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Nonstatistical Aspects of Statistical Consulting

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Statistical consulting is a complex activity that requires statistical and nonstatistical skills. Together, these skills determine the ultimate success of the consultation. This article focuses on the nonstatistical aspects of the initial meeting between statistical consultant and client and presents a model that views consulting sessions as consisting of four parts: (a) identification of relevant aspects of the problem situation, (b) definition of the client's goals, (c) determination of the actions to be taken, (d) discussion of various aspects of the consulting relationship and who will do what when. Each part gives rise to specific issues and requires that the consultant have various nonstatistical skills to deal with these issues. The effectiveness of the consultation can be enhanced by learning and practicing this model and the constituent skills.

KEY WORDS: Interpersonal skill; Model for statistical consulting; Commitment; Service; Cost; Level of analysis.

1. INTRODUCTION

Statistical consulting poses difficult challenges, some of which have little to do with statistics per se. Occasionally, for example, one encounters a domineering client who makes unrealistic demands. This client typically charges through the door 10 minutes late and informs the consultant that s/he wants all of the statistical work done by the consultant, including a substantial amount of programming, coding, and keypunching, and ends by saying, "Would you please have it ready by this afternoon?"

Evidence available from many sources suggests that there are major gaps in the formal training of Ph.D. statisticians that must be filled before they can become effective statistical consultants. Many complaints center around deficiencies in the area we refer to as *non-statistical aspects of statistical consulting*—conducting a consulting session, interpersonal relations, written and oral communication skills, and so on.

This article addresses these deficiencies by proposing a model for the parts of a consulting session and by discussing nonstatistical issues that occur in each part. Our model views a consulting session as consisting of four parts: identification of the situation, definition of

the client's goals, determination of proposals for action, and summary discussions. This model is useful in training apprentice consultants. Partitioning the consulting task into four parts enables them to focus on mastering the interpersonal and statistical skills required for each part.

A major assumption in this approach to statistical consulting is that it is *problem minded*, not *solution minded* (Maier 1970). That is, the most important activity statistical consultants can engage in is helping clients to *understand* the nature of their problem so that clients themselves can take appropriate action *and* develop greater statistical competence in the process. Thus, statistical consulting from this perspective has two goals: (a) solve an immediate statistical or methodological problem, and (b) increase the capacity of clients to understand and solve similar problems when they arise in the future.

Argyris (1970) suggests similar conditions for effective organization consulting, namely that a consultant (he uses the term "interventionist") must maintain or increase clients' current performance while increasing their capacity to generate valid information, free choice, and internal commitment in solving problems in general. In this article we place more emphasis on solving the immediate problem than does Argyris.

Both consultants and clients desire to learn new things, master new subjects, and develop self-confidence by tackling new issues. By emphasizing the goal of increasing client competence, consultants and clients must pay attention to those aspects of consulting that can enhance a person's sense of mastery, self-worth, and curiosity, in addition to solving a particular statistical problem. Note that the immediate problem solved by the consultant and client may differ from the problem as initially presented.

Three decades ago, Eisenhart (1947) assessed the role of the statistical consultant and maintained that the consultant shall determine "what conclusions can be drawn and with what confidence" and "the amount and type of data needed as evidence." These aspects of statistical consulting are important; they are embodied in goal (a) above. In this article, we expand Eisenhart's view by including an increase in the competence of the client as another desired outcome of statistical consulting.

Finally, we make one additional assumption: that consultants have the appropriate level of formal training in applied statistics, mathematical statistics, numerical analysis, mathematics, computers, and so on, required to make them competent in their jobs. As in Cox (1968) and Daniel (1969), we emphasize the importance of serious exposure to the scientific method and how scientists actually work. Good consulting skills do not make up for a lack of statistical competence or depth in these

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areas. Good consulting skills help the statistician to better assist the scientist and thereby improve the quality of the scientific contribution that they make.

2. A MODEL FOR STATISTICAL CONSULTING

The first session between consultant and client is particularly important because it establishes precedents for the rest of the consulting relationship. This session may be one of the most difficult between client and consultant because it often brings together two people who have never met before and who may have negative expectations of each other and of the outcome of the encounter (Hyams 1971).

Borrowing in part from Fosmire and Wallen (1971), we identify four parts of consulting sessions:

1. identification of relevant aspects of the problem *situation*;
2. definition of the client's *goals*;
3. determination of the actions to be taken (*proposals*); and
4. *discussion* of various aspects of the consulting relationship and who will do what when (see Harrison 1973).

Each of these four parts raises various issues and requires specific skills on the part of the consultant. The parts of the session are not necessarily executed in this order; moving back and forth among them is necessary. To arrive at effective proposals that are executed in accordance with the results of the discussions requires emphasis on the situation and goals. Doing this reduces the probability of "errors of the third kind," namely, the right answer to the wrong problem (Kimball 1957).

An extended discussion of many points relating to this model for statistical consulting can be found in Boen and Zahn (1982).

2.1 Identification of the Situation

After the consultant and client spend some time getting to know each other (an essential activity), one of the tasks they face in the first consulting session is determining the current state of affairs with respect to the client's specific problem and overall situation. In addition to understanding whether the client has collected three or four waves of data in 10 years, it is also important to understand if the client is under time constraints, if there are other collaborators, if the client has complete autonomy over the use of the data, if similar research has been conducted elsewhere, what attempts have been made to solve the current problem, and so on. Hyams (1971) notes that there is a benefit in beginning the consultation by learning the substantive difficulties and importance of the work being done.

Bliss (1969), reporting on his experiences as a statistical consultant advising biologists, proposes a similar, careful identification of the situation before answering any statistical questions. He notes that his "first rule [for statistical consultants] would be to avoid answering

any questions on statistics asked initially by the biologist" until the biological background of the problem is ascertained because "frequently the statistical function he [the biologist] proposes to compute is not the one most pertinent to his problem."

Both clients and consultants have assumptions about what information is relevant and irrelevant; some clients decide to present only limited aspects of their problem. Other clients may do quite the opposite, inundating the consultant with all possible details. A direct approach is for the consultant to state at the outset what s/he needs to hear and the range of issues that are relevant, and then to ask the client if there is anything that is particularly relevant that the consultant has not mentioned. Cox (1968) presents an especially helpful list of statistical topics to examine in this part of the consulting session: (a) objectives of the experiment, hypothesis formulation and specification; (b) experimental plan and design; (c) execution; (d) analysis; and (e) interpretation and inference.

As the client defines the situation, the consultant should frequently *reflect back* to the client his or her own emerging understanding of the client's situation. The following is an interchange that shows how the statistical consultant (SC) helps clarify the situation by reflecting information the client (CT) has presented.

- CT. The 75 subjects were divided into three groups and observed under seven different conditions.
- SC. So, for condition one you divided the subjects into three groups and . . .
- CT. No, that was done randomly.
- SC. You went to a random number table, assigned subjects to one of three groups, and then each group was observed under condition one.
- CT. Yes. Well, what's a random number table?

Note the clarification that occurred as a result of the SC merely reflecting the comments of the CT. Such behavior helps prevent the misunderstanding and ambiguities that are so common in any conversation. Reflective listening not only helps the consultant get a clearer understanding of the client's problem, but it also helps the client check to see if his or her intended communications are getting across.

Another tool that may be of use to the consultant is the *probing question* (e.g., "Did you randomize the assignment of subjects to treatments?"). This may be of particular use after the client has had a chance to define the situation as s/he sees it (see Kahn and Cannell 1957).

Some clients start describing their problem with a solution. "I just have one question that I want you to answer for me. Shouldn't I perform MANOVA on this data set?" Occasionally, it is a legitimate consulting function to endorse clients' own solutions to their problems; such initiative and independence should be encouraged by the consultant. However, the consultant's most pressing job in this situation is first to understand the problem and grasp what questions or goals the client has in his or her analysis, and only then to give the endorsement.

Consultants will enhance their survival probabilities if they learn to say to clients who poke their heads in the door, "I'm sorry, but I just don't have enough information about what you are trying to do to give you a thoughtful answer. Why don't we discuss it in more detail or set up an appointment to explore that idea?" This is not always what the client is looking for, but the alternative is for the consultant to give a half-baked answer and over the long run to lose credibility.

If the client is working in a substantive field about which the consultant knows little, it is essential that the client learn about this limitation. Perhaps statistical consultants should be substantive experts in every consulting problem considered, but, given the realities of time demands and the breadth of subjects presented by clients, this is difficult. As Daniel (1969) notes, it is crucial that you know your limitations and that you make them known to your client.

2.2 Definition of Goals

At some point both client and consultant will be satisfied that they have enough understanding of the situation to proceed to goal definition. If the situation has been well described, defining appropriate goals is feasible. Thus, the first thing to check is that the situation is clearly and thoroughly described. To make the transition to the goal-definition phase, the consultant can simply state, "I think I have a good understanding of where things stand right now. Let's take a look at what kinds of questions you have."

An alternative strategy is to start the session with a preliminary definition of goals to set the scene. Then attention can shift to identifying the situation, followed by a clarification of the goals.

There are several issues that emerge when client and consultant set out to clarify, formulate, and (perhaps) reformulate the client's research questions. Perhaps the most difficult issue occurs either when the client's data do not appropriately address the research objectives or when a client's theory is not clearly enough thought through to define appropriate research objectives. The skillful consultant can offer some short-range assistance. Between the Scylla of passive acceptance ("Oh so you want to find out if *A* causes *B* by correlating them?") and the Charybdis of disdainful punitiveness ("Why, didn't you ever learn in Statistics 100 that you can't do *that*?") is a response of constructive confrontation that informs the client that there is a gap between the desired goals and the resources available. The consultant can help the client explore how the critical mistake was made, how to redesign the study, or which research questions can be addressed with the existing data set.

Given that the data set is appropriate, consultants can play an invaluable role simply helping clients to formulate clear research objectives. Questions such as, What would you hope to answer by performing that analysis?, or How will you know if you've answered that question? lead the client to define goals that are more in accord with available theory and resources.

2.3 Determination of Proposals

After identifying the situation and defining goals, the next step is to determine what actions will be taken. Clients and consultants who experience difficulties specifying actions to take should realize that these difficulties are frequently due to unclear situations and goals. That is, the clearer the problem is, the clearer and more creative (Maier 1970) the proposals for solving it will be. This notwithstanding, difficulties do arise in formulating proposals, one of the most frequent being that the most appropriate statistical analyses sometimes require knowledge and ability that the client does not have. Two solutions are (a) that the consultant perform a state-of-the-art analysis for the client, and (b) that the client become more knowledgeable about statistics. Both solutions have strengths and weaknesses. The first solution may be the least painful but does not increase the capacity of the client to understand or solve future statistical problems. The second solution increases the client's capacity but does not solve the client's immediate need.

There is a third solution: the consultant can help the client formulate statistical analyses that are within his grasp, while fully informing the client about what the consultant is doing and why. Consultants can feel perfectly free to explain the rationale behind this strategy. "In your case, client *X*, there are three possibilities . . . [consultant then outlines the three solutions]. We will concentrate on analyses that you can understand and can perform, because then you will be learning something and you will be able to interpret and define the results. If there are faulty assumptions underlying the analyses, we will discuss them and develop some notion of how much these might affect the result." This solution contributes to achieving one of our major goals in statistical consultation, namely, increasing the client's ability to deal with this class of problems. Education of the clients is also mentioned as an important goal by Hyams (1971). He notes that this is another way of overcoming a client's defensive rejection of the application of statistics to the work being done.

There are factors other than the client's level of expertise that relate to the question of what analysis to carry out for each client. These factors include the quality of the data and the design, assumptions of various methods and how the data relate to them, costs, purpose of the analysis (planning future studies or publication or decision making), resources available to the client (time, money, computing, and expertise), the client's and the client's boss's understanding of statistics, and whether the client will be presenting the analysis on his or her own. Statistical consultants have often approached the question of choice of analysis as if they had the power to choose the technique and dictate that it be used. Clients bristle when they discover that their statistical consultant holds this point of view. We recommend an alternative approach, based on the fact that the statistician does not have this power. The client owns the consulting problem and, thus, has the ultimate

say as to what analysis is done. We suggest that the consultant discuss with the client each of the potential analyses relative to the many factors just named, making clear what analyses are recommended. This enables the client to make an informed choice among the alternatives. Consultants can help clients make this choice by clearly communicating their level of commitment to the client and what level of service they are willing to provide, either voluntarily, for a fee, or in trade for coauthorship or the right to use the data. By *commitment* we mean "an agreement or pledge to do something in the future." By *service* we mean "contribution to the welfare of others." The client who has this information knows what the consultant can be counted on to do, rather than having to guess. In our experience, consultants and clients rarely share this information. This creates a lot of uncertainty in the relationship, which undercuts the quality of the scientific work being done.

Sometimes, it is necessary to do a state-of-the-art analysis that is beyond the client's abilities. This situation poses a dilemma with respect to the two goals for statistical consultation stated in Section 1; it forces a collaborative relationship between the statistical consultant and the client in which the consultant performs the statistical work outside the consulting sessions, in addition to meeting with the client in the sessions. If the statistical consultant is doing all the statistical work, a natural question is How are the competencies of the client being increased? Even in collaboration, the client may still learn some statistical material and thereby become more competent. The question is, How much and at what level does the client wish to learn?

Salsburg (1973) lists several actions that consultants may find useful when constructing action proposals, including getting experimenters to make provisions for the unexpected and to design simple experiments. He discusses a number of useful strategies for data analysis and presenting reports, including recomputing summary statistics on subsets of the data, plotting the data, and preparing a report with displays that are comprehensible to the reader.

While formulating actions, clients need to be able to think about the actions they are planning, and consultants can be helpful by simply sitting silently, while the client thinks quietly or out loud. Although this may seem overly simplistic, adults in our culture often feel uncomfortable when silence occurs in a conversation. Silent reflection is a useful strategy for joint problem solving (Delbecq and Van de Ven 1975).

Another technique is to have clients run through their next steps out loud to the consultant. Not only do consultants learn how much of their proposal is comprehended by the client, but also clients get a chance to practice their own reflective listening skills!

Statistical analyses cause anxieties in many clients, partly because most people want to avoid appearing ignorant, and partly because there is so much new to learn in order not to be ignorant. This puts clients in a difficult bind—damned if they show their ignorance and damned if they don't. Consultants must work to create

conditions in which the answer to the question, is all that clear? is not "yes," when it should be "no."

2.4 Summary Discussions

The most difficult part of the first session for both consultants and clients is the discussion of topics that are generally regarded as, if not taboo, at least very sensitive—money, credit, mutual expectations, division of labor, and so on. Clients, for example, may expect the statistical consultant to be research assistant, statistical advisor, collaborator, keypunch operator, or computer programmer. On the other hand, consultants may expect clients to commit themselves to a minimum number of consulting sessions, to read some methodological articles, or to allow the consultant to use the data set for research. Expectations do exist, and the consequence of not discussing them openly may be the belated discovery that client and consultant expectations are quite different. One of our colleagues found himself six months into a consulting project when it became clear that recognition of his work would be a footnote at best, when he had expected coauthorship. The discussion during this part of the consulting session may range from informal, resulting, for example, in a verbal agreement that there will be another meeting soon, to formal, resulting in a written legal contract.

When consultants and clients openly discuss expectations, conflicting expectations may become apparent. Consultants do not always have to have their way, nor is "the client always right." With patience and careful reflective listening, client and consultant can often identify a *modus operandi* that is substantially within the expectations of both. For example, instead of doing the programming, the consultant may be able to locate someone else who will. Or, if the client's budget is limited, perhaps it can be reallocated to cover the most crucial statistical analyses (see Filley 1975 for an approach to receiving these types of conflicts).

Costs are one of the major topics to be considered early in a consulting relationship and monitored throughout. Boen (1982) gives an extensive discussion of cost estimation, price structure, and scheduling in a self-supporting university consulting laboratory. In our experience it is never too early to clarify how much the consultation services will cost. However, an estimate of the cost for the total project is premature until one has spent enough time on it to know its magnitude and its major complications.

The costs of various analyses and the client's resources play a key role in determining how the project will be carried out. This is another time in the consultation in which it is critical that the consultant be clear about his or her commitment to the client and the level of service he or she is willing to provide. Depending on the consultant's level of commitment and service, analyses beyond those that the client's resources could purchase may be possible if the consultant is willing to volunteer or trade some services for coauthorship or the privilege of using the data set.

Earlier in this article we raised the problem of a consultant lacking expertise in the client's area. After identifying this lack, it can be discussed and various approaches explored. The client may decide that within current constraints, this consultant's advice, even with its necessary limitations, is preferable to none at all. Another possibility is for the consultant to invest time in developing expertise. Who will pay for this time investment is another matter to discuss.

Particularly salient in discussing expectations are power and status differences between the consultant and the client. The consultant may be the client's statistics instructor, or the client may be a prestigious scientist in the company the consultant has just joined. If we are to believe sociologists and social psychologists, *no amount of open discussion will completely eliminate the effects of status differences*. To deal with status differences, we believe that it is essential for consultants to have a clear picture of their organizational position, career aspirations, job responsibilities, and alternative employment possibilities, as well as an explainable rationale for dealing with clients in a way that will achieve both goals of statistical consulting—short-run problem solving and long-run capacity of clients to solve their own problems. Obviously, these are issues to be thought out *before* the consulting session. Sessions with one's colleagues and supervisors, as well as with oneself, are required to develop positions on these issues.

Hyams (1971) points out another reason for considering these issues in advance. He points out that consultants desire "the three R's: Reality, Respect, and Reward" and emphasizes that the consultant must constantly be evaluating his or her own motivation and expectations, in addition to those of the client. He also notes the special perils that await the young consultant in this regard. Often this consultant receives the most difficult clients, which makes it all the more critical to formulate a position with respect to the three R's and the handling of difficult clients.

Comments by Bross (1974) relate to the discussion of expectations. Bross explores the responsibilities of a statistician in a collaborative clinical trial, but his comments relate to the responsibilities of statistical consultants in general. He notes that the statistician may choose the role of a scientist and take the appropriate level of responsibility for the study's outcome, or he may assume the role of a shoe clerk and only be concerned about the short-term gratification of the customer. This choice has considerable impact on the consulting relationship and certainly should be considered in the discussion of expectations. He also points out the risks, especially for young statisticians, of choosing to function as a scientist in the absence of a supporting professional superstructure. Other authors who discuss the importance of a professional organization in helping to make the choice of scientist a viable one include Boen and Smith (1975), Gibbons (1973), and Deming (1965).

Several authors have indicated additional related topics to explore: (a) the neutrality of the statistician in the

advocacy process (Gibbons 1973); (b) professional standards of the statistician (Deming 1965); and (c) areas of competence and incompetence of the statistician (Daniel 1969).

Deming (1965) presents a comprehensive description of his position on key matters to be dealt with by consultant and client when they are discussing expectations. Dealing with all the matters Deming mentions may be difficult in the short run but will certainly pay off in the long run.

Cameron (1969) describes aspects of statistical consulting in a scientific laboratory that could profitably be considered during the discussion of expectations by a consultant working in that environment. These include funding, continuity, service to the organization, educational role, and computations.

There is disagreement about which of the previously mentioned issues should be discussed and when to discuss them. This is a difficult question, especially for the inexperienced consultant. The consultant must consider these issues and make a conscious decision about which issues to discuss and when. At a minimum, the consultant and client should explicitly agree who will be doing what tasks and when. Beyond this, the issues become more difficult to discuss. The novice should proceed carefully, especially if the consultation appears to involve interpersonal or interorganizational conflicts.

3. EASIER SAID THAN DONE

It is much easier to write about consulting than it is to practice it. Specifying that in order to conduct effective consulting sessions one needs to directly discuss expectations is like stating that in order to ride a bicycle one must develop the skill of maintaining one's balance. Such a prescription is helpful in retrospect and is like explaining to the experienced bicyclist what s/he did correctly, and its use is questionable for teaching the novice. However, this model is useful because it directs attention to some of the more relevant behavioral variables in teaching and practicing effective statistical consulting. There is no manual that by itself can teach the skill of riding a bicycle. Similarly, in consulting there is no substitute for practice, high-quality experience, observation of experts, and competent supervision.

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