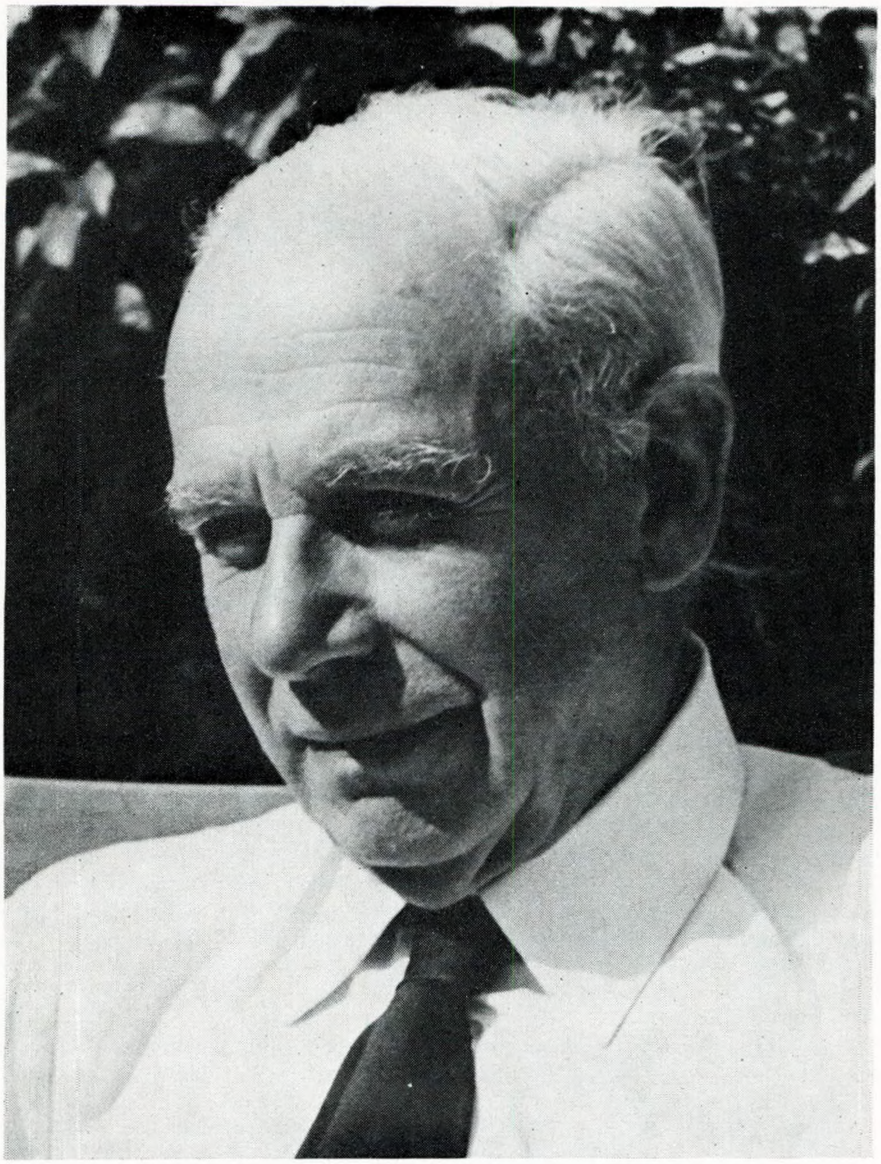

D. H. Alexander, O.B.E., F.C.G.I., WH.SCH., M.Sc., C.Eng., F.I.Mar.E.

D. H. ALEXANDER, O.B.E., F.C.G.I., WH.SCH., M.Sc., C.Eng., F.I.Mar.E.

After attending the Belfast Model School and the Technical High School D. H. Alexander served his apprenticeship as a fitter and draughtsman in the Engine Works of Messrs. Harland & Wolff Ltd. During his last year he was awarded a Lloyd's Register Scholarship by the Institute of Marine Engineers which he joined as a Graduate in November, 1922. He entered Imperial College London in 1922 and in 1925 was awarded the ACGI and BSc (1st Class Hons.) As the holder of a Senior Whitworth Scholarship he then entered Trinity College, Cambridge and obtained the MSc in 1927. With the aid of a Robert Blair Fellowship from the LCC Mr. Alexander studied at Harvard University, USA from which he obtained the degree of SM in 1928.

On his return from America Mr. Alexander became a Member of the Institute and was appointed as an assistant Engine Works Manager at Harland & Wolff Ltd. After a short period at the Manchester College of Technology he served as Head of the Department of Civil and Mechanical Engineering at Sunderland Technical College and in 1935 became Principal of the Belfast College of Technology, a position he held until his retirement in July, 1967. He was awarded the OBE (Civil) in 1947 and later the honorary distinction of FCGI.

Mr. Alexander became a member of the Northern Ireland Panel in 1955 and its Chairman in 1963. In April, 1961 he was elected an Institute Local Vice-President for Belfast. When the Northern Ireland Branch of the Institute was formed he became the first Chairman and served on the Institute's Education and training Committee in 1966, becoming its Chairman in 1969. He was elected to the Institute's Council in 1970 as a Vice-President and has served on Council as such since.

Mr. Alexander was the Institute's representative on the CEI Education and training Committee from 1968 to 1973 and on its successor Standing Committee "A" Qualifications and Registration (Chartered Engineer Section of ERB) from 1974 onwards. He was also Chairman of the Northern Ireland CEI Local Committee in 1969 and 1970.

Mr. Alexander was involved in many public duties in Northern Ireland. He was on the Committee of the country's largest hospital and was Chairman of its works Committee. He was the inaugural Chairman of the Northern Ireland Division of the National Housebuilding Council, a member of the Government Scientific Advisory Committee, and served on the Council of the Linen Industry Research Association. For thirty years he was a member of the Faculty of Applied Science and Technology of the Queen's University of Belfast.

PRESIDENTIAL ADDRESS

by

D. H. ALEXANDER, O.B.E., F.C.G.I., WH.SCH., M.Sc., C.Eng., F.I.Mar.E.

THE MAKING OF THE ENGINEER, THEN AND NOW

A presidential address sometimes consists of a first hand account of engineering work with which the author has been closely associated, and, as the president is often a man of much experience, a record of engineering problems and how they have been overcome is generally of great interest to his audience. I have not been engaged in engineering work of such a nature as would enable me to follow that example. However, my contacts with marine engineering have extended over a very long period, first in the manufacture of marine machinery and then in the education of the men who design, make and operate it. I have therefore chosen in this address to look at the changes which have taken place and are still taking place in the training of the marine engineer.

The industrial revolution had its origin in England and the enterprising blacksmiths and millwrights who were pressed into service to turn the dreams of the inventors into working machines of wood, iron and brass, quickly found the value of some elementary education in mathematics and science. To the early blacksmith it must have seemed to be magic when he found that the schoolmaster or village parson could tell him the length of iron needed to make a tyre for a wheel merely by measuring the diameter and not the circumference. I was later to find that same homage paid by a foreman to my slide rule as was paid by his predecessor to the Greek symbol "pi".

The great exhibition of 1851 led to the formation of the City and Guilds of London Institute and to the emergence of a national system of evening class education for apprentices in the mechanics' institutes and similar organisations. This system of adding technical education to craft skills reached its climax in the National and Higher National Certificate schemes. The co-operation of the technical colleges with the Ministry of Education and the guidance of the appropriate professional engineering institution enabled the apprentice to acquire the necessary technical education to turn the mechanic of today into the engineer of tomorrow. Until very recently men trained in this way contributed much to the development of the national engineering industry. The British engineer has long had his roots in the workshop and has added the necessary education to craft skill and industrial experience.

On the Continent, however, because of their later entry into the industrial field, engineers have been trained in a different way. Instead of entering industry straight from school the would-be engineer goes to college where he is taught the basic sciences and the manner of their application to engineering problems and then enters industry as a professional engineer to acquire experience in the application of his training. When Britain entered the EEC one of the rules to which we agreed was that professional men must be free to travel and to practise in all the subscribing countries. This called for a common standard of qualifications and it did not prove possible to convince the other countries that our part time courses for the Higher National Certificate, even with two or three endorsements, could be regarded as equivalent to those leading to a degree in engineering. Consequently, with the formation of the CEI, it was agreed that the professional engineering institutions should demand a degree standard from all their corporate members. Not all engineers are convinced that this was a wise decision.

We are becoming aware that it is not easy in this country to divide engineering workers into two distinct classes as is done on the Continent. The use of the term "technician engineer" is proof of that. It is in the field of marine engineering that the imposition of this somewhat artificial boundary presents the greatest problems. The adoption of the steam engine, and especially the boiler, for the purpose of marine propulsion soon showed that public safety demanded government action to ensure that the operator of the plant was properly qualified for the task. The first Board of Trade examinations for this purpose were held in 1863 and have been continuously revised and brought up to date to keep pace with engineering developments. Men qualified in this way have long enjoyed public acclaim, far outside the marine environment, as thoroughly competent all round engineers.

At the time of my apprenticeship it was the ambition of many of my workmates to be taken on as junior engineers and ultimately to earn a Chief Engineer's certificate. When a new ship was completed the superintendent engineer always liked to recruit a junior engineer from the engine builder's workers and he had the advice of the shop foreman in selecting the ablest of the many young applicants. At that time, a great deal of repair and maintenance work was carried out in the engine room workshop and sometimes the superintendent asked for a turner instead of a fitter, and on one occasion when one large ship was finished he asked for a brassfinisher because of his skill in soldering and brazing and in copper pipe work.

Most of these young men were successful in obtaining their certificates. The best of them had acquired a sound knowledge of engineering principles through attendance at evening classes during their apprenticeship. This they supplemented by reading at sea and then, after a surprisingly short spell with a crammer between voyages, they presented themselves for examination. The examinations were held in many ports and at short intervals which facilitated arrangements of this nature for all this preparation was carried out at the expense of the young engineer. It was not unknown for a fitter who was almost illiterate to go to sea as a junior engineer and by prolonged and diligent reading at sea, ultimately obtain his Chief Engineer's certificate. I still have my father's copy of Reid's handbook in which the first chapter teaches the aspiring engineer to write down numbers in units, tens and hundreds and then goes on to addition and subtraction and the more difficult arts of multiplication and division!

It should be noted that it was not necessary for the shipowner to make any provision for the training and education of his engineers. All the necessary practical training was obtained in the shops and fitting out berths of the engine builders and the young engineer was able to stand a watch immediately on going to sea. The chief engineer's certificate was a qualification much sought after ashore by manufacturing concerns and public bodies which operated steam boilers and many kinds of processing machinery.

The situation changed very quickly with the introduction of the National Certificate schemes in the Twenties. These courses were the most imaginative and successful educational advances made in the present century and made a massive contribution to British engineering progress. The acceptance of the Higher National Certificate with suitable endorsements as a qualification for Associate Membership of the Institutions of Mechanical and of Electrical Engineers proved to be a much more attractive goal for ambitious apprentices than was the acquisition of the Chief Engineer's Certificate. Associate Membership of these two and of the Institution of Civil Engineers (but not of The Institute of Marine Engineers) was officially regarded as the equivalent of an engineering degree and opened up the way to many public appointments and to higher official salary scales.

These developments had a pronounced effect on the quality of young men prepared to undergo the rigours of a sea going career to obtain a much prized certificate. They could now obtain this more highly valued award by part-time study ashore. Shipowners were compelled to institute a training programme to provide engine room personnel and the

Alternative Entry scheme was born. This later came to be known as the Cadet entry and its initial success was somewhat blunted by government education policy which opened up the way to the universities to very many young men who proved capable of satisfying their entrance requirements. This large and expansive investment in higher education did not benefit the engineering industry as much as might have been expected. Formerly, boys of ability and ambition sought skilled apprenticeships as being the most rewarding opportunity offered by the employment market. Now, on leaving school, they had complete freedom of choice from all the subjects offered in the university, and many elected for those less demanding than engineering or courses offering higher rewards. The marine engineering industry suffered more than other branches of engineering because, not only was the traditional apprenticeship entry curtailed, but the attraction of the cadetship diminished and the university graduate was not prepared to serve at sea when more attractive jobs were available in other forms of engineering. It might seem that entrance to the cadetship courses is confined to those school leavers who have not the qualities to earn university entrance or to those few who are prepared to forgo a university place offered to them because of their intense desire to pursue a sea going career. Whatever may be the cause it is proving difficult to get enough marine engineers with that degree of technical education necessary to earn chartered status in the engineering profession.

The CEI conducts examinations which determine the academic standard required from a chartered engineer. An engineering degree from a British university and from many foreign universities is accepted as equivalent. In addition candidates must produce evidence of satisfactory engineering training such as an apprenticeship and have been employed with some degree of engineering responsibility. Many young men in other engineering institutions are able to satisfy all those requirements at about the age of 25 or 26. Not many are able to enter The Institute of Marine Engineers in this way.

The qualifications required for marine engineers have always been exacting and sea service has been regarded as being very important. Mention has been made of the reluctance of graduates to submit to it and the cadetship scheme, having been specifically designed to meet the standard laid down by the Department of Trade for the award of certificates of competency, falls short of the requirements of CEI. As a result, the Chief Engineer, though trained well beyond its requirements, is classified as a Technician Engineer. The obvious way to remedy this would seem to be through the Extra First Class certificate which is the only award other than a university degree to give exemption from the CEI examination. However, the Extra First Class examination is surrounded by difficulties which even the very able find hard to surmount.

Compare the nature of the academic tests confronting the sea-going engineer aspiring to Chartered status through the Extra First Class Certificate, with those facing the entrant to one of the other engineering disciplines through the university degree course. The odds are so heavily weighted against the marine engineer that only a very brave man is prepared to make the great effort needed. The young mechanical, electrical or civil engineer goes straight from school to the university, there to continue in the same line of studies, taking examinations set by his own teachers until, at the age of 22, he emerges with a degree which satisfies completely the academic requirements of the CEI

By contrast, however, the sea-going engineer generally leaves school before reaching university entrance standard. He spends a number of years in study, in the workshop and in sea service and about the age of 26 finds himself with a Chief Engineer's Certificate and in the position to contemplate tackling the Extra First Class certificate examination. He now meets many obstacles; he is a highly skilled engineer and his employer finds difficulty in releasing him for a period of full time study. He is ill fitted to undertake a demanding course pitched at a high academic level, for his previous studies have been directed towards a technician engineer qualification. Being too short for the ground to be covered the courses available are very intensive and are followed by a difficult external examination. On top of all this he may be married and have taken on domestic responsibilities so he has to face a heavy financial burden.

If the marine engineering industry is to have the numbers of men qualified to become leaders in the profession then thought must be given to finding ways by which the young man who is fit and willing to work may be given the opportunity of completing his academic studies to degree standard at an early age as is done in other cases. Of course, academic distinction alone will not produce the successful engineer; he must possess judgement, have a knowledge of men and a feeling for the materials he uses. For these reasons and because of the long experience we have of the value of sea training, I think it is to the ranks of our sea-going engineers we should go when looking for our future leaders. It is of course possible to select these "leaders" straight from school and give them—and them alone—the academic and practical training to fit them for the task ahead. Bearing in mind however the importance of personal qualities I would much prefer to select young men from the ranks of the general entry who, over a period of two years, had indicated quite clearly to their tutors and to their employers that they possessed the qualities of brain, heart and hand and the willingness to work which would justify giving them the education necessary to fit them for future positions of responsibility.

Hitherto we have regarded the course for a university degree as starting from three "A" level school subjects on which the succeeding lectures would be based. Some students left school before reaching three "A" levels and had shown ability in pursuing engineering studies directed towards a technician engineer qualification. When it became obvious that they were suitable material for a degree course they were granted entry to the university but were obliged to turn back and prepare to join the school leavers.

From the large number of young men who annually embark on a sea-going career there are enough with the ability to justify the construction of a special university course which would enable them, after two years service, to embark on a four year sandwich course leading to a degree. Being already in the system and with the guidance of two years of monitored progress, suitable students should be readily identified. The entrance requirements of this course would not be three "A" levels but the possession of a good OND.

Having already covered much of the engineering content of the degree these men would have time in which to make good the mathematics and science in which they were deficient. The relevant lectures would be delivered in the context of the engineering subjects in which they would be applied and would be more effective than similar work done in a general manner at school. There is no reason why a young marine engineer, after a four year sandwich course of university study and sea service should not emerge at the age of 23 with a BSc in marine engineering. This degree would be accepted as covering the academic requirements of the Department of Trade for the award of the First Class and the Extra First Class Certificates. The actual certificates would be awarded when the remaining specialist requirements of the Department had been met.

I said earlier that it might seem that the cadetship scheme must recruit from the ranks of those who had not the ability to proceed to a degree. Many of course have that ability but because of their impatience with school or their desire to enter industry they left before they had the opportunity or the urge to demonstrate their quality. There are many reasons other than lack of ability which cause boys to have poor scholastic records at school and it is not unusual for indifference at school to be replaced by a desire to study when the objectives of the course are clearly revealed.

I have pointed out that the introduction of the National Certificate Schemes led to a drying up of the flow of able apprentices to the traditional entrance to sea service and to the subsequent adoption of the Cadetship scheme. This form of training would become necessary a little later for quite different reasons. Until a short time ago the traditional entrant to service in the engine room found that, with the possible exception of the generator and electrical distribution system, he had had experience of working with all the equipment under his control. Now, with the fitting of so much highly specialised control and other apparatus he would require some training of the type which can only be given in a cadet course.

To illustrate some of the factors which have conditioned our attitudes toward the training of the marine engineer I propose to show some slides of the very early development of the marine steam engine. These slides are of historic interest but from two of them in particular I hope to draw an important message.

Because of the low steam pressures the cylinders of Watt's early engines were of necessity large heavy castings and rested on the ground with the piston rod pointing upwards. To have the power delivered to the level required by most of its applications, Watt quite naturally used a rocking beam with a return connecting rod hanging downward. This arrangement was too high and top heavy for fitting in a ship and, to get the power from a cylinder resting on the tank top to the paddle shaft, levers on each side of the cylinder were used. The drive was taken from the crosshead yoke to those levers and up vertically by connecting rods to the paddle shaft. This became the standard drive for early paddle steamers and was fitted to many naval and merchant vessels.

Efforts were continually being made to obtain some form of direct drive and many ingenious devices were used but the distance between the tank top and the paddle wheel centre was too short to allow any one of them to displace the side lever engine. None of the designers—or manufacturers—seemed to be able to produce a reliable sliding crosshead guide for all used the so called "parallel motion" for this purpose. These straight line motions, for that is their proper title, were only approximations to a straight line for indeed it was not until the middle of the last century that a true straight line motion was invented. Curiosity prompted me to examine the performance of two forms of parallel motion fitted to ships' engines. The first was the traditional form used in side lever engines. The piston stroke was six feet and the crosshead pursued a path which moved about .072 inches from the straight line at about one quarter of the stroke from each end. The other was a design fitted to the Gorgon engine and the crosshead described an unsymmetrical path which in a stroke of three feet was .06 inches off the straight line at the outer end of the stroke.

As ships became larger, steam pressures higher and powers greater it became possible to get a direct drive to the paddle shaft by dispensing with the connecting rod and allowing the piston rod to act directly on the crank pin. This was done by mounting the cylinder on trunnions through which were led the steam and the exhaust as the cylinders oscillated to follow the movement of the crank pin so that the piston rod acted on it directly. Further rises in power and steam pressure and the complexities of double and triple expansion led the way to the final form for paddle drive which was the diagonal engine with a conventional sliding crosshead and connecting rod.

In contrast, with the wide variety of drives used to propel the early paddle steamers the advent of the screw propeller quickly found the steam engine attaining its final form which was "the inverted direct acting triple expansion steam engine". As an apprentice I was puzzled by the continual use of this expression in the press not realising that "inverted" meant "not like Watt's" and "direct acting" meant "not using side levers". The advances in the steam engine over a period of nearly one hundred years showed great improvements in its thermal efficiency. Because they operated with jet condensers, salt water feed and steam pressure of less than 20 pounds per square inch the early side lever engines used between four and five pounds of coal per indicated horsepower per hour. Fresh water feed, higher steam pressures and triple expansion brought this down to 1.4 pounds of coal per 1 h.p. per hour. Superheating, feed heating and improved vacuum techniques brought a further reduction to 1.15 pounds of coal and the use of an exhaust turbine enabled over 1 h.p. to be produced per hour for the consumption of about one pound of coal.

I have been given two examples of triple expansion steam engines built by the same firm on the NE coast and they illustrate my second reason for showing those slides. Though the building of these two engines was separated by a period of 60 years there is actually no difference in their mechanical design. During this long period companies were led to the belief that no special training was required for sea-going engineers and very little for the engine designers. The first learned enough during his apprenticeship to stand a watch immediately on going to sea in his first ship; the designer merely had to copy the work of his predecessor with minor improvements.

Even though we are now working in a new era we have not adjusted our sights to meet this fresh challenge. The training of the sea-going engineer is limited to that required to operate the machinery with which his ship is fitted and little effort is made to supply the industry with the man who should be able to survey the field of engineering progress and select for ship use the most suitable machinery available. It should not be assumed that more advanced training, if agreed upon, should be limited to a few men in senior positions ashore. It is a tribute to the quality of the men, and not to the suitability of their training that so many of our superintendents, and the chief engineers of some large modern vessels are able to perform their duties so well. In many cases they are working right up to the limit of their engineering education.

When considering the provision of advanced engineering education the policy should be to give the academic part, up to the age of 22 or 23, to those who show quite clearly that they have the necessary ability and then for each company to select for advancement those required for their own projected needs. Some people believe that the industry's requirements for men trained in this way is very small. However, in the larger vessels with sophisticated machinery the Chief Engineer should be something more than an engine driver. He should be regarded as an arm of company management afloat. Where ship propulsion is concerned board decisions should not be made by accountants inadequately briefed. The advice of the Chief Engineer should be very valuable, especially if his education contains some training in management so that he is able to evaluate the financial arguments which should influence his technical advice.

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