SECRET

"The designation "LIMITED" indicates a report dealing with information which is more restricted than the information in the usual C reports. Persons receiving these reports are not to show them to other members of the project, even of the same laboratory, without specific authorization."

WHAT IS WRONG WITH US?

L. Szilard

September 21, 1942

LIMITED

No RD

Introduction

These lines are primarily addressed to those with whom I have shared for years the knowledge that it is within our power to construct atomic bombs. What the existence of these bombs will mean we all know. It will bring disaster upon the world if the Germans are ready before we are. It may bring disaster upon the world even if we anticipate them and win the war, but lose the peace that will follow.

We cannot have peace in a world in which various sovereign nations have atomic bombs in the possession of their armies and any of these armies could win a war within twenty-four hours after it starts one. One has to visualize a world in which a lone airplane could appear over a big city like Chicago, drop his bomb, and thereby destroy the city in a single flash. Not one house may be left standing and the radioactive substances scattered by the bomb may make the area uninhabitable for some time to come.

It will be for those whom the constitution has entrusted with determining the policy of this country to take determined action near the end of the war in order to safeguard us from such a "peace". They will have to be prepared for this task in order to be able to fulfill it and some way will have to be found to do this.

Perhaps it would be well if we devoted more thought to the ultimate political necessities which will arise out of our present work. You may feel, however, that it is of more immediate concern to us that the work which is pursued at Chicago is not progressing as rapidly as it should.

SECRET

Troubles Brewing at the Washington End?

Roughly speaking, there are two kinds of troubles which frustrate our work. Troubles which originate at Washington end of our organization, and troubles which originate at the Chicago end of our organization.

The unsatisfactory state of our metal supply, nine months after the reorganization which led to a merger of the Chicago and the Columbia projects, is illustrative of the effect of the trouble which originates in Washington. But although this trouble originates outside of Chicago, I do not think that we ought to blame anybody but ourselves for this calamity. We knew from the outset that the division of authority between Murphree and Compton, with respect to processing our materials, would lead precisely to this sort of catastrophe. This was not only known privately to many members of our group, but it was openly stated by a number of us at an almost public joint meeting of Columbia and Chicago groups at Columbia in January. Even "outsiders" like D. P. Mitchell and Smyth saw the point and joined in the chorus of those who condemned the proposed arrangement as unworkable. There was not a single voice raised in favor of the proposal of dividing the authority for processing our materials between Compton and Murphree.

We may have to answer before history the question why we tolerated an arrangement which we knew could not work. It is not possible for us to shift the blame to Dr. Bush or Dr. Conant, who originally decided in favor of that arrangement without consulting us. They cannot devote their full time and attention to our problems, and this matter is of such complexity that nothing less than that will do. However intelligent a man may be, if he is not in direct contact with our problems, he is not able to foresee the consequences of decisions which affect the outcome of our work.

Under the circumstances, it would have been our duty to tell Dr. Bush, in January, that the arrangement which he devised would not work. We might not have been able to persuade him that the arrangement was, objectively speaking, unworkable, but surely he would have known that no arrangement can be successful if the men who are supposed to make it work lack the faith that they can make it work.

We may be tempted, of course, to shift the blame on to Compton and say that it would have been for him to tell Dr. Bush that the scheme was unacceptable. This, I believe, would be unfair to Compton, and on this point I have to elaborate because it has an important bearing on the future, as well as on the past.

Our project is exceptionally rich in men who belong to the creative type and represent what may be called the artistic temperament. Compton is one of them, and there are quite a few others. To be sure, each of these men has his shortcomings and limitations. However, it would be a grave mistake to believe that because each of us has certain obvious weaknesses, the group as a whole is not fit to carry the full responsibility for its task. If we were properly organized, those shortcomings and weaknesses would not add up, but rather cancel out, within the group. If we were properly organized, there would be no task in physics, engineering or production, which we could not tackle and master, as long as each of us realizes the limitations of the others and sincerely tries to find out something about his own limitations.

Compton was put in charge of our project last fall by Dr. Bush, but if the question of leadership had been put up to our group, he would have been elected by unanimous vote. We may complain about his not taking a strong stand in Washington, but let us be clear on this point above

SECRET

all: We cannot eat our cake and have it; if we want a man who can run our project at Chicago and create here an atmosphere of friendship and loyalty, we cannot expect the same to go to Dr. Bush and threaten to resign unless he is given all the authority required for the success of our project, or to go over the head of Dr. Bush to the President, and ask the President for this authority.

This is amply born out by past experience. Only rarely is it possible to make a forecast with a high degree of assurance and such a clear case as we had in January with respect to the division of responsibility between Compton and Murphree may not occur again. If Compton did not take action then, he cannot be expected to take action in any other case which is less clear cut as long as he has to ask for things for himself.

The situation might be different if Compton considered himself as our representative in Washington and asked in our name for whatever was necessary to make our project successful. He could then refuse to make a decision on any of the issues which affect our work until he had an opportunity fully to discuss the matter with us.

Viewed in this light, it ought to be clear to us that we, and we alone, are to be blamed for the frustration of our work which originates from the Washington end of our organization. We should have asked Compton to make our views clear, or if he should have preferred this, we should have made our stand clear in Washington ourselves. It is my personal conviction, however, that we shall not be able to make progress in this direction until we have put our own house in order.

What is Wrong at the Chicago End?

While the metal situation illustrates the trouble which originates in Washington, the fact that we have not developed a satisfactory cooling system and are not mentally prepared to do so in the near future, illustrates the trouble which originates at the Chicago end of our organization.

In one respect at least, the troubles which originate at Chicago are less serious since it is entirely within the authority of Compton to remedy the situation.

Stated in abstract form, the trouble at Chicago arises out of the fact that the work is organized along somewhat authoritative rather than democratic lines. There is a sprinkling of democratic spots here and there, but they do not form a coherent network which could be functional. This is partly due to a compartmentalization of information which is imposed on Compton from Washington. Since this is again trouble which does not originate at Chicago, we may pass it over here until such time as we have solved the "local" Chicago problems.

In order that we should be able to do so, it is necessary to realize that there are certain inherent difficulties which cannot be removed and must be met by skillful adjustment of our organization.

I believe that we ought to say at the outset that the breakdown of the Chicago organization is of our own making. Though certain trends followed by Compton which will have to be mentioned later do represent obstacles standing in the way of a well functioning organization, it was entirely within our power to compensate for these trends by making full use of the existing machinery. This we did not do and therefore we may say that the blame is ours, and ours only. At the most we can say in our defense that there were mitigating circumstances.

SECRET

Compton likes to avoid violent clashes of opinions which are unavoidable within a committee small or large if vital issues are devated, on which strong feeling prevails. In accordance with this, he has a tendency to steer a meeting towards greatest harmony rather than toward vital decisions. He prefers to deal with the more important issues in private conversations, a method which is either time consuming, or leaves many members of the planning board uninformed. But even in private conversation with Compton I personally find it difficult to have an issue settled. Perhaps this is my fault. I am, as a rule, rather outspoken, and if I do not call a spade a spade I find it rather difficult to find a suitable name for it. It may be that in talking to Compton I am overplaying a delicate instrument. This is, by the way, an opportunity to apologize to all members of our group for my outspokenness and to ask them to consider it as one of the inevitable hardships of the war.

Just as the question of the metal supply illustrates the trouble at the Washington end, the question of the choice of a cooling system for the power unit illustrates the difficulties at the Chicago end.

SECRET

We knew for a long time that there are three possible ways in which the power plant could be cooled: by helium, by water and by bismuth. The question whether these three systems should be designed simultaneously and the design be carried out possibly up to the blueprint stage on all three of them, or whether one of these systems should be worked out in preference to others, and which should be given preference, was never put up for decision to any of our committee. Even so these committees should have considered as one of their most important tasks to decide this question at an early date. No such decision was taken.

By May, it became apparent to everybody that k will go over 1. An engineering group turned up somehow in our project and started to work, under the direction of Mr. Moore, on plans for the helium cooled system. Nobody knew why the helium cooled system was given preference by this group, but it was the general impression that somehow, somewhere, somebody decided that we shall build a helium cooled system first and place orders for the heavy accessory equipment which the system required at an early date.

In the meantime, Wigner and his division became more and more convinced that a water cooled system could be built in a much shorter time, although they were not willing to say that they could foresee with certainty all questions of operational safety. The question whether Wigner would be willing to assume the responsibility for developing this system, if necessary, into the blueprint stage, was never put to him, and remains undecided up until the present day. Clearly, if Wigner were willing to assume this responsibility, an engineering staff would have to be added to his division in order to help them to produce usable plans for a water cooled unit. A proper balance between physicists and engineers in Wigner's division

SECRET

would require the addition of quite a number of engineers to this division.

It has been my personal opinion that it is not possible to judge the relative advantages and disadvantages of any of the three systems until they have been designed in detail, although it may not be necessary to carry the design into the blueprint stage. I further held the view that, particularly in the case of the water and bismuth cooled power units, certain simple technological tests will have to be made before the detailed designing of the power unit can be carried through with faith in its ultimate success. A thorough designing job can hardly be accomplished in the absence of such faith. I have therefore pressed for the establishment of a technological division which after a while came into existence.

I was put in charge of this division which had the task of looking after the technological problems involved in the three different cooling systems. For a time, it looked as if we might have three almost different groups, each comprising physicists and engineers to work simultaneously on designs for these different cooling systems. It is still my opinion that that would have been the right course of action. While I personally felt that I can contribute most towards developing the bismuth cooled system because I have more faith in this sytem than in the others, I am quite aware of the fact that this may be a purely personal preference, and I do not have any well founded opinion as to which of these three systems shall prove to be the most successful, or can be made to work fastest.

I, myself, was quite prepared to assume the responsibility for developing a design for the bismuth cooled plant. I felt, however, that this work could not be pursued with confidence unless the metallurgical problems which are involved were settled. As far as I could tell, Compton was in full agreement with this approach, and thanks to his vigorous help we

SECRET

succeeded in having Foote, a metallurgist, released from Cooper Union. Simultaneously, I contacted various organizations with a view of having a pump designed for liquid bismuth. Four tons of bismuth were ordered at a cost of $10,000.

Thus I made arrangement to divide my time between looking after the technological division and the designing of a bismuth cooled power unit. These two tasks are almost too much for one man and the only reason why I thought that I would be able to manage them was the fact that Creutz, Foote and Marshall can very well carry most of the burden of the technological division. Foote was supposed to look after the bismuth, Marshall after the recasting of uranium metal, and Creutz after the problems of the water cooled plant, and many other things as well. What became of all these plans?

About six weeks ago I was informed that "we are sending through Marshall and Creutz to Boston to fuse Alexander's metal at M.I.T." If Creutz had left, the whole technological division would have collapsed and the work of the theoretical division working on the water cooled power unit would have been frustrated, since Creutz was looking after the technology of the water cooled unit. I succeeded in substituting Foote for Creutz. I agreed to his departure because I assumed that it would be for two weeks at the most and besides I had reached the conclusion that it is not longer worth while to fight about individual issues.

It was not possible to have a date set for Marshall's and Foote's return in six weeks. All work on the bismuth cooled plant is stopped. While I may be wrong in laying such emphasis on the bismuth cooled plant, it is a fact that nobody else has looked into this matter, with the possible exception of the theoretical division, and consequently there is nobody in a position to express an opinion whether the damage brought about by Foote's and Marshall's continued absence is counterbalanced by the good they can do at M.I.T. So

SECRET

Nobody has made an effort to find men who could replace Foote and Marshall at M.I.T.

In the meantime, Dr. Moore's division carried the design of the helium plant into considerable detail. We were all under the impression that it has been decided to build a helium cooled plant and to place an order for heavy parts of the equipment at an early date. For this reason, while I had been studying this type of cooling at the earlier stages of our project, I did not continue to pay any attention to the questions connected with the helium cooling.

Suddenly, about a week ago, a few of us were informed that we are expected to express an opinion whether a helium cooled plant should or should not be built. I possibly could have formed such an opinion if I had followed the development of the helium cooled power plant for the past two or three months and I should certainly have been very glad to do so. In the circumstances, I do not believe that any opinion that I personally might now express on the subject would be worth anything, and I see no way how I could form a valid opinion within a short time.

Diagnosis

If I have to give a diagnosis in an abstract and therefore necessarily misleading form, I should say this: In the past, the men who were on the technical committee and the planning board did not have the feeling that they were responsible for the success of the project. There was no mechanism for reaching decisions and consequently decisions were reached in a haphazard way. Essential decisions were being omitted or were taken many months after they were due. As time went on, more and more of us began to emphasize that we do not want to be held responsible for what was or was not happening. There was more and more shrugging of shoulders among the group leaders and an increasing tendency of narrowing down their responsibility to this or that detail of the work with which they had been

SECRET

explicitly entrusted.

To all this came an increasing tendency of compartmentalization of information imposed upon Compton by the Washington end of our organization and inevitably our best men are losing the zest for their work. Recently, a major decision was taken by the Executive Committee which usually meets once a month in Washington. This decision will vitally affect our project. It was the third major decision within a year which was taken without consulting our group, our planning board, or our technological committee. Finally, a stage has been reached where it becomes clear that we have to choose between two alternatives:

We may take the stand that the responsibility for the success of this work has been delegated by the President to Dr. Bush. It has been delegated by Dr. Bush to Dr. Conant. Dr. Conant delegates this responsibility (accompanied by only part of the necessary authority) to Compton. Compton delegates to each of us some particular task and we can lead a very pleasant life while we do our duty. We live in a pleasant part of a pleasant city, in the pleasant company of each other, and have in Dr. Compton the most pleasant "boss" we could wish to have. There is every reason why we should be happy and since there is a war on, we are even willing to work overtime.

Alternatively, we may take the stand that those who have originated the work on this terrible weapon and those who have materially contributed to its development, have, before God and the World, the duty to see to it that it should be ready to be used at the proper time and in the proper way.

I believe that each of us has now to decide where he feels that his responsibility lies.

For some time it has been apparent that those who are in key administrative positions and are responsible for the administration of the machinery of the uranium projects talk one language and those physicists and chemists who are supposed to make this machinery turn out results talk another language. It seems to be very difficult for one group to understand the point of view of the other and this has gradually led to a situation which would seem to be very unsound and not without danger. Being fairly widely acquainted with the physicists and chemists in our project and in some of the related projects, I have heard in the past two years many private expressions of opinion concerning the overall organization of the uranium projects. As time went on I heard more and more often speak about "us" and about "them" with the project leaders, according to the issue involved, included either in "us" or in "them". Many of "us" have gradually arrived at the conclusion that there is nothing we can do to change this undesirable state of affairs, or at least that there is nothing we can do as long as the war is on.

We must admit, however, that our attempts to acquaint Dr. Bush with our point of view may not have been adequate and it is questionable whether we can say whether we did all that is in our power in this respect.

Naturally in talking to Dr. Bush I made it clear that I was talking only in my own name and that I was attempting to give my interpretation of what I believe is the picture as seen from "our" side.

Clearly the shortcomings of ~~every~~ an organization such as ours can be interpreted in either of two ways. On the one hand it can be interpreted in terms of the individual limitations of the persons who happen to be in key administrative positions and the shortcomings which scientists may have in common with each other. On the other hand, these shortcomings can be interpreted in terms of the weaknesses of the overall organization or more particularly in terms of the machinery which is used by this organization to arrive at decisions and the limited role which this organization delegates to its scientists. ~~It seems to me that only this second type of interpretation is useful as a basis for discussing the possibility of improving the organization.~~ and (therefore) many there

I attempted to describe to Dr. Bush how this organization functions by reviewing ~~the~~ past ~~and I am inclosing a list of the points which I mentioned to him in this connection for your information.~~ (over the years) Naturally

The following points were among those which I mentioned to Dr. Bush

I cannot say I put any blame upon.

1 Part I

I am writing to you because I feel that in the present circumstances I ought to inform you about a conversation which I had with Dr. Bush early last week and which came about somewhat accidentally as a sequel to a correspondence started early in December. It would almost seem that those who created the overall organization of the uranium projects and are responsible for the administration of this machinery talk one language and the physicists and chemists who are supposed to make this machinery work talk another language, and both groups find it very difficult to understand each other's point of view. Being fairly widely acquainted with the scientific personnel not only in our project but in some of the related projects, I heard more and more speak about "us" and about "them", with the project leaders somewhere in between, according to the person and the issue involved, included either in "us" or in "them." Various persons at various times came to the conclusion that there is nothing that "we" can do and they expressed this view frankly in private conversations.

While this conclusion may be perfectly correct, I feel that the attempts made to acquaint Dr. Bush with "our" point of view may not have been adequate and I do not believe we can say that we did all that is in our power in this respect.

In talking to Dr. Bush I made it clear that I was talking only in my own name and that I was attempting to give him my interpretation of what I believed is the picture as seen from "our" side. Clearly the shortcomings of every organization such

a committee represent. Clearly Urey, Compton and Lawrence were the only members of the committee who knew enough to be able to weigh all the pertinent factors, but being busy each with his own project, they do not know enough about each other's project. Moreover, none of them could push his own project in such a committee without putting himself into an awkward position and each of them had to lean backward if they had to give their opinion concerning one of the projects which compete with their own project.

This committee made, in the course of 1942, quite important decisions concerning which side-lines should be pushed and which side-lines should be dropped and the scientists had always an uneasy feeling concerning the wisdom of these decisions. Many believed that in this committee Dr. Conant's views always prevailed and so the committee's decisions were mostly regarded as Dr. Conant's decisions.

Dr. Conant at that time was far from being able to give his full time and attention to that matter and it ought to be generally recognized that no one who devotes only part of his time to these very complex questions can hope to arrive as consistently at the right decisions as can a man of perhaps even smaller capacity but whose sole concern is the U project.

According to the official schedule, construction was to be started in September 1942 on the experimental power unit of 1000 kw in the neighborhood of Chicago which was supposed to go into operation in May 1943 and which was to have the main purpose of supplying the chemists with 1 gram of plutonium per day. This schedule was suddenly upset by the executive committee in September 1942. We were told that the experimental plant would not be built near Chicago but in the Tennessee Valley and the reason given was that the experimental power unit ought to be built at the same place where the production plant would be built. Since a helium cooled

Retype

in density will occur within a few weeks of operation at 250,000 kw since we know that corresponding changes in electric resistivity and Young's module occur during the bombardment. Perhaps if the power unit can be allowed to run at a few hundred degrees such changes in density can be avoided, but whether or not this is the case is, at the moment, anybody's guess. We were informed by Wigner ~~That such changes in density might occur was predicted by Wigner~~ and another construction which does not require such very narrow tolerances could have gone a long way towards avoiding potential destruction of the power unit by this effect.

Potential corrosion and erosion of the Al cans is one of the major weaknesses of the water cooled system. The cooling water may deposit a thin film on the Al cans thereby causing overheating and corrosion. In the absence of a pilot plant no satisfactory tests of this point could be performed under operating conditions and such tests as might have been performed in the Tennessee Valley were not performed either.

In spite of all this, we must hope now that through a series of lucky breaks the production units will operate at 250000 KW each for a reasonable period of time, say three months ~~each~~, and if that should happen one might ~~could~~ say that the foolhardy risks which were taken were justified.

Influence of the du Pont Company

Since in the present setup the Government cannot be guided by the advice of the scientists ~~who know most about the problems involved,~~ it has to turn for advice to its contractors, who thus play a dual role as both contractors and advisors of the Government. This dual role of the contractors is severely criticized by the scientists who believe that it leads to the suppression of certain promising branches of this work.

So far all those lines of development which can be expected to survive the war are concentrated in the hands of the du Pont Company. The scientists have come to believe that when the du Pont Company picks out certain lines of development for which it happens to be particularly well adapted by its existing equipment and by its available personnel, the du Pont Company successfully exerts an influence in the direction of preventing the scientists from establishing a collaboration with other firms for the development of alternative lines of development (for which the du Pont Company is not suited either because it lacks equipment or because it lacks suitable personnel or because the men in charge of the du Pont Company lack the theoretical background to enable them to appreciate those alternative lines of development).

The first instance of keeping out competitors of du Pont occurred shortly after Thanksgiving 1942. At that time a contract was placed with the du Pont Company for producing heavy water by one of several processes which were proposed by Dr. Urey. The du Pont Company found one of these processes more suitable than the others from the point of view of their previous experience and from the point of view of their equipment. It is certainly the privilege of every company to choose the method which suits them best. Since, however, in the process adopted by du Pont 30,000 tons of coal are used per month for the production of about 3 tons of heavy water (a quantity which is too small to be of real significance for the production of plutonium). In the opinion of Urey and his collaborators such an alternative process was available and could be expected to be about three or four times as efficient with respect to coal consumption. In addition they were of the opinion that the investment costs would be considerably