

# Suggestions For Giving Talks

Robert Geroch

*Enrico Fermi Institute*

*5640 Ellis Avenue, Chicago, Illinois 60637*

(September 16, 1973)

## I. CHOICE OF SUBJECT

As a general rule, one chooses for his subject the broadest and most general version that he can feel comfortable with. This almost always involves broadening the scope of what one really wants to say. The problem is that one naturally divides the subject into what is known and what is not known, and works at the interface. To your audience, however, almost everything is unknown: they have no feeling for where this interface is, or how the problems at the interface arise from the larger context. Thus, instead of talking about killing tensors, one could talk about conservation laws for particles in general relativity (including perhaps, some discussion of spinning particles, charged particles, what happens when a particle breaks into two particles, how this subject is related to conservation of stress-energy, etc.). Of course, what is the most general version one can feel comfortable with depends on how specialized one's audience is. (Thus, for an audience of non-relativists, perhaps 90% of the discussion will be on issues one does not actively think about on a day-to-day basis; for an audience of relativists, perhaps 60%; and for an audience of specialists in one's own sub-field, perhaps 35%).

The next step is to think of a title. Most of your audience will probably decide whether or not to come based solely on this title. Ideally, one wants a title which indicates what the subject is, what the level of the discussion will be, and which is lively and friendly without being cute. Questions and assertions often make good titles. Of course, one should use no word in the title with which one does not expect one's audience to be familiar. Thus, for an audience of relativists, "Linearized Fields in a Kerr Background Metric" sounds technical, "Perturbations of the Kerr Solution" sounds dull, and "Black Holes are Stable" sounds good.

## II. THE PLAN

Divide the various things you want to say into three or four messages. (Three is, perhaps, slightly better than four, and either is much better than any other number.). A message might consist, for example, of some important point together with supporting arguments and examples, or of a collection of remarks which share some common property. Each of these messages will, eventually, become a short talk in its own right. Assign to each message a title (e.g., "The Initial-Value Formulation of Gen-

eral Relativity"), and invent, for each, a non-technical summary of the message in a sentence or so (e.g., "The 'initial time' becomes, in general relativity, a spacelike three-dimensional surface; the 'state of the the gravitational field at that time' becomes a pair of tensor fields on this surface, subject to certain constraint equations; the 'evolution of the system' is then described by equations which give the change in these fields under changes in the spacelike surface."). The more cohesive each message is, the better.

It is almost always necessary, in order to obtain such an organization, to recast the subject into a form which is essentially different from the way in which you normally think about it. (In one's mind, the subject is innumerable interconnected small points. In the talk, the subject will be three of four main points.). In particular, one often has to omit some details one might otherwise have wanted to say, omit connections between certain points, or add material to fill out a message. The idea is that, with three or four messages, the audience can grasp and hold onto the structure of the entire talk. (People simply are not going to come away from any talk with more than three of four essential points.). The difficult thing about planning a talk, in my opinion, is to divide things into messages which are sufficiently specific and cohesive that each can be treated as a unit (hence, remembered by the audience), and yet sufficiently general that, taken together, the messages tell one's story. One would like to come up with several (hopefully, very different) organizations, and then select the best for further refinement.

## III. THE INTRODUCTION

The introduction normally consists of two parts: the placing of one's subject into its context in the rest of physics, and a description of the talk itself.

Start on as general a level as is feasible. If it's convenient (with a general audience), you might begin with some remarks about a recent trend in physics as a whole. Or (with a more specialized audience), you might begin with something about the direction of recent research in a broad area of physics (e.g., General Relativity), or some very general problem toward which a substantial research effort has been directed. Then, very slowly, increase the specialization until you get to the specific subject you're going to talk about. There may be three or four transitions between your starting point and the arrival at your subject. (Even if you feel your audience knows this ma-

terial already, it is still worth repeating. You must fix in their minds the broad framework into which your subject fits.). If you don't know of any single, natural context for your subject, make one up.

Throughout this discussion, emphasize the types of problems under attack, why they are being attacked, the methods one uses in the attack, the reasons one thinks along these lines, etc. Why does one think about this subject at all? Why is it interesting? What has it contributed to our understanding of Nature? What is the present state of the subject? Where is it going; what can we expect in the future? (Predictions about the future are always a good way to generate enthusiasm.). It is here that one sets the mood for the entire talk. As clearly and forcefully as you can, state what the scope of your subject is, and set that subject in its broader context.

The next step is to reveal the plan of the talk. That is, one says what his three or four messages will be. You might give the title of each message (and, perhaps, write these titles on the board, so you can check them off as each message is delivered), and a few descriptive sentences on each one. Furthermore, one wants to tie all these messages together. How do the various messages relate to each other, and how, taken together, do the messages constitute a summary of your subject? If it can be done conveniently, you might also reveal here what your general conclusions will be. In short, one gives a short talk on the structure of his talk.

This introduction normally consumes about one-fifth of the time available.

#### IV. THE BODY OF THE TALK

At the beginning of each message, state again what the title of the message is, that you're now beginning on that message, and, if you like, a few sentences about the content of the message. At the end of each message, state that you've finished the message, and give your few-sentence summary of it. (That is, sentences which begin "We now begin our discussion of..." and "To summarize,..."). These summaries, particularly, are very important: they give your audience a chance to think over what you've said, and to draw it all together. (They also provide an opportunity for those who have gotten lost in that message to again pick up the thread of the talk.). This transition from one message to the next must be abundantly clear to the audience. One can also repeat, between certain messages, what the plan is, where you are currently in that plan, and how all the messages will tie together. It is crucial that, at every moment during the talk, your audience knows what the plan is and where they are in that plan.

The body of each message should be a short talk in itself, with a clear, central objective. (Thus, for example, if you use in one message material from an earlier one,

you should briefly summarize that material first.). A message normally consists of three to six points you want to make.

The mode of presentation of a message is not normally the way one thinks about it privately. In particular, one should try diligently to suppress everything which does not bear directly on the central objective of the message. Examples:

- i) By changing one's private notation, one can often avoid introducing most variables.
- ii) By rearranging one's private definitions, one can often avoid completely the definition (and hence subsequent discussion) of certain extraneous concepts.
- iii) By presenting matters from a different (and, perhaps, "less correct") point of view, one can often arrange things so that certain side issues simply do not arise.
- iv) By introducing an analogy, one can often afford (i.e., without loss of clarity) to omit the details of a topic. (Analogies are particularly valuable for topics with which there are associated a large number of small points.) By referring to the analogy, the audience can answer most questions on the topic for themselves.
- v) In discussing a calculation, one need only make it (very) clear what went in and what came out. (If there are several consecutive calculations, one should consider them as one, and just give the input and the output of the whole mess.)

In short, avoid everything which leads away from your message. It is even sometimes necessary to say things which are (technically) incorrect, or which contain omissions, in order to accomplish this objective.

#### V. THE CONCLUSION

At the end of the talk, summarize (in non-technical language) what your main points were, and what the context of the subject is. Of course, you will also tie together the messages, make them seem like parts of a whole. This is also a good time to state various questions one would like to have answered. You might also add, at the very end, any predictions you'd like to make concerning what is likely to happen in this subject in the future.

#### VI. VISUAL MATERIAL

Figures are easier to understand than words. Words are easier to understand than equations.

Say it with a figure (or graph, or table) if at all possible. (It is surprising how many ideas can be reduced to or illustrated by a figure.). Figures should, of course, be simple, with all inessential details omitted. Label everything that can be labeled, and, if the figure is on a slide, give it a title. You should intend that every single mark on a figure will be fully understood by the audience. (If they don't understand something, leave it off the figure.). It takes time to absorb a figure, so have some remarks to make about the figure while they're staring at it. (Even though it may be clear from the labeling, describe the figure and its message in words.). Do not use several figures when one can be made to do the job. It's often possible to invent a single, strong figure (or graph, or table) which forcefully summarizes the essential point.

If you make a point in words, or give an argument in words, it's often possible to summarize it on a slide or on the blackboard. This might be done by writing out a sentence or two in full. (This endows your point with strong emphasis.). For an argument with several steps, one might list the steps (one phrase for each), to bring out the structure of the argument. It never hurts to read aloud what is displayed. It's not usually a good idea to try to get more than two sentences on a slide. (If one is stating a theorem, for example, one might condense some complicated conditions into a descriptive phrase in quotation marks.). The slide should, of course, be up far longer than it takes to read it. One would normally spend at least several minutes on a slide. (If it's to be less, perhaps the whole slide can be replaced by a descriptive phrase in some other slide.).

The last resort for expressing an idea is through an equation. In my opinion, equations should be thought of as tools for making a point, not as data to be stored by the audience for their future use. (How many times have you actually used, in your own work, a detailed equation copied from a lecture?). Thus, an equation should be a "picture" which is presented, described in detail, discussed physically, etc. Every symbol appearing should be defined, and, if necessary, discussed. All this takes time, so it is a good idea to set aside several minutes to treat a single equation. (The meaning of important symbols should be repeated in later equations, even though they were defined and discussed at their first appearance.). If a talk has more than five non-trivial equations in it, it's beginning to get equation-heavy. One can often simplify equations by a clever choice of variables (e.g., define a variable to represent "the effect of the gravitational field on the stress of the body"). Furthermore, one can often leave out whole batches of terms by summarizing them with a phrase, e.g., " + small terms". If some terms are not going to be discussed in detail, replace them by a word saying why they are not important. One can sometimes get rid of an entire equation by writing it symbolically, or with words replacing the terms. You should intend that every single mark that appears in an equation will be completely understood by your audience.

Ideally, one would like to have about ten slides (or

blackboard presentations) in an hour talk, with one under discussion perhaps 70 % of the time.

## VII. GENERAL SUGGESTIONS

Speak loudly and firmly, with conviction. Try to make every sentence you construct a sentence you can be confident about. (Don't, for example, say that something is sort of true, or use a weak, hesitant voice. A rough physical argument is not just a sloppy version of some precise argument; it is a carefully formulated, defensible statement, beginning, for example, with "In physical terms ...") Use full sentences as you compose your thoughts or think of how to best express your next idea. If you realize you've made a serious error, or have gotten confused, say so, and try to straighten things out, out loud, with your audience. If you realize that you've said something in an unclear way, it's usually best to announce this fact, and that you'll now try to say it again. You can usually tell from your audience's facial expressions when they don't understand, and when you're going too slowly.

Be explicit whenever you can find a way to do so. Avoid "this" and "that" as nouns: say "that tensor" or "that charged particle". Don't say "it" for something that has a name. One can sometimes introduce an artificial explicitness. Thus, in a discussion, "the ten-gram mass" and "the five-gram mass" are better labels than "this mass" and "that mass", or " $m_1$ " and " $m_2$ ".

Try to keep the audience informed of what you're doing, how things fit together, where you're going, etc. Thus, if you give an example of an argument, say before you start that it is an example, and after you're done that it was an example and that you're now returning to the main discussion.

Some of your comments will be vastly more important than others. It is vital that you indicate this relative importance. The following are techniques for emphasizing a point:

- i) Say the point in a single, loud, short sentence,
- ii) repeat the point several times,
- iii) pause after making the point,
- iv) say "The following point is important:..."

By using combinations of such techniques, try to get the correct distribution of emphasis in your presentation.

Do not allow your audience to get bored. If they look bored, try to drum up some enthusiasm. You might, for example, stop what you're doing and repeat, loudly, what your plan is, where you are in that plan, and why this problem is of interest. It is almost always a disaster to run over one's time. (The audience becomes bored and anxious to leave. Not only do they not learn anything

after your time is up, but they tend to lose the thread of what went before.) If you see that your time is up before you've finished, I would suggest that you stop there, and summarize in a few sentences. One often prepares a few additional points (e.g. examples) which could be worked into the talk, but which are not essential. One can decide during the talk whether or not to include these points, in order to make the time come out right.

Everyone has his own system for notes for a talk. I prefer a single sheet of paper with an outline of the talk on one side: the introduction, titles of the messages, and conclusion are the main divisions; the five or so points to be made in each of these divisions (summarized to a phrase) are the subdivisions. Occasionally, one jots an equation or two on the back.

In my opinion, the most important point about answering questions after (during) a talk is to be completely honest. If someone says that an argument does not seem convincing, and if you have doubts about it, say that it doesn't seem convincing to you either. If someone catches you on an "omission", say that you omitted it to simplify the discussion, and fill in the missing material. If someone asks something that hasn't occurred to you, say that it hasn't occurred to you, and whatever else you can. If someone asks a question in the middle of the talk, it's usually best, after the answer, to resume by working your way slowly up to where you were, saying the most distant material in a general way, getting more specific until you reach the point at which you were interrupted. If a discussion within the audience threatens to take over (in the middle of the talk), one can say (firmly) that he would prefer to postpone discussion of the issue until the end.

Talking about physics does not closely resemble thinking about physics because the purposes in the two cases are entirely different. The amount of information you emit is irrelevant; it's the amount you cause to be absorbed that counts. A talk has a clear objective, to force certain information into the minds of the audience. The idea is to direct one's entire effort to accomplish this objective. Surprisingly, experience in giving talks does not, after the first few, seem to make much difference in one's ability to give a good talk. What does make a difference, in my opinion, is having given serious and hard thought, over a period of time, to the art of speaking. Two times are particularly valuable for doing this: after you have just given a talk, and while you are listening to the talks of others. (Was the material properly arranged? What points were not clear? Why? What went over well, and what badly? Did the audience understand the plan of the talk? Were they bored? At what points, and why?)