On the necessity for a permanent commission on state scientific questions : [a paper read at the Royal United Service Institution] / by A. Strange.

J. Marshall Esq. F.R.S.

with the author's Compts.

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ON THE NECESSITY FOR A PERMANENT COMMISSION ON STATE SCIENTIFIC QUESTIONS.

A Paper read at the Royal United Service Institution.

(Authors alone are responsible for the contents of their respective memoirs.)

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Monday, May 15th, 1871.

COLONEL W. F. DRUMMOND JERVOIS, C.B., R.E., Deputy Director of Works for Fortifications, in the Chair.

ON THE NECESSITY FOR A PERMANENT COMMISSION ON STATE SCIENTIFIC QUESTIONS.

By Lieutenant-Colonel A. STRANGE, F.R.S., Inspector of Scientific Instruments, India Department.

THE duty of the Government with respect to science is one of the questions of the day. No question of equal importance has perhaps been more carelessly considered and more heedlessly postponed than this. And now that a hearing has been obtained for it, neither the governing class nor the masses are qualified to discuss it intelligently. The governing class, because it is for the most part composed of men in whose education, as even the highest education was conducted 30 to 50 years ago, science occupied an insignificant place; and the masses, because they may be taken to be virtually destitute of scientific knowledge. Those who wield, and those who confer, the powers of government being alike incapable of dealing with this question, it devolves on another section of the community to urge its claims to attention.

The section qualified to do this is composed of scientific men, properly so called, of professional men, such as engineers, and certain manufacturers who are engaged in applying science practically, and of a limited number of Officers in the naval and military services. This section is without much political influence, but its intellectual power is enormous, and this power has never been so strongly exerted, or so decidedly acknowledged as at the present time.

A tangible acknowledgment of the claims of science consists in the recent appointment of a Royal Commission "on Scientiffc Instruction and the Advancement of Science," which is now sitting. The problem

which this Commission is expected to solve is one of very great complexity, delicacy, and difficulty. It has to survey the whole world of scientific thought, and to construct a chart on which the districts that it is the duty of State to occupy, shall be clearly delineated, with boundary lines so drawn as not to trench upon tracts which may be best left to individual or corporate management. It has then to devise a form of government of which not a trace at present exists, fitted to administer the affairs of the newly acquired territories. Instruction in science is one thing, and, I admit, an indispensable thing, without which there can be no foundation for future scientific progress; scientific investigation is another and perfectly distinct thing, constituting the end to which instruction is the means. Each may be pursued separately and solely. But if instruction be scanty, investigation will be unsound; if investigation is neglected, progress must be impossible. It will be for the Royal Commission now sitting to point out the relation of instruction to investigation, and to decide how far and by what agency, the Government may beneficially aid each.

The first Report of the Royal Commission has been published. It deals with certain limited matters of detail only, relating to the occupation of some new buildings at South Kensington. Possibly the settlement of these details may have claimed immediate attention with reference to the arrangement of the buildings in question. This first report has therefore not touched the great problems above adverted to, which await the deliberation of the Commission, and an authoritative solution of which at its hands is anxiously expected by the scientific world.

It may be asked why, as a Royal Commission is investigating the relation of science to the State, the subject of the present paper should be brought forward independently of that body. The reply is, first, that discussions of any of the questions on which the Royal Commission is deliberating can hardly fail to afford light and assistance useful to the inquiry; secondly, that the problem submitted to the Royal Commission is, "How should the State aid science?" whereas the question on which I am to address you is totally different, namely, "How can science aid the State?" Although this latter question may be considered by the Royal Commission, it is certainly not necessarily a part of their programme, and as it is a question of at least equal importance with the former one, it is most undesirable that it should be overlooked.

To the question, "How can science aid the State?" I reply, "By "means of a permanent scientific commission or council, constituted "for the purpose of advising the Government on all State Scientific "questions.

In order to apprehend the aim of this proposal, its practical operation and probable results, it must be examined systematically and in detail. I propose to do this under the following heads:—

I. The scope implied by the term State scientific questions, and the importance of those questions.

II. How are such questions at present dealt with, and with what results?

III. What should be the constitution and functions of the proposed council of science?

IV. What objections can be alleged against the proposed council?

I. *The scope implied by the term State Scientific Questions, and the Importance of those Questions.*

In this term I include, first, everything relating to the construction of ships-of-war, and of their armaments, ammunition, and equipments, —to naval sanitary arrangements, and to the employment of the naval service on explorations and scientific researches generally. I include, secondly, everything relating to military ordnance, small arms, ammunition; to Army equipments of all kinds, to the sanitary arrangements of barracks and hospitals, to the construction and protection of fortifications, and to the employment of the Army for purposes tending to advance purely scientific knowledge. And I include, thirdly, all those questions of science which affect the civil life and well-being of the community, such as drainage, sewage, ventilation, contagion, telegraphy, meteorology, astronomy, surveys, and the physical sciences generally, so far as they are promoted by the Government. Many fiscal and commercial questions of great importance, which have a scientific basis, must also be included.

I have not attempted to specify all the scientific questions that come, or should come, before the Government of a civilized country. They are almost innumerable, and their simple enumeration would occupy the whole of my available space. They may all be comprised under the three great divisions—naval, military, civil.

As to their importance what need be said? Are an efficient Navy and Army important? Are the health and welfare of the general community important? And if they are, then let me ask, have we an efficient Navy and Army at this moment? Have we ships-of-war that command the confidence of sailors? Is our naval ordnance beyond any improvement? Are our land artillery and our military small arms perfect? I wish to avoid exaggeration. I will not say, as some do, that all these things are, with us, execrably bad; I will not even say that in many of them we are behind other nations; my case does not require the support of such extreme opinions. I shall, I believe, be able to maintain my ground by the statement, which few will attempt to controvert, that practical and well informed men consider all our naval and military armaments, equipments, and ammunition to be susceptible of improvement, and that such improvement can in most cases be effected only by attention to scientific principles. I must add to this another opinion, in which all competent judges will concur, that so long as human knowledge advances, in other words so long as the world lasts, there will be an incessant demand for improvement in these things.

The importance of civil and social questions into which science enters is at least as great as that of the questions to which I have adverted. If it is important that a community be protected from foreign invasion, it is equally important that the health, welfare, and

commercial and intellectual progress of the community for whose benefit costly naval and military forces are kept up, should receive due attention.

We have witnessed an example on the grandest scale, of the successful application of science to war so recently, that, before a naval and military audience, it must be quite unnecessary to dwell upon it. But these events have confirmed a conviction previously held by many who had seriously studied such subjects, namely, that in the present stage of human progress, science is indispensable to national greatness, that the arts cannot flourish, trade cannot prosper, knowledge cannot advance, war cannot succeed with a nation that neglects science. Other things also are necessary, a strong, just, and wise Government, constitutional and religious freedom, love of order and respect for the laws. Without these, also, there cannot be national greatness, but even with these the nation that is not foremost in science cannot be foremost in civilization.

Assuming these opinions to be sound, it is no rash assertion to say that "State Scientific Questions" are of immeasurable importance.

II. *How are such Questions at present dealt with, and with what Results?*

I wish to preface my remarks on this head by saying that they are not intended to apply to any particular party in politics. In speaking of the shortcomings of the Government, I mean to include ALL Administrations, whatever political principles they may have represented. I cannot perceive any difference worth noting between different Cabinets as regards science. All have, in my opinion, displayed, in the most elaborate manner, their incapacity to grasp science as a national matter. I am not aware of a single attempt on the part of any Government that has ever existed in England to define its duties with regard to science, or to model any administrative agency for dealing with it in a rational, efficient, and comprehensive manner. It would be invidious and unjust to single out any set of Ministers as having been more negligent in this matter than others, where all have been to all intents and purposes equally indifferent to it.

How then are State scientific questions now dealt with? The answer is, desultorily, capriciously, inefficiently, irresponsibly, when they are dealt with at all, but in many instances of the greatest moment they are absolutely neglected. The number of questions involving science on which Government has to decide, are innumerable and never ending. Every day adds to their number and their urgency. This vast increase of such questions has taken place within a period which, in the life of a nation, is very brief. At the time of the Crimean War our Artillery was many generations old. No attempt had been made during the time of any one then living to grapple with its defects. Our musket only a few years before was the old Brown Bess of antiquity—smooth-bored, muzzle-loading, lumbering, heavy, inaccurate, and inefficient.

Our Navy was of wood, and steam had only been partially intro-

duced into war vessels. Since that time, a revolution in such matters has taken place. Rifled and breech-loading cannon and small arms, armour-plated steam ships, new projectiles, new ammunition, and new equipments of all kinds have been introduced; but none of these things have been created at once; they have grown by successive stages, and are perpetually growing and undergoing modification; their condition has always been, and still is, one of transition. Foreign nations have entered on the same labour of reconstruction, and there is, therefore, or should be, a keen competition between them and us. In the national advantages of greater wealth, more extensive mineral resources, larger manufacturing power, no people can vie with us. What provision does our Government contain for utilising to the utmost these unrivalled advantages? What are the official arrangements by means of which the administration of the day can successfully apply the discoveries of science to the developing and perfecting of our naval and military appliances, not to speak at present of the multitudinous wants of civil life that clamour for attention?

The reply is that our official scientific arrangements are substantially the same now as they were in the pre-scientific era—they may be more extensive in degree, but they are the same in kind,—the butter may be spread further, but there is not more butter. The enormous scientific activity of the last 30 or 40 years does not seem to have struck the official world as a fact having a bearing on the humdrum routine of the Departments—more secretaries—more clerks—more subordinates of various kinds have been appointed to prevent accumulation of arrears; more committees of inquiry have sat, more scientific witnesses have been examined, more reports published, if not read. But not a single step has been taken towards the creation of an *organisation* capable of concentrating and directing all this scattered effort.

The example of foreign nations, the pressure of the public, and the demands of inventors, daily set before the Government scientific puzzles, which they are often, if not generally, at their wit's end to solve. It never seems to occur to them that these puzzles will never cease and that they will increase in difficulty as a matter of absolute certainty. The attempt is made to stave off by temporary expedients work of a permanent character. The puzzles are guessed at, and the guess is oftener wrong than right. Problems too deep for guessing are either pushed out of sight or submitted to methods of investigation that end in a blunder, perhaps a catastrophe.

I do not wish either to declaim or to exaggerate. I will briefly indicate the provision that does exist for the solution of State scientific questions. It is of three principal kinds. First, official subordinates in various departments. Second, temporary and special committees. Third, consultation with individuals eminent in science, or with scientific bodies. I omit debates in Parliament, because no scientific question ever was or will be solved by such an assembly, and I omit also the press, which is so influential in other respects, as altogether unreliable for such inquiries.

The objections to the first kind of provision, viz., official subordinates, are, that such persons have almost invariably other duties of an execu-

tive nature to perform, and have not therefore the leisure necessary for scientific investigation. Science, moreover, is now in a stage in which scarcely any one problem can be adequately grasped by a siugle mind; this remark particularly applies to State scientific problems, which are invariably of a mixed order, requiring a great variety of attainments for their perfect comprehension. Lastly, subordinates are disqualified for the office of advisers by the very fact that they are subordinates. No inferior can be expected to urge distasteful counsels on a powerful superior, and no superior can be expected to abandon his own preconceived ideas in consequence of the timid and feeble remonstrances of an inferior under his orders. Subordinates then are unfitted to be counsellers, because they must in the majority of cases be deficient in leisure, attainments, and independence.

One clear, decided example of the inadequacy of this source of scientific advice is as good as a thousand. There can be no more apposite example than that of the ill-fated ship "Captain." The design of this ship came from without. Captain Cowper Coles, though a naval Officer, must be considered as a typical independent inventor. He urged his ideas on the Admiralty by every available means, by papers and lectures at this and other Institutions,—by articles and letters in the public journals,—and by interpellations in Parliament. He was, no doubt, actuated by excellent motives. He was of a most ingenious turn of mind, and had a very persevering, energetic nature. But no one has said that he was a man of science. It was perfectly well known to those who knew him at all, that he was nothing of the kind. His inventions were precisely of that order that required strict scientific investigation. They were novel; they involved complex and even contradictory conditions, and they touched the most vital interests of the nation—her naval supremacy. So difficult is the problem which they represent, that although perhaps no such problem ever underwent so much anxious and able investigation, no generally accepted solution of it has as yet been arrived at. This tremendous issue was left in the hands of the Admiralty and its subordinates. We know with what result. It is not my purpose to fix the blame of that result on any individual. It has not, in my opinion, indeed, been brought home to any one in particular. But there stands this indisputable fact that the most recent specimen of English naval architecture, given to the nation under the auspices of the Admiralty and its advisers and subordinates, went to the bottom in an average squall. It is idle to say that no responsibility rested in this particular case on the Admiralty officials. One thing of three must have happened. Either the design was not thoroughly investigated by the Admiralty subordinates,—or, if investigated, it was not objected to by them,—or, if objected to by them, their advice was disregarded by their superiors. Whichever of these was the true cause, the imperfection of the system is equally established. The Admiralty wished to adopt Captain Coles's design, and either the knowledge or the authority necessary to prevent so fatal a mistake, was wanting. Can it be for a moment supposed, that had an established, competent, and independent adviser of the Government pronounced an authoritative No, any Minister that ever lived would

have dared to act in opposition thereto? But there existed no such adviser,—and the ordinary official advisers were either supine or overridden,—for the purposes of my argument it matters not which.

The second expedient—temporary committees, has been very largely employed for the purpose of guiding the Government through their scientific difficulties. There are very serious objections to this expedient. First, there seems to be no rule, either for their appointment or for their composition. If the Government is much pressed by public opinion (which on such subjects is not over-well informed), or if it sees a difficulty ahead, which, however, it often fails to do, a Committee is the result. But there is no guarantee for the proper composition of the Committee. There always lurks about some of the names a suspicion either of incompetence, or of leaning towards the supposed foregone conclusion of the Government. But, passing by such suspicions, there remains the fact, that the members are selected either by some Minister who, not being a scientific man, probably knows nothing about the qualifications necessary for conducting the proposed inquiry, or by some outside and irresponsible person to whom the Minister has applied for help. It is quite overlooked that the selection of the proper persons for conducting any given inquiry can only be made by some one having a knowledge of the subject of the inquiry, or of subjects cognate thereto; the selection is in itself a scientific question. Though some temporary Committees have done good service, it may be safely declared, that on the whole they have failed to give reasonable satisfaction.

A second objection to such Committees consists in the fact itself that they are temporary. As such they necessarily commence their labours, however well they may have been selected, with but a partial and confused knowledge of the question at issue, and much time is lost in gaining some insight into it. After much work and expense, they reach a certain stage in the inquiry at which a report is possible. Perhaps by that time the public pressure or other cause that led to their appointment, has died out, or action is necessary,—in either case the Committee is considered to have served its purpose, and is broken up; the members disperse, take up other duties, the knowledge of a particular subject which they gained in the course of their inquiry is lost to the country, and a scientific problem is left half solved, until at some future day it must be taken up again for completion, and all the old work gone over *de novo*. The system of temporary Committees, in fact, implies a belief that finality is attainable in those mixed scientific problems in which chiefly the State is interested, or that such problems can advantageously be taken to bits and studied piecemeal; whilst the fact is, that no one such problem that can be mentioned ever has, or ever will, as long as human ingenuity survives, come to an end. Permanent arrangements alone can deal with the unbroken continuity and unceasing change of scientific development.

A third objection to such Committees consists in the fact that much of the investigation carried on by several Committees may be common to each. This involves the repetition of the same work, and great consequent waste of time, effort, and money; besides sometimes leading to

perplexing contradictions in the respective results. This would be avoidable if the various Committees were subject to one common authority, and were instructed to avoid needless repetitions of the same or similar researches. But no such common authority exists in England. Scientific Committees work, therefore, as independently of each other as if their respecaive inquiries could be of no use to any but themselves.

A recent debate in Parliament throws much light on the constitution and functions of such Committees. It related to the Martini-Henry rifle, and took place only a few days ago, on the 28th April. I will cite some extracts.

Colonel Barttelot, in moving for a Select Committee of the House of Commons, said:—"Why for the last 15 years we have been doing "nothing but arming and re-arming, and building and re-building. "Thinking we had found a better method of building ships, thinking "we had found a better method of constructing guns or small arms, "we rushed with precipitate haste to a wholesale execution of the idea "of the moment, and before the idea of the moment had been fully "embodied, at vast public expenditure, some superior inventions were "brought forward, and the whole thing had to be done over again."

These words illustrate my last remarks. In another place he stated:—"The House was aware of the enormous sums which had been "expended upon the trials of various weapons, and from a return "which he had obtained he found that £232,227 had been given as "rewards to inventors of ordnance, and £80,124 to inventors of small "arms. Those sums, however, did not include the cost of the experi- "ments entered into to try the value of these different arms, which "had amounted to an enormous sum. For instance, no less than a "million of money had been expended upon the 4-ton 7-inch Arm- "strong gun for the Navy, which, after all, had been condemned. And "the country was now to be called upon to sanction an expenditure of "three or four millions upon a weapon, the value of which was, at all "events, doubtful."

And, again, speaking of the witnesses examined by the Committee, he said:—"When gentlemen received a fee of 50 guineas—for that "was the sum paid to those witnesses—although he admitted that they "were men above all suspicion, yet they would naturally be more "inclined to advocate one side of the question than the other, if they "possibly could."

Lord Elcho, opposing the Select Committee of the House, and defending the Martini-Henry Committee, of which he was a member, gives this account of its origin, constitution, and functions:—"Prussia "had used breech-loading arms to suppress the revolutionary movement "of 1848, but it was not till 1866 that steps were taken to supply our "Army with a breech-loading weapon. In that year General Peel, "then Secretary for War, offered three prizes—one of £1,000 for the "best combination of qualities in a military rifle; another of £600 for "the best breech-loading arrangement; and a third of £400 for the "best ammunition. An invitation was sent to a number of gunmakers, "and 105 responded to it. In March, 1867, a Committee was

" appointed, consisting of Lieutenant-Colonel Fletcher (President), " Captain Rawlins, Captain Mackinnon, Earl Spencer, Mr. Edward " Ross, and Captain Hay, of the Royal Artillery, who was Secretary. " This Committee reported in 1869."

It issued five Reports, which his Lordship described; he then proceeded :—" The powers of the Committee were then extended, so as to " enable them to examine and report upon the best arm for the " service."

After describing the Reports that followed this extension, he said :— " Immediately after this, two minor Committees were appointed, one " consisting of military members of the original body, to consider such " questions as those of bayonets, muzzle-stoppers, and the rest, and " the other to report upon the powder best to be used, and other similar " questions. The second great division commenced with the appoint- " ment in May, 1870, of the Commitiee with which rested the final " decision."

There seems to have been a perfect jumble of Committees.

But the most remarkable fact concerning the composition and functions of this very complex Committee is thus described by his Lordship :— " When it was proposed to him to serve on the Committee, he stipu- " lated that the best and most decisive scientific and mechanical " authorities should be invited to examine the breech action. The " question arose who should be on the Committee, and he recommended " Mr. Gregory, President of the Institute of Civil Engineers. " Mr. Gregory was added to the Committee, and was consulted as to " the scientific witnesses who should be examined. He recommended " Mr. Bramwell, Mr. Nasmith, Dr. Pole, and Mr. Woods as scientific " men, and Colonel Dickson, Mr. Perry, a practical man from Enfield, " Captain Beaumont (South Durham), and Mr. Martini were also " added to the list. It occurred to him that the scientific evidence " would be overhauled, and he asked Mr. Gregory the grounds upon " which he had recommended these gentlemen to the Committee. " Mr. Gregory replied that they were not only men of high scientific " character and distinguished antecedents, but also of different orders " of mind and methods of treating the subject."

From this it is clear that the scientific element in this scientific Committee was quite an after-thought, due to Lord Elcho's sagacity.

I gather from the expressions " the best and most decisive scientific " and mechanical authorities," and " the scientific witnesses," and from the fact, which can hardly be gainsaid, that the witnesses named above were more conversant with mechanical and scientific subjects than the members of the Committee, that the Committee was expected rather to collect evidence than to investigate for itself and arrive at its own independent scientific judgment. If the Committee was fully qualified for the task, which is nowhere asserted by Lord Elcho, it would not have required the assistance of scientific witnesses; if it were not qualified, neither would it be competent to elicit and sift evidence on a subject on which even scientific opinion might be expected to differ very widely. It appears to me that the witnesses,

or persons with their special qualifications, should have composed the Committee.

The next speaker was Mr. Bass, who said, with perfect truth, "The "question was certainly one of a purely technical character, and no "one could thoroughly discuss it who was not master of all the tech- "nical details; adding, "It would not be easy to find a higher "authority upon it than Mr. Whitworth, and he was informed that "Mr. Whitworth was totally opposed to the rifle under consideration."

Another speaker, Mr. Malcolm, justly "ridiculed the proposal for "referring this question to a Committee of that House, who would "merely be able to weigh the evidence of the gunmakers on the one "side or the other. No Committee of that House could afford the "time for going down to Woolwich Marshes and practically testing "the rifles in every possible way;" which, however, was all that the original quasi Scientific Committee it appears was expected to do.

Colonel Jervis, a high authority, then remarked:—"These inven- "tions were constantly cropping up one after another; improvements "rapidly followed on each other; and he believed it would be many "years yet before they got what might be called a perfect weapon," a remark which strikes at the very root of temporary Committees, though no substitute for such Committees is hinted at by this or any other speaker in the debate.

It is noticeable that speaker after speaker in the debate questioned the fitness of the House of Commons to discuss a technical question. There was an evident dissatisfaction with the decision of the Committee, and a desire to revise it, yet no one could point to a tribunal qualified for the task. It was well known to all that no such tribunal exists in England. But the dilemma suggested no remedy to any one. Nothing was left but either to accept the distasteful decision of the Committee or to appoint a Select Committee of the House; and the latter measure, as a self-evident absurdity, was very properly negatived by a large majority. The Martini-Henry rifle, therefore, for the present stands its ground in spite of considerable opposition and distrust. It is not my purpose on this occasion to give my own opinion on that rifle. I aim at a much larger and more important object. Nor do I intend in the most remote manner to question the zeal and fairness of the Committee. I seek a different lesson from this particular example—one quite apart from individual matters of any kind.

What I learn from it is this—that temporary Committees, as usually constituted, have not the weight of authority necessary to command public confidence, and that the work they are set to do is not temporary work, but continuous work, needing perpetual revision, and never coming to an end.

I come now to the third source from which the Government draws its scientific inspiration, namely, individuals eminent in science and scientific bodies. Recourse is had to such sources without any system whatever; there exists no rule, for instance, defining what cases should be submitted to an individual, what cases to a scientific society, and what cases to a temporary committee. Nor is it possible to assess the

degree of responsibility attaching to an individual or to a scientific society advising the Government. If the advice so obtained is rejected, nothing about it is known publicly; if it is adopted and turns out unsound, the right to blame the adviser is absent. It is impossible to ascertain when such consultations have occurred, and with what results. The probability is that they are not frequent. During the two years that I served on the Council of the Royal Society, I only remember one application from Government for advice. It was on some point connected with coppering ships. A committee was formed of the most competent persons, and probably very sound counsel was afforded. But it is evident that this is an expedient that cannot be frequently employed, as it would occupy too much of the time of the Society which should be devoted to its legitimate objects. Advising the Government is certainly not one of these, nor should the Government of a great, powerful, and opulent nation like England be reduced to such makeshifts as private societies for direction in matters of such tremendous national moment.

Having shown, I trust, that Government is without recognised scientific advisers, I proceed to discuss:—

III. *What should be the constitution and functions of the proposed Council of Science?*

The ground requires to be cleared before approaching this question. I have heard it urged that the various Departments of the State should be complete in themselves, each with its own consultative element, as distinct from its executive. This appears at first sight a plausible arrangement, but it will not bear examination. Many of the scientific inquiries that devolve on the Government affect several departments, and in such cases it would be wasteful to have numerous repetitions of the same investigation when one would do; and if, under the supposed arrangement, one investigation of a given class of subjects was decided on, the selection of the particular department to which it should be referred would cause endless bickerings and jealousies,—the co-operation of Departments being, like universal peace, a somewhat remote hope. Again several Departments would require identical scientific advisers. For instance few Departments could dispense with a chemist; a number of chemists would have to be employed where one or two would suffice. And further it would be found necessary to provide for each of the Departments requiring scientific advice, representatives of several branches of science. The aggregate number of scientific advisers would be enormous if each Department were independently efficient. Finally such a system would not be homogeneous, and would be found very difficult to work practically, on account of the diversity of decisions that would occur on questions more or less identical. There would then arise, just what has now arisen, want of a final court of scientific appeal to reconcile discordancies and give certainty to the action of the executive.

For these reasons I discard this suggestion, and revert to the proposal which forms the subject of this paper, namely, that there should

be one permanent great council for advising and assisting the Government on all State scientific questions. This council should be purely consultative, not executive. All Departments should equally be entitled to its assistance. The Council should not be expected to initiate questions, though it might occasionally see fit to propose certain investigations to the Government, without whose sanction, however, they should not be undertaken. The Government should not be bound on all occasions of scientific difficulty, either to resort to, or be guided by, the opinion of the Council; but it would of course become in either case absolutely responsible for all consequences.

The proceedings of such a body would embrace a vast field. Since there is no branch of science with which the Government does not at some time or other come in contact, every well defined branch of science should be fully represented on the Council. There would require to be pure and mixed mathematicians, astronomers, surveyors, chemists, physicists, engineers, physiologists, physicians, surgeons, naturalists, geologists, meteorologists; for some of these subjects two or more representatives of their different subdivisions would be needed. The naval and military services of all arms, and the commercial element should also be present. Probably not less than 50 members would be required for thorough efficiency. The Council of the Royal Society numbers 21 members, and this body takes little or no cognizance of naval and military questions, nor of those relating to public health, except indirectly, as illustrating philosophical views.

The Council would conduct its business by means of working sub-committees, into which it would divide itself for specific purposes. The reports of such sub-committees should be submitted to the whole Council for general discussion, and the responsibility for the advice ultimately tendered to the Government should rest on the Council as a whole, not on the section or sub-committee with which it might have originated. This mode of working would insure dispatch of business, special aptitude in the investigators, and large views derived from a great variety of attainments and habits of thought. Decisions thus matured could not fail to command public confidence.

The duties that would devolve on this Council, stated broadly, would be—

1st. To advise the Government on all questions arising in the ordinary routine of administration, submitted to it by the various Departments.

2nd. To advise the Government on special questions, such as the founding of new scientific institutions, and the modification or abolition of old ones; the sanctioning of scientific expeditions, and applications for grants for scientific purposes.

3rd. To receive, consider, and decide upon inventions tendered to Government for the use of the State.

4. To conduct or superintend the experiments necessary to enable it to perform the above duties.

As to the first branch of its duties little need be said. The number and variety of questions involving scientific considerations entering into the current work of the different Departments are almost unlimited.

A large proportion of them could be answered at once by competent persons, but there would remain many that would require investigation, discussion, and often experiment.

The second branch, special questions, would not perhaps be so extensive, but it would be exceedingly important. At present there exists literally no provision for dealing with such questions. Sometimes one person, supposed to have a knowledge of the matter at issue, sometimes another is consulted, sometimes no one. At present the Royal Commission now sitting is probably dealing with the subject of existing and required scientific institutions. But supposing this body settles all such matters in the most satisfactory manner at the present time, a reconsideration of them will very soon be demanded by the rapid advance of science, and the perpetually changing relations of different lines and modes of physical inquiry. But the Royal Commission is a temporary body. Its functions will sooner or later cease, whilst the mutations and permutations of scientific thought are incessant. Questions relating to State scientific institutions require ceaseless watching,—never-ending modification. A permanent body, such as I propose, alone can preserve the national scientific establishments in a condition of vigorous efficiency on a level with the existing state of physical knowledge.

The sanctioning of special scientific researches and expeditions will be a very important duty, which there is at present no one qualified to perform. Last year, when the aid of Government was desired for the Solar Eclipse Expedition, this want was strongly felt. The men of science went first to one Department and were snubbed by it; they then tried another, from which they did not receive even a snub, their communication being totally ignored. Ultimately, a private individual obtained by personal influence an interview with the Chancellor of the Exchequer, and succeeded in inducing that Minister to sanction an object with which his particular Department had no concern. Had there been a Department for Science, none of this fumbling would have occurred; but as it was, the expedition was almost rendered impracticable by delay, and its object was only attained through the strenuous exertions of a few energetic private individuals voluntarily devoting their time to the purpose.

Analogous to this is the case mentioned last year at a conference at the Society of Arts* by Lord Henry Lennox, that recently "wishing to "ask a question in the House of Commons as to the National Collec- "tions, he found that, if he put his question at all, he must put it to "four or five different Members of the Government, and perhaps to "one gentleman who was not a member of the Government at all. "He therefore was obliged to put his question to the Prime Minister, "as representing the collective wisdom of the Government, although "those who really had to supply the answer, were sitting around "him." I question whether the state of things here described exists in any civilised country but our own.

Sanctioning of grants of money for aiding scientific objects comes under

* "Soc. of Arts Journal," 8th April, 1870, p. 454.

the same head as sanctioning expeditions. At present £1,000 per annum is granted by Government for such purposes, and it is distributed by the Government Grant Committee of the Royal Society. As a member of this Committee I can testify to the extreme care, fidelity, and impartiality with which it performs this gratuitous duty. The amount of the grant might with advantage be much increased, as at present only small sums can be given out of it to each applicant; these are often quite insufficient, and as they must unavoidably be small, no application for aiding extensive and costly researches can expect efficient aid from so narrow a source. The proposed council would be a public body, precisely qualified to perform the duty now imposed on private individuals.

The third branch of duties devolving naturally on the Council would be the dealing with inventions tendered for the use of the State. Perhaps my views on this point will not lose force from the fact that I have never tendered inventions to the Government, and am not personally interested in any such. No duty which I propose to assign to the Council is more important than this. At present the different departments are inundated with inventions, which there is no one possessing both the needful qualifications and the requisite leisure to grapple with. They should be relieved of this oppressive labour and responsibility. It is quite notorious that both the Departments and the inventors have great ground for complaint. The Departments because they do not possess machinery adequate to cope with the flood of inventions, and inventors because their proposals often do not and cannot receive fair attention.

Inventions offered to Government may be classified under two principal heads—the mature and the embryo. The mature inventions require judgment to be exercised as to their acceptance or rejection—a contrivance good in itself may be unsuitable to the policy of the Government, or to the conditions with which it would, if adopted, have to be combined, as, for instance, a particular kind of gun might not suit the class of ships then building. With this order of invention only a mixed body of professional and scientific men could satisfactorily deal.

The second order—the embryo inventions—include every imaginable conception, from the utterly valueless crotchets of visionaries to germs of the most magnificent promise. Can any one pretend for a moment that we possess the means of sifting patiently and discriminately the heterogeneous mass of suggestive ideas that the most inventive people in the world are daily accumulating?

The ordinary official view of the matter is that individuals must be left to work out their own ideas. In many, perhaps in the majority of cases, that may be true, but now and then a suggestion may come from one too poor to work it out, which, if the powerful resources of the State were applied to it, would turn out to be of priceless value. Should we despise the pearl because the search for it is laborious?

All inventions offered to the State should come before the Council of Science, who should advise the Government as to the adoption of some, and as to aiding in the development of others. The examination to

which such a body would subject such proposals, though it would probably not satisfy each individual projector, would certainly satisfy the nation that this wide and creative sphere of its intellectual supremacy was receiving fitting attention—no such satisfaction at present is felt.

Again, though many inventions are adopted by the State, the inventors do not always receive liberal treatment. At present, as the law stands, the State has a right to the free use of a patented invention, and this seems necessary. But the State properly admits that the proprietor of a useful patent, thus adopted, should be remunerated. Theoretically that seems very fair, but practically the amount of the remuneration is fixed by the Government or by the Department using the invention, and this amount is often niggardly in the extreme. If it were fixed by an independent and highly qualified body like the proposed Council, a nearer approach to an equitable arrangement of such matters would probably be arrived at.

It is impossible to speak of inventions without suggesting thoughts of patents. I propose to say very little regarding these monopolies, because a discussion on our Patent Laws is very far from being the object of my present address. Though very divergent views are held on the subject, all are, I think, agreed that our present patent system is glaringly defective, neither affording to inventors due encouragement and security, nor to the community generally, adequate legitimate advantages. The question how to improve this most unsatisfactory system is one of extreme difficulty, involving a multitude of nice legal points, and of equally subtle scientific considerations. The Judges say that the problem cannot be solved by themselves singly, and that special scientific aid must be afforded them. Where is this to come from? Whence could it come with such authority and impartiality as from the Council, whose creation we are now considering?

The 4th class of duties which the Council would have to perform would relate to the experiments and investigations necessary to enable it to perform the duties previously enumerated. Regarding the necessity for providing the Council with the agency, appliances, accommodation, and funds requisite for these purposes, there can hardly be two opinions. They are absolutely indispensable. I need not here attempt to define what would be wanted. Such details would follow naturally the affirmation of the great principle involved in the creation of the Council.

I come now to a question on which opinions may differ—namely, the question whether the Council should be a paid or an unpaid body. I say, unhesitatingly, that it should be handsomely paid. If the heads of duties to be performed, of which I have given but an outline, be duly considered, it will be seen that they will be laborious, responsible, and beneficial in the highest degree; and that they can only be adequately performed by highly qualified persons. It is idle to expect that such men as will be necessary, will devote themselves almost exclusively, as they will have to do, to such labour from pure love of science and of their fellow-creatures. The delights of philosophical speculation are one thing, carrying with them their own reward—a

reward beyond any money consideration; downright official routine work is quite another thing. In no other professional field is it unpaid; nor is it ever worth much if not paid for. It has hitherto been too much the custom to treat men of science as exceptions to all other professions; to assume that whilst it is quite proper to enrich and ennoble soldiers who fight for pay, lawyers who evade or apply the law according to circumstances; physicians who kill or cure as seemeth best to them, and even divines, whose mission to save souls might be deemed a sufficient privilege; the man of science who contrives the arms with which the soldier won his fortune and his coronet, who surrounds the lawyer, the physician, and the divine with the luxuries which their superior privileges enable them to command, should work for love, and die, as he too often does, in poverty.

If the Council, the creation of which I now advocate, does its duty, it will confer benefits untold on every member of the community, from highest to lowest; from the military and naval appliances necessary to protect our unequalled national wealth, down to the smallest and least regarded necessaries of our ordinary life, the influence of this Council will be felt; and is it either just or wise to expect such benefits for nothing?

The salary that I should recommend as appropriate would be £1,500 per annum to each member of the Council. It may be urged that there will be no guarantee that these offices will not become sinecures. Of course neglect of duty may happen here as elsewhere; but care in selecting the members will afford some hope that they will be men of honour, and, as a rule, true men of science are seldom idlers. But an incentive to work may be given by the principle adopted on boards of public companies—namely, payment according to attendance. I need not, however, dwell on such matters of detail.

My sketch of the proposed Council will not be complete without some indication of the mode of constituting it.

The two characteristics which it is most essential to ensure are high qualifications and the most entire freedom from political bias. The members would probably be of three classes—1st, ex-officio members, being heads of certain existing State scientific institutions, such as the Astronomer Royal, the Director of the School of Mines, the Mint Master, &c.; 2nd, military and naval members; 3rd, scientific members, not of either of the two first classes.

Regarding, 1st, the ex-officio members, nothing need be said. The election of the 2nd class might be initiated by that part of the corps to be represented then serving in England, as for instance the Engineers, the Artillery, or the Navy. The arm of the Service requiring a member, should select four names; these should be sent up to the Council, who should reduce them to two; and of these two the Government should be bound to appoint one, without power to reject either of them, or to substitute a nominee of their own. For class 3, the scientific societies would form the best constituencies; and the election might be conducted in the same manner as that of class 2,—four names being first selected by the Society whose branch of science had to be represented, these reduced to two by the Council itself, of whom one

should be appointed by the Government. In this way each arm of the Service or branch of science would be represented by a person in whom they had confidence; the Council, itself powerfully interested in the efficiency of its colleagues, would have a voice in their election, and the Government would also participate to a moderate extent in the ultimate result. I do not give this as the only or the best form of election, but as one of many feasible forms by means of which an efficient body, free from suspicion of subserviency to the Government of the day, may be constituted.

I come now to the last division of my subject.

IV. *What objections can be alleged against the proposed Council?*

Difficulties innumerable can of course be conjured up in this as in every case of reform, but I have only heard three definite objections raised that seem to me to deserve any notice. They are:—

1st. That this is a system of centralization, and therefore objectionable.

2nd. That it will be liable to jobbery.

3rd. That it will be too costly.

I will touch on each of these briefly.

As to centralization, I admit the impeachment, but claim it as an advantage, not an evil. Those who are scared by centralization forget that it constitutes the very basis of civilization and of stable efficient government. In primitive savage life there is no centralization, no united effort for a common purpose. Each individual struggles single-handed for his rights. Civilization teaches us to set apart certain members of the community for purposes beneficial to the whole, to form them into distinct bodies, having definite duties to be executed, under the direction of a head central authority. The Army, the Navy, the police, the post-office, are examples of such bodies, the animating and ruling law of which is centralization. In the case of the police, we have local, in the other cases imperial, centralization. The body we are considering will have to perform duties of a strictly imperial character, contributing directly to the efficiency of the defensive power of the empire, and to the security and well-being of every member of the community. It is a body which not only would not be effective, but which could not exist but in a centralized form.

As to the second objection, that the arrangement I have proposed would be liable to jobbery, I must own that, as I contemplate the employment of human beings only, I do certainly expect to see the operation of human motives. But if jobbery be a fatal objection to the scheme, then on the same principle we ought to have no Army, Navy, church, bench, magistracy, municipalities, or Parliament, for in each of these the discovery of some traces of jobbery will probably reward a diligent scrutiny. It is not apparent why a degree of purity not dreamt of in regard to any other profession should be insisted on when science is in question; nor is it clear why men of science should, *à priori*, be deemed more corrupt than their neighbours. Of course

every precaution should be taken against corruption in so important a body, and the rest must be left to that sense of honour to be found in all other professions, and of which even men of science are perhaps not entirely devoid.

The third objection, undue costliness, is, in my opinion, as invalid as the other two. My proposal has two main objects—to increase efficiency, and to diminish blunders. Both are in the strictest sense economical objects. If it does not seem calculated to attain these objects, it should on no account be adopted. If it gives satisfactory promise of their attainment, no expenditure that it is likely to occasion will be too great in order to secure them. Let any one who is terrified by the cost, visit our ports, dockyards, and arsenals, and there see the ships that have been built which should not have been built, the cannons made that should never have existed, and the useless arms and equipments of the pre-scientific ages. Let him count the cost of these and compare it with the probable cost of substituting for the reign of haphazard ignorance, a reign of systematic intelligence. To take one example—that of Her Majesty's ship "Captain." This vessel, with her armament and stores, probably cost the nation three or four hundred thousand pounds. Who shall assess in money the value of the 500 noble lives that perished with her? Would not the nation willingly give a million to have them back? If so, we have as the cost of one single blunder committed by one Department something like a million and a half of money, a sum that would go a long way to permanently endow a body which, had it existed a year ago, must have prevented that blunder. But if I dwelt on the preservation, prolongation, and increased comfort of civil life which such a Council would certainly tend materially to secure, the cost of its maintenance would appear absolutely insignificant in comparison with the blessings it would shower on the nation. Against the cry of costliness I oppose the assertion, easily established, that nothing is so ruinous as disregard of the laws of nature, and nothing so profitable as intelligent obedience to them. Science, looked at in the dryest commercial spirit, must, in the long run, *pay*.

I must guard myself against the supposition that the proposal I have here advocated comprises all that is necessary for the efficient administration of scientific State affairs. It is only one part of a great system that has to be created. Other parts of the system will, no doubt, receive due attention from the Royal Commission now considering them. But there is one part so important that I feel called on to name it; I mean the appointment of a Minister of Science. He need not necessarily be exclusively devoted to science; he might, perhaps, with advantage, have charge of education and the fine arts also; but some one in Parliament directly representing the scientific branches of the national services has become absolutely indispensable. Another urgent want which, as its scientific character is not purely physical, will probably not be dealt with by the Royal Commission on Science, is that of a High War Council—a Council of Naval and Military Officers of the greatest professional attainments and distinction, constituted for the purpose of advising the Government on the highest

problems of strategical science. At present we have not a vestige of anything of the kind, and are consequently, as a military nation, almost destitute of the basis of the military art.

No one could have heard the admirable lecture on our "National Defences," delivered at the Royal Institution on Friday last, by the distinguished Officer who has done us the honour to preside here this evening, without being struck with our deficiencies in this fundamental desideratum, or without asking himself the question on whom should devolve the duty of constructing and propounding the broad outline of our military defensive tactics. I will name only one question of the deepest importance, the solution of which has not yet been seriously attempted, much less reached—namely, what position in our defensive system are the Volunteers to occupy in the event of actual war? This question is only one of multitudes, equally momentous, that would occupy the attention of such a High War Council as I have incidentally referred to.

The present seems an opportune time for considering the question before us. The administration of the Admiralty and the construction of war vessels are undergoing investigation—the Army is being re organized—and we have been strongly impressed with the efficacy of science and system in the Prussian Army. The public mind is now as ripe as it probably ever will be for the reception of the idea, that the cost of our Army and Navy is more likely to be diminished than increased by due attention to the conditions on which efficiency depends.

When we have all Scientific National Institutions under one Minister of State, advised by a permanent, independent, and highly qualified consultative body—when we have a similar body to advise the Ministers of War and Marine in strategical science—then the fact that, in accordance with our marvellous constitution, these Ministers must almost necessarily be men without pretension to a knowledge of the affairs which they administer, need cause us no alarm. When these combinations have been, as they assuredly will be, sooner or later, effected, the wealth, resources, and intelligence of the nation, having due scope, will render us unapproachable in the arts of peace, and unconquerable in war—but not till then.

In conclusion, I must claim for the proposal I have advocated that there is nothing revolutionary in its character.

I aim at creating no new principle. We have already, as an integral part of our administration, a body constituted on the very same principle as that now advocated. I allude to the Council of India. In a debate which took place in the House of Lords only four days ago (Thursday, May 12), the Duke of Argyll, Secretary of State for India, spoke as follows:—"It should be borne in mind that the Government "of India was nothing more nor less than a standing Royal Commis- "sion for the administration of the affairs of that country. And how "was that Royal Commission composed? Of some of the ablest men "who had worked their way up to important positions in India, of "English statesmen, and of men who were acquainted with legislative "work in this country."

Now consider for a moment why and how this India Council—this *standing Commission*, as His Grace appropriately calls it—was constituted. It was seen, on transferring India to the hands of a Minister of State that, according to our political system, the holder of that Office would not necessarily possess any special knowledge of India and its peculiar usages and inhabitants. It was felt that such a country could not be governed safely without this special knowledge, and the want was supplied by the appointment of a Council containing many experienced Indian civil and military Officers. That Council has now existed for several years, and has aided with its advice many Secretaries of State belonging to various political parties. Not one of these—no one competent to speak on the subject—has disputed the necessity for that Council. Its creation is admitted on all hands to have been theoretically wise, and its working practically efficient and beneficial. And remember that this Council is, as it should be, handsomely paid.

Now compare the case of India with the case of science. Dissimilar though they may at first appear, there exists between them a most striking and close analogy. Substitute for the peculiar languages and usages of the people of India, the peculiar language, methods, and principles of physical science,—is not special knowledge in the one case as indispensable to efficient administration as in the other? Then compare the Secretary of State for India with those Secretaries of State who are most concerned with scientific questions,—are the latter ever selected on account of their scientific knowledge? Would it be possible, according to our political system, so to select them? Take the Right Honourable Gentleman now filling the arduous post of First Lord of the Admiralty,—does any one suppose, or does he himself pretend, that he is conversant with naval architecture and naval ordnance? The very contrary is avowed and justified. It is a principle with all parties in politics that the Admiralty should be presided over by a civilian, and that administrative abilities alone (whatever they may be) are a sufficient qualification for the post. I am not contending that this principle is wrong. I am not at present concerned with that question. I am merely asserting that it rules,—and I then say that the civil First Lord is precisely in the same condition as to naval scientific knowledge as the Secretary of State for India is with regard to special Indian knowledge,—but the latter has a highly and specially-informed independent body to advise him, whilst the former is left to his own devices and to such counsel as his executive subordinates may be able to afford him,—the loss of the "Captain" tells us with what probable consequences.

But the Admiralty is only one department. All departments equally need, at some time or other, many of them constantly, special scientific guidance, and for none of them is there any provision that can for a moment be compared with the assistance afforded to the single department for India by its "*standing Commission.*"

My proposal, therefore, I maintain, aims at the creation of no new principle,—but only at the extension of one already existing, and universally approved after long experience. Nor do I aim at creating new labours. The work of which I have been speaking, is now being

done or supposed to be done, and it is paid for heavily by the nation, but it is not well done. I propose to improve its quality by improving the agency to which it is assigned. I propose to substitute concentration for scattered effort, system for chance, organization for disorder. I propose neither to exact from the Queen's advisers new duties, nor to fix upon them new responsibilities. The end and aim of my proposal is to lighten their labours and anxieties by putting into their hands better arms than those with which they now vainly strive to uphold the power and the glory of the nation.

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