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LECTURE.

Friday, April 25, 1879.

ADMIRAL A. P. RYDER in the Chair.

BROADSIDE FIRE, AND A NAVAL WAR GAME.

By Captain P. H. COLOMB, R.N.

1. To Admiral Randolph belongs the honour, which, so far as I know, will be unchallenged, of being the only man in Europe who has distinctly faced a tactical problem in naval warfare. No doubt there are others, especially on the Continent, who have incidentally met and discussed various questions which present themselves the moment we leave the well-trodden path of vague generalities, and come to particular and definite facts. But it is to be observed of these authors—of whom Admiral Bourgois, of the French Navy, is an example—that their treatment of different points is only incidental and partial. If they treat of the gun as a weapon they will take up its accuracy, its penetrating effect, and perhaps its arc of training. If they take up the ram, they will show how it is governed by the curves described in turning. If they take the torpedo, they will speak of it almost as if there was no other weapon available, and certainly as if the enemy was passive. But Admiral Randolph has taken up all these points. He has assumed an active enemy replying to the attack to the best of his ability, and he has endeavoured to come to some *relative* conclusions on a single point—the best method of placing the guns on board an armoured ship.

2. I am sure the gallant Admiral would be the last to assert that he has finally disposed of the question. On the contrary, I feel confident that his wish in reading his papers was to stir us all up to further and closer investigation by the use of the methods he has put into our hands.

3. What are those methods? They are, first, the placing together and considering the relative tactical effects of *time* and *space*. Time, as it effects the covering of distances, either on a straight course, or in turning through given angles, and as it determines the rapidity of fire. Space, as it governs the approach or withdrawal of enemies' ships; as it bounds the possibility of ramming; as it interferes with the arc of

training of the guns, and the hits and penetration of the projectiles. Time and space together, sometimes in concert, sometimes in opposition, as they affect movement and gun-fire; naturally also torpedo fire, if we were yet in a condition to take up that subject.

4. Using Admiral Randolph's methods, and acknowledging very fully my obligations to him and to them, I propose to make one small advance in their application, and to see whether we shall be led to any further or different conclusions by this slight improvement.

5. Admiral Randolph assumed a space in turning and a time in turning for the two ships which played the part of examples. I propose now to substitute for these assumptions nearly the accurate results of an experiment. In the year 1877, the turning powers of Her Majesty's ship "Thunderer" were very carefully ascertained, and mapped out for several different speeds. There are niceties in the results which must hereafter come into play, but we are hardly ready for them yet. But in taking the broad results for two different speeds, and using them as Admiral Randolph used the assumed results, we are evidently on ground which is just the surer by as much as the data are nearer the truth. In any conclusions we may arrive at to-day, we may assure ourselves that in so far as they depend on turning powers at speed, they will be very nearly true for two ships similar to the "Thunderer" in smooth water. You will observe, therefore, that while we shall still, and necessarily, be dealing largely with assumptions which may be challenged as only remotely approaching the truth, we shall be resting a good deal on what cannot be challenged, except within very narrow limits. We shall get, I think, another illustration of an axiom on which I have for many years insisted, namely, that the differences of opinion which exist amongst us on the rights and wrongs of naval tactics, are removable in peace time by study and experiment. In fact everything which is going on in the naval world convinces me more and more of the growth of mechanism—if I may use the expression—in future sea-fights. We seem to be losing every day some page in that large chapter of accidents which made past sea-fights so romantic even in the dry pages of James. By consequence, we are approaching every day towards a system when the certainties are calculated beforehand, and when a ship or a fleet may mechanically and scientifically win, or be beaten, without touching, except in the persons of one or two leaders, on that splendid heritage of personal heroism which our naval forefathers bequeathed to us. It does not require any wide stretch of a humorous imagination to think, in these days of rams and torpedoes, of Officers and ships' companies in cork jackets standing by to swim for it as the fleets approach, but doing nothing else. For as, if you propose to sink the ship, the men in her are neither here nor there, you may come to an agreement to give up the destruction of life which would be the chief result of a "brutal" artillery fire, and simply play the game of ship-sinking until either side has had enough of it. Of course, in such coming times, we should have a properly organized "Blue-cross" society, whose business it would be to pick up the cork jackets which, with those in them, would be the

only *débris* of the fight. But this is by the way, and for our posterity to consider.

6. If I may venture to offer a criticism on Admiral Randolph's first paper, I may perhaps be allowed to say that I think he pushed his method too far on that occasion, and hoped to get more from it than it was quite capable of yielding in its then condition. Although we may, by the use of the Admiral's great powers, bring about a consensus of opinion on such a subject as the relative values of broadside or end-on fire, I think we should be continually reminding one another that this is not our object. It is quite possible that we may all—including the very ablest—think wrongly on such a question, and our object is to get at the actual facts quite apart from any opinions that we may hold. The effect on my mind on first reading the Admiral's paper was, that in supporting broadside fire as I had done, I had gone beyond the facts, and could not offer a sufficient defence to the Admiral's end-on attack. But when I began to analyse more closely, I could not help feeling that much of his apparent superiority was due to a skilful use of elements in the combat which he disallowed to his opponent. He appeared, for instance, to permit himself a command of regulation of speed, which his opponent did not exercise; and in the case of the ram, he gave himself a superiority which does not appear to me to be inherent in that weapon. Many years ago I endeavoured to show in this theatre that the difference between ramming and being rammed was exceedingly fine, and was in fact a question of very few seconds in time, and very few yards in space. I venture to think that this point was not altogether as present to the Admiral's mind, throughout his hypothetical combat, as it is to my own. I found in short—or perhaps I should say I thought I found—that all the results arrived at by the Admiral were not supported by a still closer investigation, and a still more rigid adherence to ascertained facts.

7. As I am not here making a reply to the gallant Admiral, but really following out the methods he has proposed to some of their conclusions, I shall not now follow him further, but will merely note that if the discussion takes the peculiar form which I shall have the honour of suggesting, the points to which I have adverted will naturally work themselves to the front.

8. I think the problem before us at the present epoch of naval progress was correctly stated by the gallant Officer in his title, and I may perhaps be allowed to say that, in the discussion which followed, there was a difficulty in dealing precisely with that problem, and no other. The question is, the *relative* importance of broadside as compared with end-on fire. Everyone would perhaps agree with Admiral Phillimore's dictum that no one in these days would attempt to arm a ship without providing *some* end-on fire. But this being so, the real question is "how much end-on fire, seeing that in most cases you "take it away from the broadside fire?" The gallant lecturer took a typical ship of 12 guns, and gave it as the result of his investigations that one-third of these guns may be advantageously taken away from the broadside in order to fire right ahead and right astern. But wo

need not go to hypothetical cases to see how opinion sways and varies in our Navy, and how it determines the expenditure of vast sums of the public money first in one direction and then in another, as the Service inclines to what I may term, for shortness, my view, or to the gallant Admiral's.

9. Go to the "Warrior," "Black Prince," "Resistance," "Defence," "Hector," and "Valiant;" "Achilles," "Northumberland," "Agincourt," and "Minotaur"; "Royal Oak," "Caledonia," "Ocean" and "Prince Consort"; "Enterprise," "Favorite," "Zealous," and "Research"—that is, to the series of ships ordered from 1859 to 1863—and we have only very faint indications of an opinion in favour of end-on fire. But take the later ships from 1863 onwards, and you can see as in a map the growth of this opinion. We get it faintly in the "Lord Warden" and "Lord Clyde," ordered in 1863; more strongly in the "Bellerophon," where two 6½-ton guns represented the end-on fire, as against 10 12-ton guns representing the broadside fire. In a later ship, the "Hercules," the end-on opinion has gained strength, and we find the end-on fire represented by 4 18-ton guns, and 2 12-ton guns out of a total armoured force of 8 18-ton and 2 12-ton guns. But in the "Hercules" and "Sultan" the opinion was not strong enough to actually *withdraw* guns from the broadside. Arrangements were made by which the Captain might at his discretion follow Admiral Randolph's opinion or mine. Extra ports and some extra weight of armour were the sacrifices then thought proper to make to the end-on idea. But in a few years the idea is bolder, and it builds the "Audacious" class, where—but for an enlargement of end-on ports, which we have not yet admitted on the broadside—4 guns are withdrawn from the broadsides of 10, and given up to end-on fire. We now go on a little further, and we come to the "Alexandra," where the end-on idea has made a great step. It is here not only a question of withdrawing from the strength of the broadside, but actually throwing it into the background by placing specially heavy guns as end-on guns. She carries 6 18-ton guns on the broadside, and she carries 6 end-on guns, but of these, 2 are 25-ton guns.

10. Yet the end-on idea is far from being content with its victory over the "Alexandra." It went two steps further, invaded a new province, and took away the armour from the sides of the "Nelson," "Northampton" and "Shannon;" then invaded another new province, made a dash at the turret system, and, aided perhaps by other considerations, it put the turrets of the "Inflexible" at an angle to the line of keel.

11. Thus the end-on idea, not making its practical appearance until 1863, has gone on enlarging its borders until it has insisted that even our turret system was wrong, and I know not now whether it will be content with practically reversing our ideas of fifteen years ago, or whether it wants still more!

12. But what are the causes of this wonderful change of opinion? We surely ought to be able to appeal to some definite results, either of experiment or argument, which have so decided the case in favour of

the end-on fire. Yet I believe it must be stated that there were no such things before the Admiral read his first paper here. We have the statements of opinion—vague and general—on record, and we have the effects of the opinion in the ships I have named; but we have in support of these tremendous results, only the Admiral's paper in the form of argument, and nothing that I know of in the form of experiment.

13. But Admiral Randolph's argument only goes, after all, as far as to say that the relative importance of broadside and end-on fire is as 3 to 1; we have not had his views on the question whether he would sink the level of the broadside below the level of the end-on fire as in the "Alexandra" or but on an equality with it as in the "Inflexible." So we see that if even we admitted every word of Admiral Randolph's allegations and accepted his arguments in full, we should still be lagging behind the actual facts which are before us, solid and unyielding in the ships I have named.

14. I am only too well aware that the language I am using will be construed into an attack on our naval policy so far as construction goes. If I am attacking anything—which I take leave to doubt—I am attacking the active service of the Navy, not excluding myself as an humble member of it. It is from us that the ideas have come, the embodiment is no doubt independent of our control, but I fancy few will be prepared to complain of the armament of the ships I have named who take kindly to the estimate of the relative importance of end-on fire embodied in them. But on the other hand, I am very well convinced of this, that if, in the immediate future, actual war should teach us that the relative value of the end-on fire is much less than it is credited with being in the most recent ships, neither we nor the country will spare the constructors who designed them, and they unfortunately will have little or no proof that they only did as naval opinion commanded them.

15. Thus, in brief, we see that a vast change in the method of arming our ships has come about in silent steps, and we are assumed to have come to very distinct decisions, when in reality—always excepting Admiral Randolph—we have only suffered an opinion to grow, and have passed it on, without any serious examination.

16. Let us take a concise survey of some of the broader considerations affecting this question. In such a ship as the "Alexandra," your endeavour must be to keep your enemy somewhere before the beam, where you can get your 25-ton gun to bear with four 18-ton guns. In such a position only one 18-ton gun will be out of action. Your enemy, on the other hand, will endeavour to keep a little abaft your beam if he is a simple broadside ship, because then the whole of his power will be opposed to less than two-thirds of the "Alexandra's." What means has the "Alexandra" for keeping her enemy before the beam, when the enemy is determined to remain abaft the beam? If the "Alexandra" has the greater speed, and uses it, she will but facilitate the wish of her enemy. If, on the contrary, she either has less speed, or uses less speed, her enemy can at once meet her by using still less. It is true that if the "Alexandra" can so arrange

matters as to get astern or on the quarter of her adversary at a small distance, the adversary must keep her speed if she has it, otherwise she will be ultimately and easily rammed in the stern, being the most tender point. The adversary will also, in such a case, find a great difficulty in getting out of that bow-position once she is in it, unless she has the superior speed. But this is only when the distance apart is small. If she is not at the moment afraid of the ram she can easily and at once alter her relative position to the "Alexandra." Thus we see that the position of an enemy subject to the most effective fire of the "Alexandra," must either be temporary, or else the gun-power which the "Alexandra" has been solicitous to employ, fades in value and convenience before her ram-power. If you have your enemy's stern or quarter ahead of you, and have the capacity to run into it, surely you will do so, and let your guns take their lower place? If, on the other hand, your speed is such that you cannot ram her, it is very certain that she will not stay there on either bow if she cannot make an effective reply from that position. But now take the converse case, where the adversary having got a position a couple of points abaft the "Alexandra's" beam, and finding her advantage from more than one-third of the "Alexandra's" gun-power being out of action, proposes to stay there and make use of her advantage, how is the "Alexandra" to shake her off? She dare not reduce speed, for that will bring her the adversary's ram; she dare not attempt to bring her guns out of action to bear; that also will lay her open to the ram. She may turn away from her adversary, but it is risky if the distance is small, and if not, her adversary will simply place herself on the opposite quarter and go on again.

17. Now consider a like case with an "Inflexible," as she is, opposed to another with her turrets in the middle line of the ship. The weak points in the "Inflexible" are four points before the port beam, and four points abaft the starboard beam. If the adversary can lie on either of those points she will have just double the power of the "Inflexible," and she will undoubtedly choose the starboard quarter for the reasons already given. The "Inflexible" in this case has an advantage over the "Alexandra," inasmuch as both her quarters are not equally weak: if she can only bring her opponent on her port quarter, the latter will lose her advantage. Under these conditions, it is quite certain that the adversary would not remain on the port quarter, and if she were unable to regain her true position on the starboard quarter we should either find her fighting it out on an equality on the port quarter, or yawing across and across the stern of the "Inflexible" so as to bring her after turret into play. If the "Alexandra's" battery were turned end for end, so that her strength lay abaft her beam, and her weakness before it, the adversary's nominal tactics would be to lie before the beam on either side; but this is clearly a position she could only maintain by favour. If the "Alexandra" had the superior speed she would drive her adversary off with her ram. If she had the inferior speed, she would bring him abaft her beam and subject him to her heaviest fire at her discretion.

18. If the "Alexandra" met a ship whose strength lay in stern and

quarter fire, just as the "Alexandra's" lies in bow fire, then the endeavour of each would supplement that of the other. The "Alexandra" would desire to keep her enemy on the bow, and subject to her heaviest fire, while the enemy would equally desire to keep the "Alexandra" on her quarter, and subject to *her* heaviest fire. But I do not think any naval Officer at present knows how the "Alexandra" can subject another ship to her heaviest fire if the other ship does not desire it. Certainly no one has yet shown how it is to be done. Even Admiral Randolph's paper confirms this view, for the only position at all approaching permanency which his ships take up, is where he assumes to force his enemy, by priority of his own movement, to lie on his quarter. He makes no attempt to force him to lie on his bow, because, no doubt, he has found it impossible to do so. But it is evident that he cannot really "force" his enemy to lie on his quarter. That is a question entirely in the hands of the enemy himself. It may be, perhaps, that the enemy must either lie there, or gradually discontinue the action. But this, as I have elsewhere endeavoured to point out, leaves the advantage on the side of the enemy. Admiral Randolph in such a case would have been driven off his own ground.

19. From this discussion we deduce the broad principle that in a duel in the open sea there is now but one position which can approach permanency, in which end-on fire comes into play, that is, where one ship desires to keep the other on her quarter, and the other desires to keep her enemy on the bow. I believe there are no two ships afloat which would mutually aim at these positions. No doubt these positions would be as good as any others for carrying on an artillery duel between two ships whose armaments were similarly disposed, but then the danger of the ram is so great that no ship which did not gain in gun-power by the act, would willingly allow an enemy to lie on her quarter.

20. Such broad considerations as these would lead us to suppose that the tactics of the duel—which is alone before us in this paper—would lead in the opposite direction to that at present taken in the design of our war ships; if it is in any case safe to withdraw guns from their ordinary broadside use, they should be withdrawn to strengthen the stern and quarter fire; the bow fire may be left weak.

21. The argument is somewhat close, and may therefore bear repeating. In strengthening your stern and quarter fire, you guard your weakest part from the ram attack; in strengthening your bow fire, you are but setting up a weak rivalry with your most powerful weapon—the ram. If nothing else shows it to us, Admiral Randolph's paper does so, that if the action is fought by passing and re-passing on opposite tacks, all end-on fire withdrawn from the broadside is a dead loss. He knows this so well that his whole aim is to avoid such an action. Then he shows that there is but one other form of action which has any permanency, that is where one ship leads and the other follows. But this can only be a permanent form where the bow is the strong point of one ship, either from the ram or the gun, and the stern of the other is the strong point from its gun-power. Only one

cause will make the quarterly or stern position at all permanent for a ship with weak bow fire, that is, the prospect of using her ram; but this very prospect is that which will prevent the other ships from assuming the bow position. The ship which has got into the quarterly position will assuredly keep it, however weak her bow fire may be, if she finds herself gaining on her adversary, and sees a chance of ramming. But if the ship ahead observes this gain upon her, it is quite certain that she will quit her bow position if she possibly can, even if she gives up the superiority of her fire astern. On the other hand, if the headmost ship finds herself with the superior speed and the superior stern fire, she will be desirous of maintaining that position; but then the sternmost ship will quit her place the very moment she finds her fire from thence relatively weak, and her speed inferior. It would be simply fatuous to remain there, with no prospect of ramming and an inferior gun-power. She will remain, as I said before, if her bow fire is equal to her adversary's stern fire, but then it is a question whether the adversary herself will care to maintain a position which gives her no advantage, but leaves her open to be rammed if a temporary accident happens to her engines. Thus, to repeat again the important axiom, if it is safe, and tactically proper, to withdraw any guns from the ordinary armoured broadside, they should be used to strengthen stern fire; but then such strengthening can only be useful as a last resource to guard against the case of attack from astern by a ship with superior speed and the ram. The question still remains, is it safe and tactically proper to weaken the broadside, seeing that this superior stern fire is only a last and not very firm resource, useful chiefly when escape from the ram by manœuvring is impossible?

22. These are broad principles, but are, I think, distinct enough to draw out some clear discussion with the materials I shall put before the meeting before I close. But I must now pass to some of the cases where the end-on fire idea has now its greatest triumphs. I mean the cases of the "Shannon," "Nelson," and "Northampton." I call these ships the greatest triumphs of the end-on fire idea, because they are so on the surface, and perhaps also at bottom; but if I rightly understand the idea of their design it embodies a middle ground; one not taken up by Admiral Randolph, and one which if taken up by me would not have been carried out as it has been in those ships. It is very remarkable that Admiral Randolph, when he came to face the problem of the duel so boldly as he has done, gave up the stronghold of the end-on fire idea without a struggle. If any doctrine can be said to be distinctly held by the majority of the naval tacticians whose opinions have built our modern ships, it has been the importance of bow-fire during the approach of enemies' ships. The bow-to-bow action has been the only action contemplated by the majority until Admiral Randolph practically abandoned it. Where is it gone to, when the action is not held to begin until the ships are within 800 yards of each other? But the Admiral was compelled to abandon it, I have not the slightest doubt, and I consider that the logic of facts is every day converting naval men from that most mistaken view of a sea-fight, and teaching them that, during the approach, gun-fire is

neither here nor there even from an "Alexandra." But in the "Shannon," "Nelson," and "Northampton" the heaviest guns are withdrawn from the ordinary broadside, and in the "Shannon" there is no stern fire to correspond. In all three ships the armour is withdrawn from the broadside, and in the "Shannon" protects her from raking fire from ahead only. Here it is certain the importance of the position of approach is upheld almost to an extreme point. How, therefore, shall we fight these ships, having demanded them and obtained them? Clearly, during the approach, we are expected to use and rely on our 18-ton guns forward. Clearly also we are to pass our enemy on opposite tacks with electric broadsides ready and with the men below. But now look at the tactical assumption we are making in reference to this bow 18-ton gun. If we withdraw it from the intended broadside at close quarters we are assuming that it is more effective when fired at long range end-on than when fired at short range broadside-on. If we determine to make it a part of our projected electric broadside, then we must be content not to use it as an end-on gun within say 800 yards. If we use it within that distance we must, at moderate speeds, be content to leave it out of the broadside, as it will not be ready in time.¹ Recollecting the shortness of the period of approach, I conceive that very few naval Officers would hesitate as to the proper employment of this gun under such circumstances. A round at 1,600 yards and another at 800 yards, with a very great risk of not getting a third at all, would, I feel certain, decide any Captain in command of one of these ships against employing the gun in any way during the approach, and in favour of treating it as part of his broadside. But then, in providing him with this end-on fire, which he is so unlikely to use unless the circumstances are exceptional, we have not inconsiderably detracted from the value of his broadside. To bring every gun to bear, they must all be laid right abeam, and seeing that any complete concentration is difficult even on this point, there is a very great chance of only a portion of the broadside taking effect. If in the "Nelson" the whole six guns were free to concentrate on a point 200 yards distant, the electric broadside would naturally be discharged the instant the enemy's bow appeared in the cross wires of the director. This would ensure hitting even if there was a hang fire. But if there were no concentration it would hardly be prudent to fire until the bow was well past the cross wires. A too early fire might lose shot ahead, and a too late fire might lose shot astern of the enemy's ship. In this kind of action the stern 18-ton gun would in the same way be most usefully embodied as part of the broadside, any shot fired later from it would clearly be of less value, beside the consideration that, if it did not go with the broadside, the smoke from the latter might prevent a shot being got at all at a reasonable distance.

23. Those who go fully with Admiral Randolph in the objections to electric firing would no doubt fight the "Shannon," "Nelson," and

¹ At 20 knots mutual approach, 800 yards = 1' 12"; average time between rounds with the 18-ton gun 1' 11". See Noel, "Essay on Great Britain's Maritime Power." Journal, vol. xxii, p. 464.

"Northampton" as just described, except that the captains of the guns would remain, tube-lanyard in hand, and await the order "fire" by word of mouth. But if they go still further, and condemn firing by broadsides altogether, then I am afraid they must condemn the three ships in question, for as against armoured ships of their size they may be weak. Suppose the "Nelson" pitted against a ship like the "Bellerophon," and suppose the "Nelson," rejecting the opposite tack and broadside action, takes one of Admiral Randolph's positions to bring the "Bellerophon" on her starboard quarter. Then suppose the "Bellerophon," seeing certain advantages in this position, accepts it, provided she can keep sufficiently up to bring her port broadside to bear by a slight yaw. Then we can see what will happen. She will have opposed to her one 18-ton and four 12-ton guns, but the four 12-ton guns and their crews are unprotected by armour. Every one of the "Bellerophon's" shells striking this unarmoured part will not only be horribly destructive where it strikes, but will be partly in the nature of an enfilading shot, and will create havoc along and on both sides of the deck. The "Bellerophon" will reply with five 12-ton and one 6½-ton gun. But these are all under armour. In absolute gun-power the "Bellerophon" is only inferior, if one 12-ton and one 6½-ton gun are inferior to an 18-ton gun. In relative gun-power she will vary according to her position, that is, according to the angle at which the "Nelson's" shot will impinge on her plating. The "Bellerophon" would endeavour not to engage too closely, and would take care not to expose too much of her broadside target to guns which would easily pierce her 6-inch plating. I suppose her choice position would be 500 yards, and three or four points on her enemy's quarter. Under such conditions she would be pretty safe from the 12-ton guns.¹ At the moment of firing her broadside she would be more open to hurt, but we are to suppose that she would so time her broadsides as not to open her target until after the "Nelson" had fired, and before she was again ready. Under such conditions the *relative* gun-power of the "Bellerophon" with the "Nelson" would be five 12-ton and one 6½-ton guns against a single 18-ton gun, and I should imagine that the superiority would be so great that the "Nelson's" crew would be unable to stand to their guns for any time. But this is a problem requiring special and close working out. It is quite true that a shot from the 18-ton gun would penetrate the "Bellerophon," but then several shot would strike the vulnerable battery of the "Nelson" for one which struck a vital part of the "Bellerophon," and the balance would seem to be very much indeed in favour of the latter ship. It may be said of those who reject the opposite tack system of fighting that the "Nelson" could destroy the "Bellerophon" by keeping her astern and using her protected 18-ton guns only. But I think the "Bellerophon" would not accept this kind of combat, and I do not know how the other would compel her. It may be said again that the superior speed of the "Nelson" would give her the choice of positions with a "Bel-

¹ Roughly speaking, her target as opposed to the 12-ton guns would be 8½-inch plate, 14-inch backing, and 2-inch skin. A target representing perhaps 117 in resisting power against the 12-ton shots, with 109 of energy per inch of circumference:

"Bellerophon." It would give her, I think, the choice of bringing her to action, and if the "Bellerophon" was not very careful it might give the "Nelson" the chance of the ram from astern, but there appears to be only one position which superior speed can command, that is the position ahead or on the bow of the adversary, and then we have seen that the other ship need not accept the rear position if she does not wish to do it. I think the argument goes to show that to fight with an advantage over an armoured broadside ship of their sizes, the "Shannon," "Nelson," and "Northampton" must adopt the opposite tack principle, and this is a principle which the other ships, being of inferior speed, must either accept or fly from, with the chance of being ultimately rammed from astern. But if these ships are to be fought so, then I conceive that there are very grave doubts as to the value of their special end-on arrangements. Their battery armour is disposed as though their chief danger was raking fire. Their heaviest guns are placed as if this offering of themselves to raking fire were to be the normal position of the ships in action, but it looks as though they could only take up such a position either at a great loss on the bow of the enemy, or astern of the enemy, when their presumed superior speed and consequent chance of ramming throws the whole gun question into the background.

24. I have brought these practical considerations before my brother Officers in order to at once disabuse their minds of a too prevalent view that the matter Admiral Randolph debated is speculative. There is at this moment no question which is less speculative and of more immediate application. If a strong gathering of leading naval Officers in this theatre came to a perfectly clear judgment on the relative importance of bow and end-on fire in a naval duel in the open sea, and if it could be shown that their conclusion rested on a definite basis of fact, there is not a draughtsman at the Admiralty who would not only be bound, but would feel himself bound, by that decision. It is quite certain that no clear decision has yet been arrived at, and that our ironclad ships represent every view, from nearly all end-on fire to no end-on fire. As every opinion cannot be right, some embodiments of these opinions must be wrong. The very practical question before us is, which?

25. It may be argued that no decision is possible, and that we must go on arming our ships haphazard according to the unstable opinion of the day. I do not think that anyone who holds that opinion has mentally faced its consequences. Suppose that the wrongly-armed ship on our side gets opposite the rightly-armed ship on some other side, will the passions roused in England by the result admit of a calm debate such as we can have now? No; this is the real time to debate such questions, and Admiral Randolph has shown us how to do it.

26. But to come to definite conclusions, we must submit to more restrictive conditions, than those the Admiral employs. When, under these restrictive conditions, we get conclusions which are approximately true, and cannot be controverted with any show of reason, then we enlarge our conditions by the variation of one of them, and on this we advance to further conclusions, and so on, until we establish the truth

so far as it can be established. Then, all who listened to the Admiral's papers must have become aware that no single mind was capable of establishing conclusions. They were only to be arrived at by the contest of two minds, one taking up one idea of fighting a naval duel, and the other a different idea. Then, upon the application of the fixed conditions, each combatant will learn how much of his idea is tenable, because the upholder of the other idea will find out its weak points. I venture to propose to the meeting that the discussion should take the form of arguing out some principles of the naval duel under these fixed conditions, and I have prepared the necessary materials. I will myself, assisted by any members who think with me, take up and fight a broadside ship, while I propose that some other member who relies much upon the end-on method, assisted by such as agree with him, should take up a ship armed to represent an *equality* in the importance of broadside and end-on fire. I have already shown you that our modern ships have assumed a much higher value for end-on fire, and our older ships a much lower value; to take them as equal, will therefore be a fair starting point.

27. I invite you in short to play the first naval war game which has ever been played in public in England, and the conditions and instruments of the game may be shortly described. We have first a sheet of paper representing a portion of the open sea. Two hostile ships, X and Y, have sighted and approached each other until they are end-on and distant 2,000 yards. Each ship is of like size and construction; each has the same thickness of plating and the same number of guns of identical power. The guns are in battery, not in turrets or *en barbette*. They are eight in number in each ship, and X, representing a pure broadside ship, has her guns in broadside ports, allowing of three points training before and abaft her beam. The ship Y, relying equally on broadside and on end-on fire, has her guns disposed with two on each broadside, two representing bow fire, and two representing stern fire; that is, two guns will train three points before and abaft her beam. One will fire from right ahead to two points before each beam; and one will fire from right astern to two points abaft each beam.¹ These guns are all under the single condition, that one minute of time shall elapse between each discharge.²

28. In motive power, our ships can each have a speed of 8·2 knots or of 10·4 knots, or one may have the higher speed and the other the lower. I impose the condition, however, that neither ship shall alter her speed during the fight.³ I also think that, at this first public trial, we should keep the speeds equal, and so simplify the conditions.

29. In turning powers, the ships are necessarily limited by their

¹ In the modern battery ships, the tactical value of the end-on guns is in most cases increased by enlarging the arc of training to 90°. I have a right to claim either its reduction as above or the same arc for broadside guns.

² This is Admiral Randolph's condition: the 18-ton gun averages 1' 11½" between each round in prize firing, the 12-ton gun 39½". These times would certainly be increased in action. See Noel, "Naval Essay," 1877.

³ This is one of the conditions which may hereafter be enlarged upon definite data.

speeds. But I am prepared with scales which suit either speed. These scales show the time and space occupied in turning through any number of points up to 8, or beyond that turn. These scales also show the spaces traversed on a straight curve per minute, and they also contain a scale of yards, and a means of measuring compass bearings and arcs of training for gun-fire. In employing these scales, I impose the condition on each ship, that she shall put her helm hard over when she moves it at all.¹

30. The scales are drawn from the most accurate data available. They represent very nearly the absolute truth as regards Her Majesty's ship "Thunderer" in smooth water. And if we suppose our batteries mounted on the under-water hulls of two "Thunderers," we are dealing with conditions of speed and turning powers which are only in a very small degree hypothetical.²

31. Each ship is a ram, and at liberty to use the weapon, but, of course, equally open to be rammed herself.

32. It is necessary to impose conditions of time upon the combatants, and these conditions are that so long as the distances are so great as to preclude the direct delivery of the ram blow—whatever the ultimate intentions may be—each combatant has a move extending over one minute of time. When the delivery of the ram blow is announced, the move lasts for half a minute. It is further allowed that each combatant may, when his turn comes to move, control his ship up to the end of two moves; that is, while his adversary is moving, so that he can take his ship up again where he intended she should be.

33. A successful ram will of necessity decide the combat. Otherwise the winner will be decided by the value of the shot fired. These values can be taken out from the Table, the construction of which can be briefly explained, and is a very fit subject for discussion at the end. Two elements clearly govern the probable value of shot fired, the distance of the target, and the angle at which the shot would strike. A third element comes in for ships in the size of the targets vertical and horizontal, which vary according to the angles the path of the shot makes with the line of keel. For end-on shot, the horizontal target is at its maximum, and the vertical target at its minimum and *vice versa* for broadside shot. As, with our present data, any table of this kind must be somewhat empirical and rough, I allow these two values to eliminate each other. Then I say that the maximum value of a shot fired at a ship must be when there

¹ This is also one of the conditions capable of enlargement when reliable data come before us. At present there is very little of a reliable character.

² Admiral Randolph has supposed the "Thunderer" to be an exceptional ship in turning powers; but this is not so. The diameter of her final circle, at 11 knots, is 4.3 lengths. That of the "Iron Duke," with common rudder and ordinary wheel, is 5.4 lengths at full speed. The other ships of her class, with balanced rudders and common wheels, have a final diameter of 3.8 lengths. The "Thunderer," at 11.1 knots, turns through 16 points in 2' 21". The "Iron Duke," at full speed, turns 16 points in 2' 26", and the other three ships of her class in 2' 8". Five French twin screws are stated to average a final diameter of 5.28 lengths, but there are doubts as to the measurements.

is almost a certainty of hitting, and the shot if it hits will strike fairly normal to the armour. I put this as giving a distance not exceeding 300 yards and a path of shot at right angles to the line of keel. If the shot is fired along the line of keel, I strike off 20 per cent. of this value as an allowance for the angle of the water-line plating, and for the chances of the light iron work turning the missile before it reaches the thwart-ship armour. Now, the chances of hitting a given vertical target must vary at least as the square of the distance. The power of penetrating also falls rapidly with the distance. If I reduce the value of shot fired at the broadside and end-on targets in proportion to the square of the distance, it would appear that I am giving the full value which distant fire can claim. There remains now, but to find a value for each distance for shot fired in a direction between 0° and 90° to the line of keel. This is done by considering that at 4 points from the line of keel, shot falling on the broadside and transverse plating would be equal in penetrating power, but reduced in value in consequence of their striking angle. Roughly taking such loss as one half of the maximum, we fill the columns up by interpolation.

34. I am now in the hands of the Chairman and of the meeting as to the form of the discussion. I have given the principles of my War Game, which I hope will very soon be published in a workable form, but if we play the first public game as I propose, I must remind the meeting that no single game will decide this question of placing the guns. All I am prepared to express is my belief that we are getting a key to construction and armament, which will have from this day forward a very direct and important bearing on naval policy all over the world.

35. The exact problem which I offer for investigation to-day is, can the ship X, by skill in manœuvring, employ half his gun-power over an arc extending three points before and abaft his beam, with success against a ship whose skill in manœuvring is less important because there is no point uncovered by his gun-fire, and whose only disadvantage is that in the position in which X will aim at placing him he has only three-eighths of his full strength?

36. It will have been observed that there is very little originality in my proposed methods, and that mine is not the first attempt at a War Game. I have already expressed my obligations to Admiral Randolph; I must now express them to Commander Castle, who made the first definite proposals for a War Game in 1873, and who first devised the construction of scales representing time and space in movement. I am doing little more than following where others have led, with the assistance of newer data.

Table for Valuing Shot Fired.

Distance in yards.	Striking Angle in Points.								
	0	1	2	3	4	5	6	7	8
300	80	70	60	50	50	50	60	80	100
400	45	38	33	27	27	27	33	45	55
500	29	26	22	18	18	18	22	29	37
600	20	17	15	12	12	12	15	20	25
700	15	13	11	9	9	9	11	15	19
800	11	10	8	7	7	7	8	11	14
900	9	8	7	6	6	6	7	9	11
1,000	7	6	6	5	5	5	6	7	9
1,200	5	4	4	3	3	3	4	5	6
1,400	3	3	2	2	2	2	2	3	4
1,600	3	2	2	2	2	2	2	3	3
1,800	2	2	1	1	1	1	2	2	2
2,000	1	1	0	0	0	0	1	1	1

The CHAIRMAN: It seems to me that Captain Colomb in his very interesting paper invites us to do two things: one to discuss the various suggestions he has thrown out, and the other to witness a war game this evening which he has sketched out and shadowed forth to us. The discussion is a very simple matter and will not involve any difficulty, but the war game is a very different matter; who is to be the umpire? If Captain Colomb is prepared to step down in the arena and to conduct a war game with some one else, it is necessary of course to have an umpire who thoroughly understands the game, its rules, and the whole subject, and from whose decision there is to be no appeal. Now as far as I know there is no one present to undertake that post to-day, and therefore I should be inclined to advise you to hear the discussion, and defer the war game until a future occasion. I will now call upon any gentleman who wishes to discuss the paper.

Admiral RANDOLPH: As our gallant and talented lecturer has done me the honour of making my paper the text for a large part of his paper to-day, perhaps you will permit me to make some observations upon it. First I would wish to pay him my tribute of praise, admiration, and thanks for the painstaking and thorough-going manner in which he has investigated and elucidated this very important subject, a subject second to none of the very many important ones which are the necessary studies of our profession. I said "second to none," but should I not be more correct in saying superior to all? for I believe all your material put together without good naval tactics will be absolutely worthless. Notwithstanding this, I am sorry to say I feel that although it is so important a subject it is precisely the one that is least attended to and practised of any, and certainly not through any want of zeal or fault of the Officers themselves. I hold that at the present day naval Officers, as a

body, hunger and thirst after knowledge and practice, to a degree utterly unequalled at any former period: I impute no blame or fault to anybody. At the Admiralty no doubt every possible attention is paid to this question of naval tactics, more especially perhaps in reference to its connection with naval construction. No doubt they have their discussions, arguments, and reasonings, and arrive at sound conclusions, but unfortunately we are unable to obtain those conclusions. Of course it is impossible for them to make them public, and therefore I see no better means of introducing the subject generally to the notice of the profession, of enforcing the discussion, of investigating it, and, if possible (and I believe it to be possible), arriving at some rules which unquestionably underlie the service of naval tactics. It is for this reason I have overcome my very great reluctance to obtrude my own crude and erroneous notions upon the Institution; but I came to the conclusion to invite their contradiction or overthrow, with a view to promote the discussion of this great subject, and the gallant lecturer has done me only justice in stating that that was my object, and that I did not pretend to dispose of the subject. With these few preliminary observations, I will turn to the paper which he has read.

In the first place I beg to express my great acknowledgments to the lecturer for his extreme, he will pardon me for saying so, more than courtesy, the undue compliment which he has been kind enough to pay me. He has stated in some part of his paper that I abandoned the struggle, or some portion of the struggle. I assure him so long as he is willing to maintain the struggle in the amiable and pleasant manner in which he has conducted it hitherto, and so long as he wears such soft gloves, I shall be happy to continue it. In the first place he says "the differences of opinion which exist amongst us on the rights and wrongs of naval tactics are removable in peace time by study and experiment." I certainly agree with him to a very great extent there, and so far as they are removable it is very desirable to attend to it.

Although he has done me more than justice in many respects, he has failed to do me quite sufficient in some few points. He says: "I found in short—or perhaps I should say I thought I found—that all the results arrived at by the Admiral were not supported by a still closer investigation, and a still more rigid adherence to ascertained facts." I have no complaint to make of that, but I think I shall be within reason in asking him to point out to me wherein those facts are unsupported and wrong because he gives me no opportunity of meeting them or correcting them. In paragraph 16 he enters into the question of the "Alexandra." I cannot be expected to follow him through that at present; it requires a great deal of consideration, and I have no doubt it will result in finding a great deal of instruction from it. So far as I observe I see nothing to complain of. He says the "Alexandra" "dare not reduce speed, for that will bring her the adversary's ram; she dare not attempt to bring her guns out of action to bear; that also will lay her open to the ram. She may turn away from her adversary, but it is risky if the distance is small, and if not, her adversary will simply place himself on the opposite quarter and go on again." I thought the principle of our argument was an equality in all respects except armament, and therefore of speed, therefore I fail to see how the "Alexandra" can lay herself open to ram by turning away from her enemy. The lecturer says: "I do not think any naval Officer at present knows how the 'Alexandra' can subject another ship to her heaviest fire if the other ship does not desire it. Certainly no one has yet shown how it is to be done. Even Admiral Randolph's paper confirms this view, for the only position at all approaching permanence which his ships take up, is where he assumes to force his enemy, by priority of his own movement, to lie on his quarter." I wish to ask where that assumption is made in my paper. I should explain that that is a mistaken view, and indeed I think our gallant lecturer contradicts himself. He goes on to say, "he makes no attempt to force him to lie on his bow, because, no doubt, he has found it impossible to do so." I think that is rather contradictory. "But it is evident that he cannot really 'force' his enemy to lie on his quarter." Certainly I have never assumed that it was possible. "That is a question entirely in the hands of the enemy himself." Then he goes on to say, "but this, as I have elsewhere endeavoured to point out, leaves the advantage on the side of the enemy. Admiral Randolph in such a case would have been driven off his own ground." I cannot quite see how. "The argument

"is somewhat close, and may therefore bear repeating. In strengthening your stern and quarter fire, you guard your weakest part from the ram attack; in strengthening your bow fire, you are but setting up a weak rivalry against your most powerful weapon—the ram." I am at a loss to understand how heavy and powerful bow fire sets up a rivalry against your own ram. It rather adds to the force of the ram attack. "The ship which has got into the quarterly position will assuredly keep it, however weak her bow fire may be, if she finds herself gaining on her adversary and sees a chance of ramming. But if the ship ahead observes this gain upon her, it is quite certain she will quit her bow position if she possibly can, even if she gives up the superiority of her fire astern." But this gain upon her is exactly contrary to the equality which has been assumed.

Captain COLOMB: All through the paper I have been discussing differences of speed.

Admiral RANDOLPH: Then, "on the other hand, if the headmost ship finds herself with the superior speed and the superior stern fire, she will be desirous of maintaining that position; but then the sternmost ship will quit her place the very moment she finds her fire from thence relatively weak, and her speed inferior." That is open to the same observation. Further on I find a question about the "Shannon," "Nelson," and "Northampton." "I call these ships the greatest triumphs of the end-on fire idea, because they are so on the surface, and perhaps also at bottom; but if I rightly understand the idea of their design, it embodies a middle ground; one not taken up by Admiral Randolph, and one which, if taken up by me, would not have been carried out as it has been in those ships." I think he has rather made an unfair rivalry between two ships, one being an ironclad and the other not; he has pitted the "Nelson" and "Northampton" against the "Bellerophon," a ship such as I believe they were never intended to compete with. "Those who go fully with Admiral Randolph in the objections to electric firing would no doubt fight the 'Shannon,' 'Nelson,' and 'Northampton' as just described, except that the captains of the guns would remain, tube-lanyard in hand, and await the order 'fire,' by word of mouth. But if they go still further, and condemn firing by broadside altogether, then I am afraid they must condemn the three ships in question, for, as against armoured ships of their size, they may be weak." The next thing is, "If a strong gathering of leading naval Officers in this theatre came to a perfectly clear judgment on the relative importance of bow and end-on fire in a naval duel in the open sea, and if it could be shown that their conclusion rested on a definite basis of fact, there is not a draughtsman at the Admiralty who would not only be bound, but would feel himself bound, by that decision." On that question I wish to remark that when we have arrived at a determination as to this question between two rival ships, supposing we arrive at a unanimous conclusion upon the subject, we are still very far from the position that paragraph alludes to; there would still remain the question as to various other phases of naval fights. For example, ships in squadron, or engaged with a numerous enemy, which opens the question of numbers of guns. Then again, a ship against unarmoured ships or earth batteries, involving the consideration of continuous rapid firing, as well as numbers of guns; or against ships at anchor, or inside shallows, when long range is of most importance or indispensable. In short, I think we shall ultimately be forced to the conclusion that there is no one type of ship which can be considered the modern and perfect type. The Navy of England must be composed of various types, to be combined in various proportions and various numbers, according to the operations in prospect, according to the force, number, and position of our enemy, and the varying conditions and operations of the moment.

On the subject of the war game, I do not accept that vessel (sketched on a slate) as a necessary embodiment of the principle of equal number of guns with end-on fire. I do not think there is any ship in the English service that represents the idea, unless it be the "Inflexible," of equal stern and bow fire. If you confined me to four guns fore and aft, I should certainly put three ahead and one astern. Captain Colomb has omitted to take into consideration the very certain fact that fore and aft guns can be and are carried much heavier than broadside guns, and it is impossible for him on his broadside to carry, if any, very few equal in calibre to those which are constantly carried in fore and aft fire. But when the combination of ships is effected,

which I say is absolutely necessary, with the greatest amount of discretion and foresight for an impending operation of war, after all it would be perfectly futile unless those ships are well handled; I am persuaded that if you sent the "Alexandra" and "Téméraire" to fight it out at sea, the victory would be, not to the strongest in material power, but to the one best handled. I must say, therefore, I wish to draw the attention of the meeting and the profession generally to the extreme importance of this point of practical skill in tactics. I think under many circumstances ships being fairly well handled might suffice, but in the circumstance of meeting at sea, you should not be content with equality with other nations, but we should go in for superiority. I do not think we are taking steps to attain that superiority. If I am correctly informed, foreign nations are paying much more attention to this subject than we are, and I think a great lesson can be drawn from those simple manœuvres practised in Russia some time ago, for which this Institution is greatly indebted to our gallant Chairman. Those diagrams may not have struck many as very instructive, but I think they are, for if they do not give any positive information or instruction as to what are the proper methods of attack, they certainly give a great deal of negative information as to what are not in defence. Of those collisions, six or seven in number, all except one, and that one only doubtful, are clearly traceable, not to the superior skill of the successful vessel, but to the palpable and transparent errors of the victim. Far be it from me to insinuate that our ships are not as efficiently commanded as we could desire. As far as I know they are most ably and admirably commanded—speaking from my own experience, excellently commanded. But I cannot but fear that there are a large number of Officers on the list who have not had that practice and experience at sea, and who would be found deficient and failing in proficiency if they were called upon to serve. I therefore feel the greatest possible anxiety that further steps should be taken towards the establishment of a systematic method of training our younger Officers in the practical work of handling their ships at sea. I do not think it is necessary to expend any great amount of money. The gunboat trials in the Russian squadron are full of information; a vast deal of information is got out of a very little experience in that way, and it could easily be carried a little further than steam launches and gunboats by larger vessels who need not ram each other, but spars or rafts towed astern. I hope to live to see the day when the profession will be trained under a system, and so thoroughly, that we shall incur no danger of losing our position in the naval world. I thank Captain Colomb for his admirable lecture, and for his extreme courtesy to myself personally.

Captain LONG: I rise with great diffidence before this distinguished audience, but I wish to bring to a clear issue one point in which Captain Colomb, who has taken as much if not more trouble about these subjects than any other Officer of the Navy, and Admiral Bourgois, of the French Navy, hold diametrically opposite opinions. Captain Colomb says, if you want to ram you must not point your bow to your enemy. Admiral Bourgois says, "The first conclusion to be drawn from these studies is that should one of two adversaries desire to fight a ramming action, it is sufficient to compel both to rush at each other and rub sides on opposite tacks." Captain Colomb has said, "if we collide end-on it is a drawn battle," but Admiral Bourgois says, "you must collide end-on to begin with, if you wish to fight a successful action. After that you must turn according to your powers, and endeavour to ram the other, but if you are a ram, the first thing you have to do is to ram end-on." I hope something will be said to clear up that point.

Admiral Sir GEORGE ELLIOT: I wish to a certain extent to support the French Admiral's views which have just been quoted by the last speaker, but in the first place I desire to join with Admiral Randolph heartily in my thanks to Captain Colomb for the interesting paper he has just read. I hope he will persevere. I think we owe him a debt of gratitude for the trouble he has taken. It is well enough to talk about these things, but it is a very difficult thing to bring them actually to an issue, as he has done. He knows, however, that I take rather different views from him on this subject, and I am sure he will excuse me if I refer to some parts of his lecture on which we disagree. In the first place he refers solely to guns, and does not take cognisance of the cognate question of the use of armour. That question of placing the armour is most important. I am a very strong advocate of end-on fire and end-on attack. I cannot go so far as the French Admiral in saying

that two ships *must* begin by meeting end-on, because I consider that the ship which has the weaker bow must necessarily avoid meeting his adversary's end-on attack. If a ship is a broadside ship she must have the weaker bow. I may be wrong, but that is my argument. If she is a broadside ship, she must necessarily have more of her armour, that is more of her strength, in midships, and therefore she must have the weaker bow. And when I say I fight an end-on fight, I must be allowed to take the same weight of guns as my enemy, and the same weight of armour as my enemy, and do what I like with them. I am not to be bound (as Captain Colomb proposes) to put my armour in midships and my guns pointing to the bow and stern, but I take my armour and put it where I like, and how I like, and mount my guns as I like. One of the first considerations in constructing a ship intended to ram should be to strengthen the bow, because if I did so, and if I had any reason to believe that my enemy was a broadside ship, I should conclude he must have his armour to protect the broadside guns in midships, and that his bow must be comparatively weaker than mine, and that knowledge would greatly influence my mode of attack. To show what I mean, there were two ships lying end-on alongside the Dockyard at Portsmouth, one the "Dreadnought," and the other the "Inflexible." Out of curiosity I put a question to an experienced old Officer who was in charge of the "Dreadnought," which ship's armour-plating came right forward, that is to say, that there was an armour water-line belt meeting at the bow. I said, "Suppose these two ships were ramming each other, bow to bow, at a speed of 10 or 12 knots, what would be the consequence?" "Well," he said, "I do not suppose I should bring up in the 'Dreadnought' until I came to the central citadel of the 'Inflexible.'" I quite agreed that the "Inflexible," having a weak bow, there would be nothing to stop a stouter bowed ship from destroying her in the event of end-on collision. But the other ship having armour-plating right forward, and being a stiffer ship, would not break up at all. In fact, if you take two eggs and strike one with the other, if the one is in the slightest degree stronger than the other, it will go right into the other, and will not break at all. The same with the ship; whichever has the stronger bow will destroy the other. Therefore, when I adopt end-on tactics I say you must allow me to place my armour and my guns as I like, the same weight as you have, but I must place them where I like. Therefore in a ship constructed for end-on fighting I would decidedly run at the other ship, and as the broadside ship dare not run at me she must turn away from me. I do not believe I shall be denied that. If she dare not run at me, she must turn away at a sufficient distance to avoid being rammed. But, my object still being to keep an end-on position, directly I see my adversary move, I turn towards him, steer at him full speed, and continue the same tactics. Whatever he does, I go straight at him. He may discharge one or two broadsides at my armour-plated bow, which is well protected, and in return my bow guns will continue firing on him; but he must soon commence a running fight, and then what becomes of him? He has no stern guns and no armour protection astern, but still I am firing my bow guns at him, and I have a protected bow. I have my bow strengthened by horizontal decks, and in every way made as stiff as possible, having applied a certain portion of the weight of armour for that purpose. The consequence is he turns away and I follow him. I ask at what distance will he turn away? He would not turn away out of gunshot range; if he does he runs away. You may say he runs away and gets away, but that is not fighting. The moment he turns away within gunshot range I turn towards him. The end of it must be that I come on his quarter at last. Now I say if I once get on his quarter within a certain distance that ship ought to be mine. His stern is in every respect more vulnerable than my bow, and there is nothing to protect his screws or his rudder from my bow fire. If he is out of range of fire he runs away, and both having equal speed, there the action will end. You talk of making circles, but if my sole object is to close, if I once get on his quarter within a certain distance my adversary never can turn round again. He dare not show me his broadside; let him do it. The moment I see him turn I have a shorter distance to go. Every time he attempts to turn I take the inner circle and get nearer and nearer to him, and the consequence is he will have to fight that battle out, running away the whole time, and that is all he can do. If my bow is stronger than his stern I ought to win; therefore I do not agree with Captain Colomb in some of his remarks where he said

two ships must avoid end-on meeting. I would not avoid it, I would invite it, if I in my ship met his ship.

Captain COLOMB : I did not say that. I have said in the war game that the end-on, stem-to-stem meeting necessarily makes a drawn game: that is all I have said, no more.

Admiral ELLIOT : Then I do not agree with that. It is not a drawn game if I destroy the other ship, which I maintain I can do if I have the strongest bow, and the whole of my argument is based on the assumption that you must let me put my armour where I like. If I take the guns from the midships and put them at the bow I place some armour there also, and therefore I have the stronger bow. I think Captain Colomb has shown that we are gradually growing into end-on fire. I look upon the "Nelson" and "Northampton" as the two best masted ships we have, although they do not represent my ideas of placing guns and armour, still it is an approach to the end-on principle. I think before we start with the war game the question I have just referred to should be at once settled—are we or are we not to be allowed to do what we like with the same weight of armour and guns? If you do not grant that, you at once deprive those who advocate end-on fire of one of their strongest points. I hope that Captain Colomb will be enabled to bring this matter to such a solution as will lead to instruction. I quite agree we all want to be educated on the subject of naval tactics, not only the young Officers of the Service, but the old ones. We have not turned our thoughts sufficiently to it; and even since Admiral Randolph's paper came out I am sure the consideration of it has done us all a great deal of good and has made us think of things we were sleeping over before. I hope it will not be allowed to drop, but will be carried out patiently till something is settled.¹

Admiral Sir SPENCER ROBINSON : Although there has been a very strong difference of opinion on certain matters, I concur very generally with much that has been said, and I wish to bring that agreement to bear upon the proposition that has been made. I am not going to discuss any of the matters on which there is a very wide difference of opinion, but what I should wish to say is that I think most of the objections taken would be answered and the greater part of the differences of opinion would be at once solved and laid aside if this war game could be established and played out. I would therefore propose to this meeting that one and all we should take every possible pains to get up a war game, to select an umpire, to lay down the rules, and so to have this war game played with the best abilities that can be obtained on the contending sides. I think it would not be quite possible to follow exactly the course that Admiral Elliot has suggested. It would answer no useful purpose to say that we would not try a war game nor acquire the knowledge and experience we might

¹ The "end-on" ship I would propose is fully described in the dissentient report of the minority of the Committee of Designs for Ships of War entitled "Report of Admiral George Elliot and Rear-Admiral A. P. Ryder on Designs for Ships of War," which is dated October 14, 1871. After eight years of further experience I feel more convinced than ever of the correctness of the views entertained by Admiral Ryder and myself at that date, and I would invite the perusal of this report by those who take an interest in the problem of "end-on" versus broadside fire. The only alteration which I would now propose to make in the principles of designs advocated in 1871 would be that in lieu of the athwart-ship bulkhead I should place the armour round the bows especially at and below the water-line. I am pleased to know that the principle of water-line protection which we introduced in 1871 has been lately accepted as a desirable substitute for side-armour protection by the Chief Constructor of the Navy. I trust that this controversy of "end-on" versus broadside fire may result in also bringing into prominence the superior advantages to be obtained by mounting guns on revolving platforms *en barbette* within fixed towers on the upper deck, which feature will naturally lead to the adoption of tripod masts. It must be seen at once that all-round fire, if possible to be obtained in all ships, must be superior in every respect to any system of broadside battery fire, and the increased power of heavy ordnance has produced very grave objections to the continued use of revolving turrets.—G. E.

acquire by witnessing a combat on paper conducted in that way, because the particular ship that is to fight the broadside ship with advantage must be constructed in a way in which no ship has yet been constructed. I am afraid that to wait for such a plan would delay for a very considerable period any settlement of the question how a naval action in an ironclad should be conducted, or what is the relative value of broadside as compared with end-on armament. With that exception I think a great deal that Admiral Elliot has said is perfectly true. I concur with a good deal of what Admiral Randolph has said so far as the theory of the thing goes, and I think the differences of opinion that exist between him and Captain Colomb as to certain matters of fact and certain matters of deduction will only be solved by that battle upon paper. The point that I think is impossible for this Institution to take any part in at present, is in altering the construction of a ship so fundamentally as to have the armour and guns distributed in the way that Admiral Elliot would wish to have them put. I think we must fight a battle on paper in the same manner and with the same kind of ships as we should fight a battle in the open sea. There we should no doubt find ships armed on the end-on principle, and ships armed on the broadside principle in the manner Captain Colomb has pointed out, and the battle should be fought between two ships armed in those different ways. If that can be carried out I am certain we shall all derive the greatest possible advantage from the lecture we have heard and from those very valuable papers that Admiral Randolph has read to us.

Captain CYPRIAN BRIDGE: I am sure Captain Colomb will only be too glad if I point out to him one matter in which I think he has hardly done justice to one Officer. He opens his paper by saying: "To Admiral Randolph belongs the honour, which, so far as I know, will be unchallenged, of being the only man in Europe who has distinctly faced a tactical problem in naval warfare." I am firmly convinced no papers ever read in this theatre have been of such importance on the subject of tactics (the most important of all the questions that come before naval Officers), as those which Admiral Randolph read, but at the same time I think it ought to be remembered that some years ago one Officer of the English Navy did take up one particular tactical question and, in my opinion, and I think in that of others, did thoroughly exhaust it. That I believe to be the only instance. I have read most of the tactical literature of modern days and have studied a great part of it, and as far as I know there is no single case in which any Officer has taken up one particular tactical question and exhausted it in the same manner that Commander Grenfell took up what was then considered the very important question of the towing torpedo. It may be said Captain Colomb meant only when the different arms were all being considered, but it should be recollected, if that is the case, that there was at that time a very widespread opinion that this towing torpedo might to a great extent take the place of ships armed in any other way; we heard a great deal about tug boats and small steamers being equipped with this towing torpedo, and that the whole defence of the country might be left safely to them. Captain Grenfell took up this question, and I think thoroughly exhausted it. He showed exactly what might and might not be done by that particular weapon. Captain Colomb will not be sorry, if this is an omission, that I have pointed it out, and I am quite sure he would be the last man to do injustice to Captain Grenfell, of whose labours I have reason to know he has a very high opinion.

Dealing with the questions raised in the paper, I would go on to the 9th paragraph, in which the lecturer speaks of the series of ships, mentioning them by name, ordered from 1859 to 1863, and says: "We have only very faint indications of an opinion in 'favour of end-on fire.'" I concur with him in thinking that opinion in favour of end-on fire since then has changed, and the reason I believe to be this: that at the period which he mentions, 1859, naval Officers (not naval constructors, probably, because I am sure even at this moment there can be few more magnificent instances of naval construction than the "Warrior" and "Black Prince"), that naval Officers were certainly under the influence of traditional feeling. All our previous battles had been fought with ships carrying long rows of guns on the broadside, and I do not think we had yet begun to realize how changed the conditions of naval warfare were, in seeing that ships retained their motive power probably throughout an engagement. Some years ago a French Officer in the *Revue des Deux*

Mondes pointed out the remarkable fact that although this retention of the motive power enabled the new ships to fight *de pointe* or end-on, we were still going on arming ironclads on the broadside, making them very much the same as the heavy frigates and line-of-battle ships of Nelson's days. There has been a change of opinion in this direction, and the armament of the newer ships gives a greater preponderance to end-on fire, using the word in its widest sense. I mean a capacity for firing towards the bow or stern. Suppose for the sake of argument we admit it was a mistake — which I am very far from admitting. Suppose we say, looking at it in the present state of our knowledge, that this taking of guns from the strict broadside position, and leaving them where they are, more or less in the end-on position, was a mistake. I think that at the same time the change that was made showed that the ships were being armed upon what at all events was something like a scientific principle, and we were not simply under the influence of the old traditional habit of custom, and of the designs of former ships. I had intended to have made some remarks upon the infinite variety of positions and circumstances of naval warfare, not only of naval warfare in general but even of particular actions between single ships, actions in squadrons, and actions where there might be a superiority of force on the one side or the other. But that ground has been altogether covered by Admiral Randolph, and as I should be quite unable to put forward any views on that point as well as he has done, I shall not attempt to do so. With respect to the war game on shore, I think I am right in saying a certain element of chance is allowed to intervene. I have never seen one, I have only heard it described, but I think that dice are used and a certain value is given to particular circumstances which may occur simply by throwing the dice. I do not know whether Captain Colomb thinks it necessary to introduce anything of the sort at present. Towards the end of his paper there is one paragraph which I think is very important indeed; it is a paragraph which says an immense deal, and says it because it does not put it very directly. He says: "The exact problem which I offer for investigation to-day is, can the ship X, by skill in manœuvring, employ half his gun-power over an arc extending three points before and abaft his beam, with success against a ship whose skill in manœuvring is less important because there is no point uncovered by his gun-fire, and whose only disadvantage is that in the position in which X will aim at placing him he has only one-quarter of his full strength?"

Captain COLOMB: That is a mistake; it ought to be "three-eighths of his full strength."

Captain BRIDGE: I would end the sentence at the comma before that "no point uncovered by his fire." I do not think it would be possible in so many words to say anything more strongly in favour of a ship armed as Y should be and more strongly against a ship armed as X should be; I think of all the criticisms that have been passed upon the paper that Admiral Randolph read, nothing in my opinion goes further to confirm the justice of the views that he expressed than is contained in that paragraph which I have just read.

Captain SCOTT, R.N.: The gradual development of bow and stern fire spoken of by Captain Colomb is no doubt correct, but I think that from the very first there has been a good deal of consideration given to the mode of arming ironclads. The "Enterprise," for instance, was armed for bow and stern fire, and the same system was aimed at throughout; but the means of mounting the guns so as to turn them round easily from port to port were then wanting, and a good deal of difficulty was experienced in supplying them. As these means became more and more perfect, the placing guns so as to be fought both upon the bow and upon the quarter, was more and more carried out. Many people considered it was *not* necessary to withdraw guns from the broadside to put them either at bow or stern, but that the guns should do the double duty, and in that view they were no doubt fully borne out by the results. There is no reason why these guns should not be turned by turntables, so as to be quickly brought to either position and fired. I do not think that the whole question can be fully embraced in a war game, limiting the combat to single ships; for our ships would sometimes have to fight in squadrons, at others they would have to advance up rivers, and likewise to cut out vessels. When acting in squadrons they would often not be able to use their broadside fire, and in moving up and down rivers they would frequently be unable to use broadside fire. Then there

is the question of the ship being aground and surrounded by gunboats. What chance would she have if she had merely broadside fire, especially if there were land batteries as well as gunboats playing upon her? What is required is to have each war ship armed with light guns, to play upon gunboats, and with heavy guns to attack powerful batteries, &c. There is the further point to be considered, which is, that our merchant vessels are not unlikely to be armed so as to play a prominent part in future warfare. A couple of such vessels would run an unarmoured ship very hard if she had only broadside fire; they would not allow her to use that fire, for they would follow her up closely, just as Admiral Elliot has pointed out in the case of a single combat; he has, I think, exhausted the arguments on that point. My own belief is, that our efforts should be directed to arranging all the heavy guns of a ship to fire from ahead to astern. There is no difficulty in doing this, it is merely carrying out a little further what has been already done in the case of the "Audacious" class. The guns could be mounted within circular projections,¹ so as to fire from all round the broadside to within 13° of the line of keel. This wide range of 154° on each broadside, with all the heavy guns on each side, is very important, for it leaves only 52° out of 360° which are not covered by the full broadside fire. Then, again, the ship is not always in smooth water, but you want, so far as you can, to keep the ship *steady* when firing her broadside. The circular projections would not only afford the power to do this, but you would be able (in consequence of the wide range of fire), whether advancing or retreating, to fire the whole of your guns, with a very slight alteration of course. Captain Colomb says he would yaw and fire his broadside; my experience has been that when you port the helm over the ship will heel, and you have wild firing, and if you attempted to fire while the ship was swinging, accuracy was very difficult of attainment. What is wanted is that the heavy guns should be able to command an arc of fire from ahead to astern, and I believe that future progress will be in the direction of placing light steelarmour outside the guns, and giving the ship a steel deck, extending from the ram-bow to the stern, and throwing away the rest of the usual defensive armour. I think, however, it is very difficult to apportion the relative values of broadside and bow fire; both seem to me so necessary that, like the arms and legs of the human body, you cannot dismember one from the other without materially injuring the whole fighting power of the ship.

Mr. SCOTT RUSSELL: One word only on a professional point, which must lead to a little confusion as to the mode of carrying on this matter. Admiral Elliot said he would like to take the armour away from the middle of the ship and place it on the end of the ship if the guns were carried there. I want to rid your minds of the supposition that the armour in the bow of the ship is of the least use to you in giving the ship the strength necessary to make her a better ship in the case of ramming. I am one of the few people who have taken the trouble to run down vessels, to see whether my work would or would not stand, and I assure you all the armour you have hitherto put on a ship gives weakness in that case instead of strength. You go bang at your ship, what do you find? You find the plates tilt out in the most beautiful manner, and when you hit upon them at a place which slightly dinges them in, the dinging in of the armour at that point tips it out at all the other points, and the armour tumbles down. I want you not to take away a single plate from the central battery of your ship, and stick it on the bow, in the belief that your bow will be one bit the stronger for the purpose of ramming. I want you to make your bow strong, but do not do it by armour, do it by something quite different. I am an old advocate for end-on fire, and I remain so; but now in our large armour-clad war ships, I am an advocate for broadside fire, because I am satisfied that the end-on work is chiefly to be done by ramming, and that it is only where the ram is not used that your guns are wanted, and then you ought to have them all on the broadside.

Admiral SELWYN: I think it would be a great pity if we could not come to some conclusion as to the method of following up the War Game which Captain Colomb has so kindly devised for us. It seems to me there would not be any great difficulty in making it a regular part of the performances in this theatre. Many of

¹ See Vol. xx, No. lxxxvii, page 475.—R. A. E. S.

our evenings are spent in much less interesting subjects than this, which might be usefully studied by the seniors of the profession, if we cannot get the younger men amongst us. We could easily form two parties, and obtain an umpire sufficiently firm and well obeyed to solve the little differences which would be sure to arise of judgment and the effects of certain circumstances. Of course this must be in a great measure for the judgment of the Council, but I think if a strong representation is made from the meeting that such a thing is desirable, they will be able to afford the opportunity.

Next I would point to the fact that, desirable as it is to conduct experiments like the Russian experiments, it is mainly difficult in this country on the ground of expense; but as soon as we get our motive power with a little less fuel, we shall probably be able to get what we want. I hope to be able to give you some information on that very shortly, and to show that a vessel of 800 tons and 900 indicated horse-power has been working steadily on less than one pound of coal per indicated horse-power, in other words halving the ordinary expenditure. It is not a simple experiment, but it is a definite fact.

With regard to the types of ships which have been indicated, I am one of those who would be very reluctant indeed to see types adopted. I say you may much more usefully prepare your minds for great advances in directions not now appreciated or known, and it would be a great error to set down here any type of broadside or end-on fire ship as the most desirable. I believe when we play our war game the profession will learn very much more from finding out "how not to do it" than from finding out "how to do it," because if there was or could be a perfectly plain system of fighting an action at sea, that system would be sure to be avoided, but we may learn how not to fight.

With regard to the question of protection of armour, to which Mr. Scott Russell has adverted, I think we may say even a little more. That armour has never been carried to the keel, and shot coming from a distance which happened to strike the bow would go out through the keel, and no existing armour would be any great protection. You may protect the gun, but if you do not protect the ship and the engines it is very little use protecting the guns and men. The ram attack is a question of speed and lasting speed. That is the whole question. You may have the most splendid seamen in the world, the most splendid artillerist or manœuvrer, but if he has a ship two knots inferior to his enemy in speed he cannot win. It is the old story over again. Speed, lasting speed, is the main function which settles all the conditions of a naval combat; and I do not anticipate, if we ever have to fight with ironclads meeting each other at sea, that we shall know exactly what ironclad it is that we meet, so that we shall be able to say, "that vessel has so much armour, so many guns, so much everything." We shall very rarely be able to do it. We may meet quite a new ship, of which the conditions are not known. I quite acknowledge it is absolutely necessary in a War Game to lay down certain conditions, but I think those conditions should be one ship against the other costing about as much, but do not confine them in speed or other particulars. Say "I will take such a type of ship as my ship, you choose another." Fight the two, and see what they will do, our object not being so much to show superiority of one manœuvrer over the other as to show what can be done with each class of ship. In that way we should learn very much, quite equally whether you gave a pawn to your adversary or even a castle, or whether he takes one from you.

Admiral RANDOLPH: The lecturer says, "Two elements clearly govern the probable value of shot fired, the distance of the target, and the angle at which the shot would strike. A third element comes in for ships in the size of the targets "vertical and horizontal, which vary according to the angles the path of the shot "makes with the line of keel." I wish to inquire whether Captain Colomb means to ignore any difference as to what part of a ship is struck by the shot—whether all parts are considered equally vulnerable, that is, whether a shot striking, say at the waste water pipe, or entering a port, or at the water edge between wind and water, is estimated at the same value as a shot striking the most invulnerable part of the ship? In other words, whether the comparative value of the side-and end-on hits is to be estimated only by the angle of incidence?

Captain J. C. R. COLOMB: That question as to the relative value of speed is a

very important one. It appears to me the war game may throw a good deal of light upon it. My only object in rising is to say I think it is very desirable to try one thing at a time. The main principle it appears to me to be discussed this afternoon is the relative importance of broadside to end-on fire. Of course I cannot pretend to a technical knowledge of this subject, but as one taking considerable interest in it I think a great deal of confusion and misconception has arisen from trying to settle too many things at once.

Captain P. H. COLOMB, in reply, said: I think the discussion has shown very clearly—as my brother has expressed it—that the chief difficulty in discussing these questions is to avoid trying to do too many things at once. We try, in point of fact, to run before we are in a condition to walk, and the consequence is, we sometimes leave discussions in this theatre with our ideas very nearly as unsettled as they were before we entered it, if not still more so.

Admiral Randolph thought I was not quite fair to him in saying that his only endeavour was to force his adversary to occupy the stern position. My reference is to the first diagram in his paper (a), where he assumes—and it is the only diagram he shows where the positions last relatively for any time—that A will be able to keep B on his quarter for eight to ten minutes. Then as to the chance of the "Alexandra" being rammed, I should explain to the Admiral and to the meeting, and I have stated it in an early paragraph of the paper, that I was not really replying to Admiral Randolph; I was taking a general view of the question as it appears to me, and as it was applied to our present ships, and that I have not assumed in the paper that the ships always had equal speed. I have throughout assumed that it was possible for them to have different speeds, and I have used the effects of those differences of speed in the case of the "Alexandra," the "Nelson," "Northampton," and so on. The Admiral thought I was also hard on him in saying he had made no attempt to force his enemy on his bow. Of course it is difficult to prove a negative, but I do not find in the paper any such attempt on the Admiral's part, and I conceived that he found a difficulty in forcing the enemy to remain on his bow.

With regard to my expression that the bow guns were really weak rivals to the ram, I think the expression is legitimate, and means a good deal. You are setting up your gun weapon side by side with your stem weapon; that is to say, you are setting up two weapons, one against the other, when, if your ram succeeds, it is perfectly certain your gun is neither here nor there. And I am quite sure of this one point, that when you are delivering your ram blow you will allow nothing in the shape of gun-fire to distract your attention from that; and you will distinctly forbid the fire of the bow guns in case the smoke should interfere with you just at the last minute.

Admiral Randolph said it was not fair to pit a "Bellerophon" against a "Nelson" or "Northampton," speaking as though the "Nelson" and "Northampton" were not armoured ships. They are armoured ships: they have an armoured deck under water, armour at the water-line, and armour at both ends of the battery. The broadside guns alone are not protected; everything else is. To say it is not fair to pit the "Bellerophon" against the "Nelson" I think is incorrect. You must take ships, to compare them, of something nearly the same cost, and something nearly the same displacement. Now the "Nelson" cost 333,000*l.*, and the "Bellerophon" 342,000*l.*, only 9,000*l.* difference. The "Nelson's" displacement is 7,323, and the "Bellerophon's" 7,551. I do not think you could have got, throughout the whole Navy, two ships more nearly equal to compare one with the other, except in the differences of arrangement of armour and armament.

Admiral Randolph and several other speakers advocated, as far as I understood them, the continued variation of our ships, because we could not quite see how they were likely to be employed. A letter appeared in the *Times* the other day from the Chief Constructor of the Italian Navy, in which he took a very different view. He said, "We first of all determine how we are going to employ these ships before we design them;" and he says, "We built the 'Duilio,' 'Dandolo,' and 'Italia,' with a distinct tactical object." My whole argument is that the Italian method so far is right, and that if we were to build and arm our ships without any definite ideas at all, we should be wrong.

Admiral Randolph also said he thought it was not possible to carry the heaviest guns on the broadside, though you may carry them fore and aft. I cannot of course answer as to that. As far as we have gone, the weights we have carried on the broadside have been carried successfully, and I do not know how much further we shall go. But I most cordially concur with the Admiral when he says after all the great question is the best handling of the ships. It is the whole question, it seems to me, and I take leave to say that I think I have been somewhat misunderstood if it is alleged I have put forward anything in my paper which would repel that idea. On the contrary, in the last paragraph I have put it most distinctly. I have said it does appear to me that a ship which puts her guns in a particular place, with a particular view, may, by the good handling of that ship, be in a better position than another ship which has put her guns all round so as to avoid practically the necessity of manœuvring. The contrary is more like Captain Scott's view, placing guns so as to cover the entire horizon simultaneously, and forgetting that the movement of the ship will give the real arc of training.¹ To keep all your guns to bear on definite objects seems to me a stronger position to take up than to place your guns so that whatever happens you may be able to fire some of them.

Admiral Randolph criticised my method of valuing shot, but I think he could not have quite carried my table with him. If you look at the table, there is an endeavour to do exactly what he suggests. You can only do it very roughly, but there is the attempt to do the thing. You see, when you fire a shot at your X 300 yards off, and the path of the shot is at right angles to the line of keel, I must call that the best shot you can fire at her; if you can penetrate at 300 yards you would certainly penetrate within 300, and if you fire straight at her, broadside-on, within 300 yards, you must make a very bad shot if you do not hit her. But when you fired at the same ship in the line of keel you would first of all have a smaller vertical target to fire at, and your shot would be liable to be turned by the light iron-work ahead or astern of the battery. Therefore, I take 10 per cent. off the value of that shot. Now we are still at the 300 yards range, and shot fired at a point (say) before or abaft the beam, certainly lose something by reason of not impinging exactly normal to the armour-plates. I take off 10 points for that, and in the same way I take 10 off for the shot fired at a point from the line of keel. Then I suppose a shot fired at four points to the line of keel would strike either the broadside, or transverse bulkhead, at an angle of four points, losing so much of its value as a penetrating shot because of the angle. So that we reduce the value of these shot to half the full number. Then if we go on increasing the distance, still firing at right angles to the keel, the value of the shot would go on decreasing as the square of the distance—continually decreasing, first, because of the difficulty of hitting, secondly, because of the smaller chance of penetration according to the distance.

Captain Long mentioned Admiral Bourgois, and Admiral Elliot said there was only one thing to be done, that was to run end-on. I do not quite gather that Admiral Bourgois would run stern to stern if he could do it in any other way. But the point is this: Admiral Elliot says "I will have the stronger bow," and I presume Admiral Bourgois would make the same demand, to run stern-on he must have the stronger bow. But how are you going to secure the stronger bow? You are asking for an impossibility. The two ships can go on strengthening the bow till they come to the limit of strength, and then they are equal. Then, to be reasonable, you must make a stem to stem encounter a drawn game, and I am quite satisfied nobody in real action will make a stem to stem encounter if he can avoid it; he will very often come close to it and avoid it just at the last minute. I think Sir Spencer Robinson really sufficiently answered Admiral Elliot. The difficulty in working the war game is to work it under distinct conditions, and under circumstances when we shall all be in agreement as to what is a loss and what is a gain. If you vary the armour and the guns in the ships, immediately you come to questions that are as yet insoluble, you get no further after the whole of your battles. But if, on the contrary, you take two definite ships and work them on paper in his way, your ideas will be wonderfully changed and very much enlarged and opened—very much more so than people are apt to think at least—because there is between those ships, as we

¹ See the rise of this idea in "Our Ironclad Ships," page 235.—P. II. C.

may fight them hereafter, the single difference of placing the guns. If everything is the same, except at this or that point, you will come to something like a conclusion as to which is the best way of placing the guns under those conditions. Then you may say, "Now we have got that, we will introduce another condition; we will increase the speed of one ship." We shall then come to know the relative value of broadsides and end-on when speeds are unequal, and so we shall go on till we get definite conclusions on that head also.

Admiral Elliot also argued against my view, that if guns were taken away from the broadside at all, they ought rather to strengthen the stern than the bow, and he used this singular expression: "If once I got on his quarter that ship is mine," meaning if he had superior speed. But that is what I have been saying all along. Admiral Elliot was rather fighting the war game without the necessary materials. We must pin ourselves down to very distinct and accurate conditions, or we get off the line of rail on which we ought to pursue our argument.

I am sure I have to thank all the speakers for the exceedingly complimentary way in which they have spoken of my small labours. This question of the war game is one which has long been in my mind; but the actual work I have had in devising this particular war game has really been very small. It so happened that my mind was prepared for it as soon as I got the "Thunderer's" experiments, and it became a very easy matter to turn those experiments to account in a form which no doubt will be improved upon, but under which, I cannot help thinking, there will be found some real stuff.

Captain Bridge did me only justice in thinking that I never would have lightly omitted to mention Captain Grenfell's splendid elucidation of the value of the Harvey torpedo, which I may perhaps be pardoned for saying I think killed that torpedo. I have in other places and at other times done the fullest justice to Captain Grenfell, but as I have said, that was a single point. Admiral Randolph has taken the whole question, he has taken two ships and fought them out, which nobody else has ever done. The only person I know of who has at all approached him is Captain Noel, in the essay which won the prize in the Junior Professional Association at Portsmouth. He took two fleets and led them up to one another and partially fought them, but he did not carry it through. Admiral Randolph has carried the thing right through, and has taken every possible sort of position in which a duel can be fought, and has thoroughly attacked that distinctive tactical problem. I do not think anybody else has done that before. Captain Bridge spoke of the change of opinion as to the end-on fire being due to the changed conditions which are chiefly influenced by the speed, but I think this is exactly the question we want to argue. Is it true that this power of keeping your speed should make you draw away your guns from the broadside, and put them on end-on, and especially at the bow? I fail to have heard any definite reasoning on the subject, and I do not think definite reasoning is to be got at except by experiment on paper, such as we propose here, and afterwards by experiment at sea.

Captain Bridge also spoke of the necessity of allowing for the chapter of accidents in the naval war game. I think I have considered that subject thoroughly. You have to recollect that the war game amongst military men is not to establish facts; it is to cultivate skill. Your facts are known; you know exactly what is the right thing and what is the wrong thing to do on shore amongst troops, because you have all the experiments of war before you. Under the present conditions, we in the Navy have no facts whatever to go upon, and our war game, for many years to come, until—as I hope we never shall—we have the opportunity of carrying out in fact on the ocean, it can only show us not individual skill, but the method in which we are to arm our ships and use them afterwards.

Captain Scott spoke of the "Enterprise" as to "end-on" fire. It was simply that the guns shifted; there was no actual withdrawal. He also appears to omit the fact that the movement of the ship itself will always give arcs of training, and that if you have a skillfully-handled ship you will get your arcs of training by the movements of that ship, and the necessity of providing for arcs of training appears to me to be going into the background, and not forward.

Then as to yawing, I must express a somewhat definite opinion. Many years ago, when I was in command of a small vessel, I used to practise it continually. I had

very few guns in the ship; they were heavy, and I felt if I were called into action the chances were I should either be the following ship or flying, because there were other ships of my size with more numerous guns on the broadside. I used to make very fair practice indeed with continually yawing, firing broadsides, and I think at any reasonable distance firing broadsides by word of mouth or electricity you will make very fair practice indeed.

I sometimes disagree with Admiral Selwyn, and I am exceedingly glad to be in agreement with him now. I think he put the case quite properly when he said the way to argue these questions is by means of the war game. I think, however, that too much stress has been laid upon the necessity for an umpire, for it seems to be considered that the umpire will have a great deal of work. So far as my short experience of it goes, there is very little for the umpire to do. His only work is when you have missed your aim by a yard or two ramming; up to that moment the umpire has practically nothing to do. When the game is published you will see what use there is for the umpire to decide before the game begins, because practically the umpire must represent the chapter of accidents that Captain Bridge spoke about. He will decree the number of minutes the fight is to last, and he will stop you at that time, as you would be stopped in actual war by the presence of a superior force; by driving your enemy into shallow water; by neutral waters, and so on, and he will also, when he thinks proper, pop a shoal down close to you when he wants to vary the game. But as to actually deciding, I think we shall find the points are generally so clear that the umpire will have little more to say than in a game of chess.

Admiral Selwyn seemed to say that enemies would not fight on an equality. I think that is exactly the ultimate result of all tactics. You saw that in the establishment of a line-of-battle. They fought on an equality from the time the line-of-battle was adopted by the Dutch till Nelson showed them a better way. Nobody had thought of anything beyond it. And that will be the case, I take it, in naval war, that when each side has got that which is really best—not best in his opinion, but really best—in both nations then you will fight on an equality. But I think the tactician's aim is to make sure that he is not fighting on an *inequality*; that is what he has to look for. There is one other point I wish to correct. I think when we come to examine by means of these scales, we shall see that speed itself will not give you the power of ramming. When two ships are approaching end-on close to one another, the man who keeps his nerve and his wits, and understands thoroughly what he is about, and has the best steering apparatus, will know perfectly well that the stem of the other ship will never touch him. The least touch of the helm when the ships are nearly end-on to one another will make them certainly pass broadside to broadside, rub, and so on. To effectually ram you must have, as well as speed, the superior turning power. If you have not the superior turning power it will be very difficult indeed, first of all, to ram, and, secondly, to avoid being rammed yourself.

The CHAIRMAN: I should like to ask Captain Colomb whether he has any objection (in his preference for the broadside arrangement of armament) to allow the bow gun on each side to be trained right forward if the Construction Department makes no objection to it. I know it is possible for him to say "I have made up my mind that that is the proper way to place my guns, viz., for broadside firing ONLY, and I will not accept the power to fire the two foremost guns right forwards, and the two sternmost guns right aft, as I think it would be a temptation to the Officers in command to begin their action at long ranges when they are running towards the enemy, and therefore I would block up that port if it was made for me." I should like to ask that question.

Captain COLOMB: I am most anxious for bow fire if I get it without too great a sacrifice. If you show me a method by which you give me the power of firing my broadside gun as a bow gun or a broadside, I have no objection to the "Hercules" system at all except the second port, and really I should not care very much about that.

The CHAIRMAN: I am very glad to learn that Captain Colomb has no objection to two of his guns being able to be pointed right forward and two right aft, and he would of course leave it to the discretion of the Captain who is going to engage the enemy

as to whether he opens fire from that gun trained right ahead or on the bow or keeps it trained on the broadside. Therefore in point of fact he has no objection to his guns being placed on that principle, provided always that these ahead guns can be fired on the broadside: that seems to me the desideratum. All guns to be able to be fired on the broadside, and two of them are to be fired ahead and two astern, a combination of broadside and right ahead.

Allusion has been made to the Russian experiments. I had the opportunity of seeing what was done at St. Petersburg, and I must express my regret that our Admiralty, for some reason or the other, do not direct the Commanders-in-Chief on foreign stations to set their young Officers to try experiments in ramming with their launches, protected as they are always in Russia by fascines, so as to exercise them in this matter. If we are to have Captain Colomb's war game it will be very instructive to all of us, old and young. I hope their Lordships may in some way or other do as the French Admiralty do, that is, encourage young Officers at the home ports and on foreign stations to practise this game, which may be divided into (1) games of skill where the ships are alike; (2) games to test merits of arrangements of armament, one person fighting both ships; and (3) mixed games in which skill and merits of armament are both tested. In France young Officers are almost forced to attend on certain evenings at lecture rooms specially provided in each Dockyard to discuss important questions of naval tactics. Captain Colomb's game will be introduced immediately. When I was at Brest I asked what the discussion for the night was, and was told that it was what Villeneuve ought to have done at Trafalgar instead of what he did do, and that on the previous day the subject was what ought to have been done by Admiral Bruceys when Nelson attacked at the Nile and destroyed the French Fleet, and could anything have been done to prevent or diminish Nelson's success. Young Officers who joined in such discussions and war games were likely to form much better tacticians hereafter than those who did not, and they should be encouraged. Secondly, I never could understand why we do not hear the results of the important experiments going on constantly in our large squadrons, the Channel Fleet and the Mediterranean Fleet, in the matter of evolutions. We have had I do not know how many squadrons of evolution during the last ten years. Admiral Randolph commanded one of them, and was second in command of another. I have no doubt his mind and his memorandum books are full of important information which he collected. The drawers of some rooms at the Admiralty are full of reports from our best Officers on such subjects as "groups," how best to handle them in action. I have no doubt that Admirals Hornby, Beauchamp, Seymour, Commerell, and numerous others have arrived at conclusions having the force of axioms. Those Officers who have not had the good fortune to belong to these squadrons know absolutely nothing about what has been done, what conclusions have been arrived at. There are Officers on shore on half-pay who would be delighted to be allowed to witness these evolutions in a vessel attached to the fleet for the purpose, and I think they ought to be encouraged to do so, for by that means and by that alone can they obtain that amount of knowledge which is so absolutely necessary and would be so much prized. I am not speaking for my own advantage, my naval career is well nigh ended. I speak in the interest of the country and of the junior Flag Officers and senior Captains.

I have now to thank Captain Colomb on your behalf for his most interesting paper, and to assure him that the Council of this Institution will be asked to facilitate in every way the carrying out of the naval war game in this theatre.