in Holland in the form of a manual in four volumes, specially covering the standard methods of construction obtaining in all Verolme establishments. They have been translated and printed in various languages, and form a very detailed treatise on modern shipbuilding, with sketches illustrating the most rudimentary points. It is adequate for the instructor to work direct from the manual with very little personal explanation.

In common with the Dutch yards it is the intention to develop a practical training school, equipped with a selection of the same machines as those fitted in the shops, where new trainees can be taught the correct use of all dockyard equipment.

Attendance at local technical schools is also encouraged—not only to raise the technical ability of the trainees but also to stimulate the authorities to expand the scope of the schools to include subjects having a direct application to shipbuilding.

The training of personnel in Holland was adopted to relieve the very heavy load on Dutch foremen at Rushbrooke, and to provide a nucleus of competent workers—each of whom remained only long enough in one or other of the Dutch yards to acquire mastery of one or two operations. A crippling effect on production when the operator of a certain machine absented himself through illness was avoided, in the early days, by the foreman doing the work himself, and at the same time instructing a substitute. Gradually every man acquired some knowledge of how his own job fitted into the general pattern, the initial narrow specialization is easing, and the minute supervision which was originally vital is slowly leading to a reduced ratio of foremen to workers. The number of Dutch foremen is at present constant, and they will be replaced by Irish foremen as potentially competent leaders emerge for chargehand and foreman-selection and personal training.

The Labour Force

To assess the morale, co-operation and training-receptivity of a newly employed labour force, almost entirely new to heavy industry, forms in itself an uncommon aspect of industrial psychology. Especially so when considering relations between a foreign command and indiginous workers. Related to Ireland, with a difficult historical background well within living memory, the problem was formidable. The most pessimistic moments in the dockyard's development may well be traced to misunderstanding and mutual scepticism, whether engendered by language difficulties or merely by alien prejudice, which had an infinitely more damaging effect than any technical problem the new establishment had to face. Because of their national identity, the Dutch foremen and management were bracketed together by men whose local experience of "the boss" had not always been a happy one. On the other hand, the way of life and work in Ireland, seen by a small group of Dutchmen fresh from an atmosphere of post-war rebuilding and dynamic industrial expansion in their own country, demanded a firm sense of understanding and patience. Shipbuilding began amid a complexity of worker-management relations, and seldom was there greater need for the deliberate foundation of faith and mutual trust. That foundation was accomplished and continues to improve. The substitution of goodwill and sound working relations in place of prejudice and petty antagonism must surely be recognized as the basis for every aspect of any successful shipbuilding economy. Even the process of keeping a thousand safety helmets on heads which had previously known cloth caps was fraught with difficulty and hard words, but at least three of those heads are still able to admit it might have been a good idea!

The adjustment of a largely rural community to competitive industrial conditions is keeping pace, in the majority of cases, with the gradual growth of technical competence; a result, perhaps, of the characteristic Irish aptitude for environmental attunement.

For a number of reasons and in spite of respective costs of construction on the berth and afloat, it was decided to launch the first ship at the earliest possible stage of completion. As the ship left the berth practically every man in the dockyard was watching his first launching, and from this circumstance sprang the beginnings of a new local tradition and the mentality of a shipbuilder. The whole venture appeared as a living enterprise, and a fresh pride and purpose came into being. Another keel was laid down, and the essence of continuity established.

Every attempt is made to keep all employees reasonably informed of dockyard developments and their significance, and individual printed statements are issued to every man impartially setting out the facts whenever a change of negotiating policy with the unions is agreed, or during the course of a dispute, or whenever any modification to rates or working conditions becomes necessary.

One of the lessons learned during the development of Rushbrooke was that it is grossly inadequate to provide employment for many hundreds of men, backed by conditions, terms of employment, etc., without making a real endeavour to assess the social structure and historical background in which they live. An appreciation of these factors inspires accurate anticipation of employee reaction, and greatly helps to minimize frustration due to delays and discord.

Rational Working Agreements with Trade Unions

Introducing this subject the author is conscious that it is unusual in a paper to be read before this Institution. Most reviews of modern industry lay emphasis on employer/trade union relations to such an extent that it is impossible to ignore them when considering the establishment of new industry in a country where optimum good relations could be hopefully strived for. It may be claimed that such relations with the trade unions in Ireland have been achieved and the mutual standing of employer, trade union, and worker undoubtedly benefits from them in every way.

The initial approach to the trade unions on working agreements was based on practical common sense, a mutual understanding of what the new organization was setting out to do, and an active appreciation on both sides of the decline and failure which would inevitably result from anything which interfered with the system of labour it was hoped jointly to establish.

When Verolme acquired the former ship repair company with a view to expanding it by the introduction of shipbuilding, it was necessary, for the time being, to regard ship repairing and newbuilding as separate entities as far as agreements with

FIG. 4.—GENERAL VIEW OF THE DOCKYARD AT THE BEGINNING OF RECLAMATION—SUMMER 1959

FIG. 5.—GENERAL VIEW OF THE DOCKYARD, MARCH 1962

the unions were concerned. The existing ship repair agreements were honoured, but could not be extended to newbuilding.

For shipbuilding, agreements were drawn up with only three unions, each of which represented a trade or group of trades in completely different departments of the dockyard. All steelworkers, engineers, pipefitters and electricians were protected by one union, woodworkers by another, and labourers together with transport personnel and cranemen by a third. This does not imply that every man was obliged to be a member of one of the three unions with whom agreements had been negotiated. It was made clear, since shipbuilding began at the dockyard, that each employee is completely free to belong to any union, provided he is willing to accept that only one union (not necessarily his own) has the right to negotiate on behalf of his trade. The crux of the agreements was that only the three unions concerned could be recognized as the sole negotiating representatives of the trades they covered, and of the men following those trades.

At the time of signing these agreements, it was foreseen that determined attempts would sooner or later be made by other trade unions, both Irish-based and British-based, seeking their own negotiating rights with the dockyard, but with the loyal support of the three Irish unions with whom contracts had already been concluded, the claims of the other unions were successfully resisted, and the preservation of reasonable labour flexibility ensured.

The three unions signatory to the shipbuilding agreements each cover territories which do not overlap, and consequently there is no common ground on which inter-union disputes may develop on demarcation issues. But the principle is carried further in that all steelworking and engineering trades, for instance, being represented by one and the same union, any demarcation problem between these trades immediately becomes a matter of principle for discussion between two parties only—the union representing the affected men on one side and the management on the other. It is further agreed that during such discussion, and the subsequent deliberations of an arbitrator, who is only called in if necessary, all concerned will continue work abiding by an interim decision taken by the management on the issue involved.

The conciliation machinery in all other disputes is basically similar, mediators when required usually being mutually selected. Strike or lockout action is precluded by the agreements until fourteen days after written notice of such action has been given, and it is agreed that such notice is invalid until each stage of the conciliatory procedure has in turn failed to provide a satisfactory settlement.

Although it is obviously undesirable to encourage a worker to be used beyond the limits of his own job, it has been possible to establish a degree of flexibility to avoid delays and to assist in the economical deployment of manpower and plant. The author has already pointed out that where the confinement of any workers to newbuilding would interfere with the scheduled completion of a ship under repair, then he may temporarily be transferred to the dry-dock. Conversely, when the dry-dock is not in use, the repair worker is sent to the shipbuilding shop or the berth, as required. This adjustment is essential, provided the men concerned remain basically within the limits of their trade. But from time to time it is necessary to provide for cases of departure into other trades—in full-scale pre-assembly methods the rigid enforcement of tack-welding by welders, for example, is impossible, and tack-welding at Rushbrooke is carried out by platers, using special tack-welding sets allocated for their own particular use. These minor departures have been made possible by the amalgamation of trades into combined departments with names not, perhaps, familiar to the traditional shipbuilder.

At Rushbrooke a pipefitter, for example, is responsible for all pipework in every part of the ship—no sub-division into engineers' work and plumbers' work. Similarly, all joiners' and carpenters' work is carried out by woodworkers. In the pipefitters' shop there are men who are individual specialists in engine pipework, in heating coils or in scuppers and discharges—all pipefitters working under, perhaps, three pipefitter foremen, who may themselves cover specialized fields. Similarly, in the woodworkers' shop, it is possible to see Cocks's bands being attached to 'tween deck hatch-covers on one bench, a writing desk or wardrobe being erected on the next, and a stack of deck sheathing timber lying beside a pile of formica panels—each awaiting treatment in the same shop. The men who carry out these operations could be termed, traditionally, joiners or carpenters, but they work in the same shop, are paid at the same rate, are protected by the same union and fall under the jurisdiction of the same senior foreman who also controls painters and polishers, each with their own part of the same building, and each with their own divisional foreman.

These two examples demonstrate the extent to which it has been found possible, by co-operation, to formulate an operative agreement with the trade unions, which governs the entire work-system of the dockyard. Thus the way is always clear for the introduction of new machines, techniques and methods which can be thoroughly investigated, and subsequently adopted or rejected on the grounds of what they are worth, in collaboration with the union representative with whom they are discussed. Operative flexibility obviously goes a long way towards curbing temporary redundancy at times when the programme of work in hand leads to a slack period for, say, fitting-out trades or fitters. A continuous manning-analysis at Rushbrooke has made it possible to provide for adequate manning of all work at peak periods in each trade and to offer a guarantee of continuous employment to every competent worker in the dockyard, without the fear of temporary redundancy. The security thus ensured for the worker is impossible under conditions of rigid demarcation between trades.

Acknowledgment

The preparation of a paper of this kind requires the co-operation of many specialists, and their valuable assistance is acknowledged. But the author pays a special and sincere tribute to the patient and understanding co-operation given during the development of the Cork Dockyard by the Surveyors of Lloyds Register of Shipping. Enough has been written in the foregoing pages to enable a shipbuilder to appreciate that nothing at Rushbrooke was accomplished without crises, moments of despair, and technical difficulties of many kinds. Throughout them all the Lloyds Surveyors were there to advise, discuss and resolve many matters frequently beyond the limits of what could reasonably be asked of them.

APPENDIX

Principal Shipbuilding Plant and Equipment

1. Cranes

40-ton Berth Cranes (two)

Level-luffing type by Hensen of Rotterdam.
Length of cranetrack: one at 281 metres, one at 293 metres.
Lifts 40 tons at 20 metres radius.
Lifts 18 tons at 41 metres radius.
Minimum radius 12 metres.
6 motors—all 380 V a.c., 3 phase, 50 cycles.
Travelling speed: 30 metres/min.
Hoisting speeds:—

0–2½ tons	50 metres/min.
0–9 tons	20 metres/min.
0–15 tons	12½ metres/min.
0–40 tons	5 metres/min.

40-ton Berth Crane

Level-luffing jib type by Hensen of Rotterdam.
Length of cranetrack: 270 metres.
Lifts 40 tons at 25 metres radius.
Lifts 18 tons at 48 metres radius.
Other particulars approximately as given for the two cranes above.

12-ton Dry-dock Crane

Level-luffing type by Hensen of Rotterdam.
Length of cranetrack 194 metres.
Lifts 12 tons at 15 metres radius.
Lifts 4 tons at 40 metres radius.
5 motors—all 380 V a.c., 3 phase, 50 cycles.

10-ton Stockyard Crane

Revolving gantry crane by N.K.M. of Utrecht.
Length of cranetrack: 272 metres.
Outreach: 12 metres.
3 lifting magnets on a beam operated from a rotating hoisting head.
Hoisting speed: 11 metres/min.
Travelling speed: 50 metres/min.
Hoisting, slewing, head-rotating and travelling motors 380 V a.c., 3 phase, 50 cycles.

20-ton Floating Crane

Steel non-propelled pontoon.
2 diesel-driven generators, 220 V.
3 crane winches.
2 warping winches.

Demag Mobile Cranes (two)

One to lift 9 tons.
One to lift 3½ tons.
Both diesel-driven with hydraulically operated extending jibs.

Overhead Travelling Crane in Shop

By N.K.M. of Utrecht.
One 40-ton hook.
One 20-ton hook.
Span 29 metres.
Hoisting height 15 metres.
Hoisting speeds:—
40 tons at 3·75 metres/min.
20 tons at 7·5 metres/min.
Travelling speed: 40 metres/min.
Trolley speed: 20 metres/min.
3 motors—all 380 V a.c., 3 phase, 50 cycles.

Overhead Travelling Crane in Shop (two)

By N.K.M. of Utrecht.
One 10-ton hook.
Span 27·6 metres.
Hoisting height: 9·1 metres.
Hoisting speed: 7·5 metres/min.
Travelling speed: 50 metres/min.
Trolley speed: 30 metres/min.
Motors as 40-ton shop gantry.

10-ton Electric Half-gantry Cranes (two)

2-ton Electric Overhead Trolley Cranes (twelve)

2. Stockyard and Optical Marking Tower

Plate Flattening Rolls

One set of seven 10-ft. rolls by Bakker.

Plate Roller-Conveyor Tables

Powered at every fourth roller by 2 hp electric motors.

Optical Marking Tower

Two projectors by G.A.G. of Hamburg, mercury vapour lamps, water cooled, fitted with automatic magazines for 9 × 12 cm. glass negatives.
Remote control for:—
Magazine control.
Image panning (longitudinal).
Image panning (transverse).
Image rotating.
Image focus.
Pneumatic lowering of table rollers.

3. Shipbuilding Shop Equipment

(All electric motors in shop 380 V a.c., 3 phase, 50 cycles.)

Bakker 300-ton Electro-hydraulic Plate Press

Pressing speed 50 cm./min.
Approach and return speed 425 cm./min.
Portal passage 3 m. × 3 m.
Stroke 500 mm. maximum.

Hydraulic Cold Frame-bending Machine

Maker: Scottish Machine Tools Corporation Ltd., Glasgow.
Maximum capacity 320 tons.
Maximum size of sections handled:—

Channels	17 in. × 4 in.
Bulb angles	15 in. × 4 in.
Ordinary angles	10 in. × 4 in.

Messer Portal 3,000 S. Oxy-acetylene Flame-cutting Machine

Working width 3 metres.
2 cutter carriages.
2 3-cutting sets.
2 tracer heads.
Track length 30 metres.

Messer Corta 1,000 Oxy-acetylene Flame-cutting Machine

Cutting-area 2,000 × 1,000 mm.
Area for circular cutting 50–1,000 mm.

Darley Electro-hydraulic Guillotine Shearing Machine

Maximum plate thickness 15 mm.
Length of blades 2,550 mm.
15 strokes per minute.

"Steco" Horizontal Electric Plate Bending Machine

3-roll pyramid type.
Maximum plate thickness 16 mm.
Width of rolls 2·5 metres.
Minimum radius of rolled cylinder 9 in.

Electro-hydraulic Punching and Notching Machines (two)

Maker: Darley.
Maximum capacity 120 tons.

Electro-hydraulic Bending Machine

Maker: Gorter.
Maximum capacity 120 tons.

Moes Column Drilling Machine

Rapfort Circular Sawing Machine

Bakker Horizontal Punching Machine

"Bewo" Hack Sawing Machine

Double Grinding Machine

Welding Equipment

A.C./D.C.	Automatic tractor welding plants (submerged arc) by Lincoln.
A.C.	Welding plants by Varios.
A.C.	Tack-welding plants by Varios.
D.C.	Welding plants by Siemens, Vickers, Quasi-Arc and Miller.

4. Woodworkers' Shop

Incorporating:—
Paintshop.
Polishing shop.
Timber stores.
Paint stores.
Offices.

A comprehensive range of new machinery is fitted, and the design and equipment of the shop is in line with the most advanced practice in Europe.

All woodworking machines are coupled direct to a dust-extraction plant, which returns heated air from the disposal furnaces to all parts of the building. The same plant is utilized for air conditioning and filtering in the polishing shop.

DISCUSSION

Mr. J. M. Murray, M.B.E., B.Sc. (*Vice-President*): This is a very important paper and one which is bound to arouse great interest in the shipbuilding industry. At the Spring Meetings of the Institution Mr. James Lenaghan read a paper from which it emerged that the traditional idea of shipbuilding as a craftsmanship industry was passing and that the shipyard of the future must be operated on a production line system. Many of us who have spent our professional careers in traditional shipbuilding may find it hard to accept this concept, but it is important that the change should be recognized.

The Verolme establishment at Rushbrooke has been planned in the modern idiom and the success of the venture is perhaps in the main due to the adoption of Nos. 2 and 7 of the concepts noted on page 93—rational working agreements with trade unions and the lack of precedent.

In general, the layout at the Rushbrooke yard is similar to the Verolme Alblasserdam yard in that the ships are built on slipways in the traditional fashion. On the other hand, at the same concern's yard at Botlek wet basins are used. It is axiomatic, I think, that the traditional method is the more economical for small ships and the wet basin better for very large ships. Since this yard is capable of building ships up to 55,000 tons deadweight it would be interesting to know where the line is drawn between two systems and Mr. Martin's remarks on this subject would be appreciated.

Turning to a rather different matter, it is mentioned that a scrap allowance at the Rushbrooke yard varied from 7 to 8 per cent. I find that when inquiries are made from various shipyards this figure is almost universally quoted and has been for a very long time. I would be interested to know, therefore, how this scrap allowance is determined for it is a very difficult matter to be precise.

It is very encouraging to receive from Mr. Martin an acknowledgment of the help given by Lloyd's Register in this venture. Because of the very large area covered by the operations of Lloyd's Register it is inevitable that there should be complaints occasionally. These are few, but it is very pleasant to have them offset by tributes of the kind which Mr. Martin has given.

Mr. W. R. Mellanby (*Member*): The author is to be congratulated for producing such an interesting paper, dealing with historical, practical and, an unusual subject, labour relations.

The section on planning describes how the shipyards in Holland prepare all drawings, for steelwork, and outfit for the Cork Dockyard, also how all the mould loft work is done in the optical drawing offices in Alblasserdam and Rozenburg and the projection negatives forwarded to all the Verolme yards. This appears to be a very economical method and one wonders why the yards should wish to take over this work. A joint central technical, drawing and optical drawing office is one of the main advantages gained in a consortium of shipyards.

Could the author explain why the various Verolme yards may gradually take over this work? Are there some difficulties arising which outweigh the apparent economic advantages?

The author refers to production planning but gives no details. This subject is of great importance and one feels that the success of Rushbrooke owes a great deal to careful planning. Could he give some information about the extent and implementation of the planning system? i.e. are job cards issued to the workmen detailing the work per unit?

The author describes the use of optical plate marking and I agree with him on the advantages of the system, but although a parallel system of plate production is mentioned, one must express surprise that a new up-to-date shipyard has not installed one of the various automatic cutting machines which are so much more economic. The following table of manhours from our most recent ship will make this point clear and be of interest to the author.

COMPARISON OF OPTICAL MARKING AND AUTOMATIC METHODS
Ship No. 371. 3,500 gross steel tons

LBP 476 ft. 6 in. Bm 66 ft. 0 in. D. Up. Dk. 41 ft. C_b 0·705

Optical Marking

	No. of Plates	Platers	Labourers	Feet Cut
	625	172	625	34,175
(1) Total	625	797		34,175

Flame Cutting Machine

	No. of Plates	Burners	Labourers	Feet Cut
(2) Marked plates ..	625	1,030		34,175
(3) Paralleled plates ..	125	357		12,005
(4) Total	750	1,387	Nil	46,180

Automatic Machines

	No. of plates	Platers	Burners	Feet cut
(5) From drawings ..	631	543	540	72,500
(6) Paralleled plates ..	515	226	220	30,064
(7) Total	1,146	1,529		102,564

The above figures will be of use to the author, but for the purpose of this discussion the economics can be considered by comparing the cost, in manhours, for feet cut by the two methods, thus:

For optical marking and cutting:

(1) + (2) 797 + 1,030 = 1,827 manhours required to mark and cut 34,175 ft. of plate.

and by automatic flame cutting:

(5) 543 + 540 = 1,083 manhours required to mark and cut 72,500 ft. of plate.

It can be seen that automatic plate cutting is a more economic method of producing plates. The cost of preparing drawings 1 : 10 scale and negatives for both methods is exactly equal compared on a length of cut basis.

On the subject of scrap the author states Rushbrooke percentage as 7 to 8 per cent. I suggest that these are remarkably good figures and ask the question, could the author give details similar to the following table, which gives a scrap percentage of 9·74 for 1961?

MILD STEEL SCRAP: PLATING DEPARTMENT ONLY.

	1959		1960		1961	
Gross steel issued to Plating Department	14,288 tons		11,822 tons		15,893 tons	
	Tons	Percentage of S.W.	Tons	Percentage of S.W.	Tons	Percentage of S.W.
Gross scrap produced	1,908	13·36	1,438	12·16	1,690	10·64
Less offcuts used in production.. ..	104	0·73	168	1·42	114	0·72
	1,804	12·63	1,270	10·74	1,576	9·92
Less scrap used in yard re-manufacture of smithwork and plumbers' flanges	27	0·19	22	0·19	28	0·18
Scrap sold	1,777	12·44	1,248	10·55	1,548	9·74

It is not claimed that the 1 : 10 scale loft work is the reason for the reduction in scrap in the years 1959, 1960, and 1961, but since the system was introduced in 1958 it has contributed a good deal, e.g. one is more concerned with plate ordered sizes, grouping of parts, and the reduction in the total number of plates ordered. An example of this is comparing two ships of exactly the same hull. The vessel built before introducing 1 : 10 scale work had 2,499 plates, the vessel built in 1962, using the 1 : 10 system, has 1,950 plates, a reduction of 549 plates.

The author does not mention shotblasting, or shop priming of steel before fabrication and it is my opinion that all modern shipyards should do both. It is also my opinion, which is not shared by everyone, that steel should be prime painted immediately after shotblasting, thus preventing corrosion starting.

There are many advantages to the shipbuilder as well as to the shipowner by building with clean non-rusting steel. I dealt with the economics of this in a paper given to The Institution of Mechanical Engineers in May 1962.

Mr. J. Lenaghan, C.B.E. (*Vice-President*): I knew this site very well before its development into a modern shipyard and those concerned with the planning and all the work that has followed are to be congratulated.

To construct a shipyard from scratch on a new site is a shipbuilder's dream, but to do so in a district without any real industrial background, where the labour is substantially rural and more familiar with farming and fishing, is a major undertaking deserving of the success this paper clearly shows to have been achieved.

The new Kaiser shipyards constructed in the U.S.A. in 1941 had the same manning problem as this shipyard and the procedure followed was similar, the employment of trainee labour instructed by experienced skilled craftsmen whose efforts were supplemented by book study which comprised text and sketches of practical details fully and simply described. This trainee experience should be helpful in preparing the pattern of apprenticeship training; five years is too long for such training if it is to combine technical school training with a sound practical training in the works, and if the early entries are from specially selected applicants, then a firm basis for good craftsmanship will have been laid out of which the new company in time should be able to provide its own nationals as the key personnel—foremen and supervisors.

The importance of good labour relations has been accepted from the outset and no doubt the excellent progress made since the real task of building ships commenced owes much to this approach. Three trade unions represent the correct division of labour in shipyards and if there is flexibility in the movement of the labour within each union productivity should be high and a more stable total labour force should follow.

The drawing office work appears to be centralized in Holland for the network of Verolme shipyards throughout the world. The reasons for this are apparent, but apart from staffing advantages, etc., it would be interesting to hear if a central drawing office implies that the Verolme organization supports the ideal to have a greater degree of standardization in the design and building of ships.

The steel scrap factor is stated to be 7 per cent. This is a low figure suggesting that the steel is either ordered net or that better use is made of the material with less going to waste.

When this yard was being planned it was stated in the early press report that provision would be made so that vessels of the largest size could be constructed. Would the author state if at any stage in the planning of the yard building docks as opposed to conventional slipways were considered. Capital cost and haste to get the shipyard into production no doubt had some influence, but taking the long term view would a large building dock not have had advantages?

This paper is an excellent introduction to the visit the members present are to pay to this new shipyard on the River Lee. It may appear to be a busman's holiday to some, but the surroundings in the vicinity of the shipyard (Fig. 4) suggests that even to work there could be almost a holiday.

Mr. J. D. Calder, O.B.E. (*Member*): I do not propose to say much about the vexed question of scrap, but I did glance at my friend John Tyrrell when the Cork shipbuilders talked about 7–8 per cent. I think some of us would be very glad to get down to twice 7 per cent. I refer, of course, to timber.

I would like to speak on the part of the paper which deals with the training programme. I am sure that Mr. Martin could amplify some of the details with great advantage to everybody.

There has been reference to the trade unions. As you know, on the other side of St. George's Channel we occasionally have slight differences of opinion with the unions. But having been connected for quite a long time with the problems of technical education I must say that in all the meetings we have had with the unions on this particular subject I have never known—to use a Parliamentary expression—a division on party lines. If there is one subject in industry on which there is full co-operation from the unions it is when we try to tackle the problem of training and technical education.

The training here is divided into two parts. A small number of young people serve an apprenticeship for five years, and trainees are trained for three years. Have you considered shortening the apprenticeship period? We feel that, with the longer school attendance and the existence of pre-apprentice training schemes, it seems unreasonable that apprentices should serve for five years. The unions are further ahead than the employers on this matter. I would like to see the period to be reduced to four years.

About trainees spending two or three half-days per week on four separate courses, it would be interesting to know what is the aggregate number of hours spent in each course.

I find that the manual, in four volumes, which deals with construction is on the loose-leaf system and that the students can take the loose leaves away. This is a very good idea and might well be followed in some of our Institutions.

Then the author referred to attendance at local technical schools, in addition to the yard training. What system of general supervision exists? Obviously the problem of controlling attendance does not arise, because either a boy is there or he is not. But in my own industry there is often a bonus for attendance or for a given number of marks. Is there any such system of incentives in Cork to encourage students who want to study?

At times I feel we are inclined to neglect the people who constitute the non-commissioned and lower commissioned ranks in industry, and I think we should concentrate on them.

Mr. R. C. Du Cane (*Associate-Member*): The author mentions the use of optical marking. Advances have been made in the last few years in the techniques of plate cutting by means of machines working either directly from the 1/100 scale negatives or from 1/10 scale drawings. Could the author say whether these methods were considered at the time the yard was being rebuilt and, if so, why they are not used?

Secondly, it would be interesting to know whether plate marking by the optical method and the subsequent hand burning of the plates, which is rendered necessary by this process, was selected for special reasons, perhaps connected with labour problems.

Thirdly, in view of the high cost of optical marking projection equipment, the space that it occupies in the plate shop, the need for the construction of a tower, its installation, the need for conveyors in and out of the marking room and the fact that the operation has to be carried out in darkness, one might suggest that for the forming of frames only the cost of a full size scrieve board would be of comparatively little consequence, for this could be prepared quickly from the 1/10 scale offsets. I doubt very much whether the yard could build sufficient ships over 20 years to recoup the cost of this installation. On frame bending alone such a full-scale body plan would also be of assistance in the making of moulds for shell plates. For vessels with a high proportion of parallel body, such as oil tankers, the optical method would seem to involve repetitive marking of many identical components. Machines are now available which will cut out four plates simultaneously, two port side and two starboard side.

Would the author say whether the use of drydocks instead of building slips was considered? This method of building would appear to offer certain advantages. For instance, the absence of declivity must facilitate construction very much from the point of view that everything is at right angles to a level base. Launching costs must be less, staging and access are simpler, and gantry cranes can be used to transport the prefabricated sections from the fabrication shop without transfer of the load to another crane, lowering them straight on to the building blocks. Further, it must be quite easy to provide portable roofing to such a building dock in such a manner that the roofing can be rolled along as required by progress.

The author states that plates have to be stacked horizontally in a carefully predetermined order, so that production is not held up. Has the use of standard size plates been considered? This would obviate a good deal of sorting, for it is necessary only to stack plates in accordance with their thickness. The preparation of plate cutting diagrams in the drawing office enables such plates to be used with the minimum of scrap. Much time can be saved by stacking minimum quantities of standard plates and re-ordering from time to time as stocks diminish, rather than having to wait for a special steel order to be prepared by the drawing office.

It would be interesting to know what is the proportion of supervisory staff to direct labour, i.e. the number of foremen and charge hands relative to the number of men employed on production. One might expect this to be very much greater than is usual in United Kingdom shipyards, because of the type of planning described by the author. Do the benefits of higher supervision outweigh its costs?

I was unable to find any mention of fitting out facilities. There may be three ships under construction, and three ships being fitted out. The workshops associated with fitting out appear to be scattered over a wide area. A very large proportion of the cost of building a vessel is represented by the fitting out; in fact the shipbuilder has under his control only a very small percentage of the total cost of the ship. It is important to avoid long travelling distances between vessel and workshops or stores when a ship is in the fitting-out berth. For instance, in Fig. 4, a general view of the dockyard, the painters' store is at the opposite end of the yard from the position where ships are fitting out.

The President (Viscount Simon): I think I detected in the comments of one or two of those interested in shipbuilding in the United Kingdom a tone of envy in regard to labour! I am sure we all wish to offer congratulations to the author on the position that has been achieved, because I do not think that Irish labour is notoriouly more amenable than labour in other parts.

Written Discussion

Mr. M. H. Chambers, B.Sc. (*Member*): A large amount of information is given about the equipment of the yard, but as one of those who was not able to visit Rushbrooke, I trust I will be forgiven for asking one or two questions to make the picture quite clear on certain points.

The location of the stockyard appears to be a little remote from the shop, thus necessitating a fairly long conveyor. Would the author please give the reasons for the chosen location.

Are the plate levellers and the roller conveyor in the open? If so, does this not cause a slowing down of the optical marking process in wet weather or is there a temporary marshalling area inside the shed? Is shotblasting and priming of plates and sections envisaged?

All equipment and layout particulars given in the paper are metric, and it is stated that all steel work drawings have been prepared in Holland. Am I right, therefore, in assuming that all dimensions on working drawings and measuring in the yard are in the metric system? If so, are there any points of interest arising out of teaching men who are used to measuring in inches, to measure in centimetres?

In the main fabricating shed, are the cranes running at one or two levels? Are the two-ton electric overhead trolley cranes mentioned in the Appendix of the radial wall crane type?

Author's Reply

Mr. Murray, Mr. Lenaghan and Mr. Du Cane all raised the question of building in drydocks as opposed to the traditional slipways. The use of building docks is a relatively new concept and has come about as a result of the rapid increase in size of tankers in particular, and in some cases (especially in the U.S.A.) of certain types of warship. It is difficult to generalize on where the line should economically be drawn between building-docks and slipways, as this may be a function of local conditions such as confined waters for launching, geological structure, and whether or not the yard concerned undertake ship repairs and thus wish to consider a dual-purpose design of graving dock. The latter consideration was an important one when planning the Rushbrooke yard, because the existing repair dock has a deadweight limit of about 17,000 tons, and current proposals for a second drydock tend towards accommodating bigger ships for repairs rather than for new building. It was hoped to secure orders during the dockyard's first three or four years for the type of tonnage which would in any case be more economically constructed on slipways, and later on to consider the design of a new drydock in conjunction with the comparative demand for additional new building and ship repairing facilities respectively. The advantages offered by building in drydocks, as enumerated by Mr. Du Cane, are certainly attractive and go a long way towards offsetting the high capital investment involved. In common with any other expensive piece of equipment, the higher the capital cost the more important it is that it should be operated constantly on "full load". During the war we saw the era of the 12–15,000 ton deadweight tanker, ten years ago 18,000 tonners were built in very large numbers, then 32,000 tonners became a "class". Today we have a variety of more or less standard sizes, with deadweight capacities running into six figures, which are doubtless yielding valuable service information in respect of operative economy from which may well emerge a stabilized era of, say, 85,000 tons deadweight tankers. The author suggests that the dimensions of building docks should be based on such probable trends, where all other considerations are equal; this opinion being given with the proviso that slipways exceeding 800 feet in length are not likely to be built in the future.

Several contributors to the discussion commented on the scrap allowance at Rushbrooke, and Mr. Mellanby provided some interesting figures from his own yard. Since preparing the paper, the first ship to be built at Rushbrooke has been completed and scrap sold was, in fact, slightly more than 10 per cent of steel fitted. The figures given by Mr. Mellanby indicate very close control of scrap, and similar monitoring methods which have since been investigated at Rushbrooke show that during the construction of a 730-foot bulk carrier the scrap figure is more in line with the estimate given in the paper, being the percentage which is usual in the Verolme yards in Holland. It is, however, suggested that scrap ratios are loosely related to block coefficient and a good figure for a full ship with long parallel mid-body should not necessarily be taken as the yard average.

Mr. Mellanby commented on the economic advantages of centralized technical services for a consortium of shipyards, and queried the author's remarks on decentralization. If a consortium of yards was situated in one shipbuilding locality, there can be little doubt that the benefits discussed by Mr. Mellanby

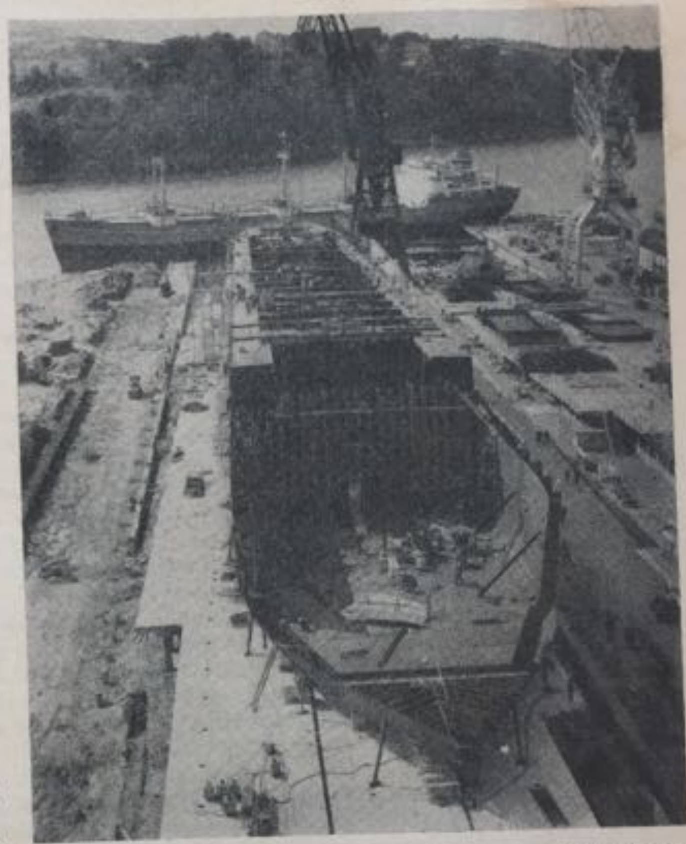


FIG. 6.—THE FIRST AND SECOND SHIPS TO BE BUILT AT RUSHBROOKE

would obtain with no difficulty. Without losing sight of the theoretical advantages of centralization, however, the author will attempt to show that circumstances can exist under which such a system may begin to lose its value, and we then watch for the point at which a degree of independence becomes economic.

Accepting that the three Verolme yards in Holland—grouped fairly closely together—are able to derive the full advantage of centralized technical services, we then turn to the establishments in other lands. We are immediately faced with the delays and expense of communication. Even in the Irish yard it may take a total of eight days to receive Holland's reply to a letter, a roll of tracings may be held up for a fortnight, and a telex or telephone call settling an urgent query costs nearly five shillings per minute. Extrapolate this argument across the Atlantic to Brazil and the problem becomes formidable. The drawings and other technical data issued by the Dutch yards can only be described as excellent, but queries do arise and the total daily bulk of signals is considerable. From the point of view of owners, classification societies and other parties concerned, the situation is frequently confusing, demanding much duplication of correspondence—to Holland and to the yard where the ship in question is being built. Faulty liaison leads to costly delays and occasionally to actual modifications.

In addition to these considerations, the current shortage of draughtsmen and other technical staff is so acute in Holland that many yards there are subcontracting drawing work to firms who exist entirely for that purpose.

In addition, the Verolme yards in Holland have to produce plans in languages other than Dutch, and while this clearly presents only a minor problem as far as English is concerned, the application of Spanish or Norwegian is a different matter.

When starting the yards overseas, therefore, initial centralization was adopted (*a*) out of necessity, because local facilities did not exist, and (*b*) in deference to its inherent advantages, but recognizing the possible need later on to modify the system to provide the most efficient procedure. The formulation of policy in this respect is not yet complete and it is likely that a compromise will ultimately be reached.

The question of central technical offices has been answered in the content of Mr. Mellanby's remarks, but Mr. Lenaghan asked whether Verolme centralization implied an advanced degree of standardization in the design and building of ships. However much the naval architect or the shipowner may deplore assembly-line methods or a standard product—preferring individuality and the opportunity to exercise his diversity or ingenuity—the fact remains, and its stature grows, that a pair of similar ships costs far less than double the price of one, and we must today look to standardization of design, as well as of construction, as one more means of getting our prices down. If shipowners could be persuaded to combine and come forward in pairs for their new ships, we would possibly be in a better position to offer prices acceptable to both sides of the market! Any hint of decentralization would not be permitted to interfere with the principle of economic standardization.

Mr. Mellanby and Mr. Du Cane made very interesting observations on automatic cutting equipment and asked why the new yard was not planned to utilize this system in addition to optical marking. The new yard in Ireland was equipped virtually as a replica of the Verolme yards established in Holland since the war, and staffed with management and foremen largely drawn from those yards. Before new equipment is standardized throughout the concern it is thoroughly evaluated in Rotterdam, and automatic cutting gear working from a revised draughting system clearly represents a case where standardization is essential throughout all the yards which use a central optical drawing office. The author is sure that the valuable figures provided by Mr. Mellanby will lend weight to the investigation of new standard capital plant which is at present being considered in Holland, but at the same time doubts whether it is economic for one member of a consortium to depart from the standards adopted by it.

Both Mr. Mellanby and Mr. Chambers raised the matter of blasting and priming of steel. In the Verolme yards in Holland, shotblasting of plates is carried out between the flattening rolls and the optical marking tower, and similar facilities are definitely contemplated at Rushbrooke. The roller conveyor has been designed with one short section in its length, which will be removed when the blasting gear is installed. The use of sharp sand is not prohibited in Ireland, and it is used at Rushbrooke in conjunction with portable equipment for sandblasting underwater surfaces or other areas where such treatment is specified. The author shares Mr. Mellanby's opinion that blasting should be followed immediately by priming, to preclude the very type of weather attack which we would otherwise favour as a means of freeing millscale. Some Japanese yards even shotblast and prime-coat all material immediately it enters the yard, so that it can be taken in for marking direct, without the risk of bottlenecks building up at the blasting and priming plant. Provided the fresh primer dries quickly enough to permit almost immediate marking, contains pigment to yield a clear image in the optical tower, and is non-toxic when disturbed by hot work, it probably is preferable to blast and prime as the material moves into the shop, thus taking advantage of pre-weathering in the stockyard and easier removal of scale.

Mr. Calder's experience of industrial education made his remarks on the subject of training of particular value. He pertinently hints that we are all apt to allow our training obligations to become eclipsed by the more immediate day-to-day problems of shipbuilding. It is encouraging to find that trade unions on both sides of the Irish Sea are ready to remind us such responsibility in a spirit of full co-operation.

It was interesting that both Mr. Calder and Mr. Lenaghan, as British shipbuilders, regard five years as an unnecessarily long period of apprenticeship. The training system at Rushbrooke was devised specifically for the three-year trainees rather than for the five-year apprentices, of which there are comparatively few. It is suggested that general adoption of the "three-year plan" will ultimately depend upon:—

(1) Full advantage being taken of the higher school leaving age, with qualified industrial advisers visiting schools to guide and pre-select the prospective "new entry" and to suggest suitable technical pre-training courses after leaving or even during the final year at school.

(2) Part-time education at night-school, day-school or shipyard training-school being stipulated by the employer as a condition of employment throughout the three years. The trainee should, by regular attendance and hard work, be enabled to recover expenses and earn incentive bonuses from his employer.

(3) The employer reserving the right to carry out post-training aptitude tests on his tradesmens' work. In the U.S.A. welders are required to pass tests every six months after qualifying, under the supervision of the American Bureau of Shipping, and there is no doubt that this system is producing good results.

If we expect today's trainees to reach the same level of competence in three years as his father did in five, it is clearly necessary to teach him his job and not to use him as cheap labour.

Mr. Calder asked for an idea of the aggregate number of hours spent in each of the four courses in the Dockyard training school. The scheme has not yet been in operation for long enough to answer exactly, but present indications are that an average trainee should complete the three general courses in 18–24 months. He would then move on to a specialized section of a tradesman's course for a further year. These periods are based on eight hours' attendance per week.

The internal training school is confined to shipbuilding, because no facilities exist at neighbouring technical schools for studying any form of naval architecture or practical ship construction. Trainee electricians and fitters attend public technical schools in Cork and Cobh: in cases where classes sit during dockyard working hours, trainees are paid against an instructor's signature certifying attendance. Payment of expenses and bonuses, and imposition of penalties are reviewed in conjunction with each trainee's record.

Mr. Du Cane inquired whether the use of standard-size plates was considered. Plates for the Rushbrooke yard—except stock material for repairs—are ordered by the Dutch yards, and only the conventional specific ordering method has been employed there. However, standard-sized plates have much to commend them, particularly for yards in countries which do not produce shipbuilding steel. Our material arrives in batches which usually represent full cargoes for coasters from Britain or the Continent, and it is virtually impossible, and certainly uneconomic, to import quickly a small number of plates urgently needed for an emergency repair job. At present we obviate the need for small-lot imports by keeping a large tonnage of stock material in hand, which is what Mr. Du Cane feels might be extended to new building as well as repairs—to build entirely "from stock". This method works very satisfactorily in several Japanese yards and the advantages are manifest, but the following points should also be raised, not as objections, but as possible sources of danger:—

(1) Drastic revision of drawing-office procedure and careful liaison with the shop to ensure economic use of material.

(2) Stocking plates covering a sufficient range of thicknesses, to avoid the danger of having to fit material "above rule" where the correct thickness is out of stock.

(3) Storing plates on edge rather than horizontally (and thus having to abandon magnetic cranes) so that material is kept in rotation. Horizontal stacking would inevitably lead to plates at the bottom of the pile never being used, and ultimately deteriorating.

It appears that two reforms beyond the control of the shipbuilder could eventually make the standard-size method of ordering extremely economic:—

(*a*) A new approach by the Classification Societies aimed at reducing the great number of plate thicknesses used in shipbuilding, by adopting a minimum thickness difference of 0·02 in. (or 0·5 mm.?).

(*b*) Greater cost incentive on the part of the steel mills for the shipbuilder to purchase substantial quantities of large standard plates. Modest incentives are already offered in respect of size, weight and multiple orders, but it is felt that co-operation between the shipbuilder and the mill could lead to considerable economies being effected in the future.

Mr. Du Cane asked about the ratio of supervisory personnel to direct labour. The figures (Autumn, 1962) are as follows, assessed per 100 men engaged on production:—

Foremen (14 per cent Irish, 86 per cent Dutch) ..	3·6
Assistant Foremen (100 per cent Irish)	0·9
Chargehands (100 per cent Irish)	0·8
Leading Hands (100 per cent Irish)	2·5
Total	7·8

The above figures do not include a number of outside managerial staff, and are indeed higher than would be regarded as usual in British shipyards, but more as a result of inexperienced labour than because of the type of planning used. They are also higher than in the Verolme yards in Holland, who use the same system of planning; equality with the Dutch yards in this respect should be attained in time.

With an inexperienced labour force abundant supervision is vital, and pays for itself repeatedly. It will naturally be reduced gradually, but must always keep a lead over the current mean level of competence.

The final point raised by Mr. Du Cane concerned fitting-out facilities at Rushbrooke. The outfitting berth seen in Fig. 5 is temporary and unsuitable, and we propose to construct a new jetty some 1,200 ft. long, bordering on the south side of the yard, necessitating further reclamation to provide a straight shoreline running in a north-westerly direction from the stockyard. On the newly reclaimed ground will be built the new engine shop and pipe-fitting shop, both of which will be situated midway between the building berths and the fitting-out quay. As Mr. Du Cane pointed out, it was not possible to site all shops which house finishing-trades in optimum positions, but due regard also had to be taken of ship-repair work, naturally centred on the drydock which is unhappily at the other end of the yard. A number of small shops or stores may be necessary on the outfitting jetty, to provide buffer storage for materials awaiting shipment, but duplication of facilities will obviously be minimized.

One of the principal items on the fitting-out quay is cranage. At present, ships are necessarily launched with their main engines, or at least the heavier sections of them, already fitted, and there is little reason to discontinue this practice. If units weighing up to 80 tons can be lifted aboard before launching, it would appear uneconomic to provide cranage for similar lifts after launching, particularly as such cranage would have an extremely low rate of utilization. Even 10- or 12-ton cranes will operate under a low mean loading-factor at the fitting-out quay, and sundry small loads may be handled with light ship-borne elevators or shipside lifts.

Mr. Chambers queried the location of the steel stockyard in relation to the optical-marking tower and shipbuilding shop. To facilitate a rapid rate of discharge from coasters alongside the jetty it was decided to arrange the material stockyard as close as possible to the jetty. Material can thus be stacked direct without intermediate sorting. Also the area lying between the western end of the stockyard and the shipbuilding shop has been reserved for a new engine shop, which will extend up to the section railway. The space available for this development would have been limited had the stockyard been placed closer to the shop.

The plate flattening rolls are under cover but the roller conveyor is not. Nor, of course, are the plates in the stockyard. Mr. Chambers rightly suggests that optical marking is retarded in wet weather. Until recently plates were brushed as they travelled towards the tower in good weather, but had to be both brushed and dried actually on the marking tables when it was raining. A covered "brush-and-dry" bay adjacent to the optical marking tower has now been built to overcome these delays.

Mr. Chambers raises an interesting point in connection with the metric system of measurement. The entire establishment uses metric measurement, and the Irish trainees who went to the various Verolme yards in Holland expressed relief when they were told that it would not be necessary to revert to feet and inches when they returned to the Cork yard!

The yard started off with the metric system, and the men have rapidly adjusted themselves to it in much the same way as they have become acclimatized to various other working conditions of an industry in which they have had no previous experience.

In the main (northern section) of the shipbuilding shop the cranes run at two different levels. At the "plate-entry" end of this section, where loads are relatively light, the roof is lower than at the west end, and the floor is covered by low-level gantries only, although these can operate over the entire length of the shop. High-level gantries (40-ton) operate only in the western half of the main shipbuilding shop. The southern section of the shop is low-roofed throughout, and is covered by three pairs of rails, running the entire length of the shop. These carry twelve travelling beams in all, which in turn support the overhead electric trolley hoists. Two-ton loads can therefore be covered at any point on the floor.

One further point, not raised during the discussion but put to the author afterwards, concerned the reason for fitting a watertight gate at the foot of the building berths. This is becoming general practice on the Continent, but not yet in Britain or the U.S.A. The declivity of the berth and the positioning of the ship on it is generally such that without a gate the berth would be immersed up to about No. 1 or 1½ section at normal high water, and the gate thus enables work to proceed at the after end at all states of the tide. The gangway across the top of the gate provides access across the berth without walking under the ship—or indeed right round the fore end once the launching ways are in position. Particularly in the case of concrete slipways, a water-tight gate enables the berth to be kept free from debris right down to the sill. It should also be mentioned that the after end of the ship and launching gear are afforded protection by the gate, particularly when spring tides and heavy weather coincide at shipyards located in exposed positions.

Finally, the author wishes to thank all those who contributed to the discussion. As always, their constructive comments have added to the value of the paper, and have also greatly assisted our sense of development at Rushbrooke.

Printed in Great Britain by Photolitho
UNWIN BROTHERS LIMITED, WOKING AND LONDON