A Holistic Approach to Training
Statistical Consultants

by

Charles E. McCulloch
Daniel R. Boroto
Duane Meeter
Ronald Polland
Douglas A. Zahn

FSU Statistics Report M641R

August, 1984

Florida State University
Department of Statistics
Tallahassee, Florida 32306
A Holistic Approach to Training Statistical Consultants
Charles E. McCulloch, Daniel R. Boroto, Duane Meeter,
Ronald Polland, Douglas A. Zahn
Florida State University

Running head: A HOLISTIC APPROACH
Abstract

We describe a holistic approach to the training of statistical consultants at Florida State University. In the preconsulting course, students first study general problemsolving techniques. Next, these techniques are used on applied statistics "textbook" problems. Then problem formulation and research methods are studied. Finally, the structure of consulting sessions is considered, along with interpersonal questions that arise. In the supervised consulting course, students work with actual clients in videotaped sessions, attend supervision sessions in which the tapes are reviewed, present case conferences, attend new material sessions, and do a project. We conclude this paper with preliminary evaluation data on the program and observations regarding what we have learned.

KEY WORDS: videotape, interpersonal, supervision, philosophy.
# Table of Contents

1. Introduction 4

2. Why a systematic training program? 5

3. Our statistical consulting philosophy 7

4. The preconsulting course 9
   4.1 Segments of a consulting session 9
   4.2 Teaching activities 10
      General problem solving 10
      Applied statistics problem solving 10
      Problem formulation 12
      Session management 13
      Interpersonal relations 13

5. The supervised consulting course 14

6. Issues in implementing our program 15
   6.1 Organization of consulting activities 15
   6.2 Videotaping 16
   6.3 Supervision 16
   6.4 Beginning to consult 17
   6.5 Time constraints 18
   6.6 Generalists vs. specialists 18
   6.7 Videotape equipment 19
   6.8 Curriculum issue 19
   6.9 Faculty 19
   6.10 Class sizes and client types 20

7. Evaluation 20
   7.1 Results of the 1983 follow-up evaluation 22
   7.2 Comments on the evaluation 23

8. Summary 24

9. References 25

10. Table 1 27

11. Figures 1-3 28
1. INTRODUCTION

A high percentage of the graduates from M. S. and Ph.D. programs in statistics enter jobs where overall success is greatly determined by their effectiveness as statistical consultants. In continuing conversations with experienced consultants from government and industry, and in repeated sessions at professional meetings, there is the recurring theme that students have difficulty making the transition from academia to government or industry. Part of this lies in the students lack of appreciation for the realities of consulting practice.

Encouraged by authors such as Cox (1968), who suggested adding a course, "Principles and Practices of Statistical Consulting," to the curriculum to complement apprenticeship training, we began in the early 1970's (as did some other statistics departments) to include training in statistical consulting in our graduate program. Since then we have gradually added more components from various disciplines to the consulting course to help students bridge the gap between academia and statistical practice. The evolution of our program is described in detail in Zahn (1982a, 1982b).

Our rather fragmented approach to course development was eventually replaced when we decided to look at the whole picture of what kinds of training will help a student to become an effective consultant. After reaching this decision, we soon realized that we (and the profession as a whole) did not have a standard definition of "effective statistical consultation." We also lacked data on what actually happened in our students' consulting sessions. The only data we and others had was second-hand anecdotes told by one of the participants in the session.

A breakthrough in the development of our program occurred when we decided to gather primary data on the statistical consulting process in the form of fifteen hours of video tapes of actual consulting sessions. These tapes showed that our students had deficiencies in statistical and nonstatistical aspects of consulting. After spending many hours reviewing these videotapes and considering these points, we decided to start from ground level to see if it was possible to develop a comprehensive program to train statistical consultants.

Our program seeks to train statistical consultants by systematically identifying and presenting statistical and nonstatistical skills in discrete, easily managed learning units, e.g., see Zahn and Boroto (1981). Over the past two years, we shifted our emphasis from the identification of key components of a course to the construction of a comprehensive curriculum for training statistical consultants. In this article we describe the result of that effort, a holistic training program for statistical consultants. This program includes training in many skills identified by others as important to the effective statistical consultant (ASA Committee on Training of Statisticians for Industry, 1980, ASA Committee on Training of Statisticians for Government, 1982, Baskerville, 1981, and Boen & Zahn, 1982).
The rest of this article is divided into seven sections:

Why a supervised training program?
Our statistical consulting philosophy
The preconsulting course
The supervised consulting course
Issues in implementing the program
Evaluation
Summary

2. WHY A SYSTEMATIC TRAINING PROGRAM?

In the 1970's our supervised consulting course was a blend of an internship (observer-apprentice) model and a trial-and-error model. In the internship model, the students observed consultations between a client and an experienced consultant. Over time, the student increased his or her abilities to conceptualize and solve statistical problems. As student competencies developed, the student assumed a greater share of responsibility for the consulting session. In the trial-and-error model, students were scheduled with clients and had a supervisor to turn to for guidance in case of problems. In using these methods in our own program, we have found them to be inadequate for meeting specific training needs:

1. Our program to train applied statisticians is of limited duration. We found there is simply not enough time for a trial-and-error model to be effective, if students are to be adequately trained in more traditional areas of statistics.

2. We identified a need for the students to encounter a wide variety of problems with different characteristics. An internship program did not provide sufficient breadth of experience.

3. We identified a need for the student to observe a wide variety of effective consulting styles. An internship model presents only a limited range of styles.

The applied M. S. program at Florida State is a three semester (changing to four semester) program in which actual consulting is a requirement. The preconsulting course and the supervised consulting course are offered in the second and third (now third and fourth) semesters, respectively. Given this short time frame, we have endeavored to find the most efficient means for training statistical consultants. In the internship model, students are exposed to demonstrations of consulting skills such as problem formulation, resource use, and interviewing and are expected to generalize the proper skills of consulting from the specific demonstrations of techniques. These demonstrations occur unsystematically and discontinuously depending on the vagaries of client flow to the internship setting. In a trial-and-error model, the students are expected to acquire these skills independently. As we shall discuss later, many of these skills are not formally taught in
traditional programs.

In the trial-and-error model (and internship), progress toward becoming an effective statistical consultant depends on entering the program with the requisite skills or identifying and acquiring them without much guidance.

In the internship method, it is often advocated that students work on one project in depth. With this approach, one sacrifices breadth for depth, i.e., that one project may only tap a narrow range of skills. It also may be difficult to arrange the timing of the project to coincide with the academic calendar. Thus, a student might be required to leave the project before it is complete.

In a systematic training program, a student can be exposed to a broad set of typical problems which illustrate specific characteristics. For example, problems requiring the formulation and interpretation of a multiple regression model or the design of an experiment might be presented. In this way, more common types of problems requiring certain skills would not be omitted from a student's training.

In a systematic training program, a student can be taught several styles of consulting directly, rather than the limited observation of a few styles (internship) or no styles (trial and error). For example, alternative interviewing styles can be illustrated and discussed through the use of video tapes. In Section 4, we present a course which allows the students to study and learn various components of a consulting style.

We found that there are some skills that internship or trial and error programs do not address. For example, how does one learn to formulate a problem in statistical terms? If one is an apprentice-observer to an experienced consultant, how is this skill assimilated? The implicit steps and thought processes of the experienced consultant occur rapidly, with no "time out" to explain the reasoning. At another level pragmatic issues arise such as what questioning style is most likely to elicit relevant information from a client. We noticed that the training of these skills using the trial and error method was unreliable.

There exists no logical reason that a skilled internship supervisor could not systematically address all of these issues. However, in practice the internship structure and emphasis is on dealing with whatever issues arise during sessions and discussing them afterwards. Thus, the number of problems discussed will vary according to the length of the internship. Our experience to this point encourages us to think that skills such as these can be effectively trained in a consulting course.

These considerations have led us to develop a program consisting of two components: first, a preconsulting course to systematically train various skills and techniques for statistical consulting and second, a supervised consulting course for practicing and extending the skills previously trained.
3. OUR STATISTICAL CONSULTING PHILOSOPHY

While viewing videotaped consulting sessions, we were surprised by the complex interpersonal aspects of statistical consulting and by the demands placed on consultants that go beyond statistical knowledge. Our interpretation of the tapes was that the statistical consultants who produced the most results were effective interpersonally as well as statistically and had a clear idea of the purpose and limits of their consulting. We also observed that there was not a universal definition of statistical consulting nor were there agreed-upon goals for engaging in consulting. The diversity of definitions and goals appeared to be the source of many of the problems we viewed in consulting sessions. Thus, we concluded that the effectiveness of a consultant training program could be enhanced by developing a broad definition of, and a common statement of purpose for, statistical consulting.

We define statistical consulting as an interpersonal interaction with the goal of increasing the utility of information disseminated in any field using statistical procedures. Our definition includes formal and informal interactions that may occur within and among all disciplines. We also found that other goals can coexist with the one we have stated, as long as they do not directly conflict with the stated goal and are held secondary to it.

Many goals for statistical consulting have emerged in our discussions with others in the field. We will contrast our goal with three widely held and apparently disparate goals of consultants.

Academic statistical consultants often have as their goal to gather ideas and data sets to enhance their own research and publication programs. If this is a preeminent goal of the consultant, consultants and clients will frequently find themselves working at cross purposes. Routine problems are likely to be met with little enthusiasm and attention by the consultant and, since the discrepancy in goals will usually not be verbalized, an undercurrent of strain and discord will likely increase. When these conditions predominate, clients are unlikely to consider consultant-suggested innovations in research design or analysis in the future. In like manner, consultants who are faced with what might seem like a disproportionate number of unresponsive clients are likely to develop a cynical approach to consulting. Neither consequence is congruent with our previously stated goal.

Statistical consultants in industry often emphasize the service aspect of consulting and point to the economic necessity of pleasing the client. Service goals have sometimes been misconstrued as blind acquiescence to the client's every request. The statistical consultant would thus function as the "Shoe Clerk" Bross (1974) describes. In our experience, clients are neither served nor pleased by an acquiescing consultant since it may appear to the client that the integrity of the consultation has been compromised and that the consultant cannot be relied on as a strong partner. We grant that an effective consultation sometimes requires courage, patience, perseverance, and interpersonal skill from the consultant to achieve the desired goal.
While viewing the videotapes, a third goal of statistical consulting became apparent. We noticed that consultants often assumed a role which might be characterized as the Gate Keeper of the Scientific Method, a position which generally collided with the wishes and expectations of the client. We found that when the consultants implied or insisted that they were the sole possessors of the standards by which to judge the quality and utility of the study, clients appeared reluctant and sometimes openly resistant to adopting the consultants' suggestions. At such times, consultants typically attributed the resistance to the clients' unwillingness to be scientific. Psychologists have reliably produced comparable resistance in laboratory studies on persuasion and refer to the phenomena as psychological reactance. Psychological reactance is an interpersonal phenomenon and is the result of the authoritarian role assumed by the consultant. It is not due to ideological differences between the consultant and the client, nor is it reflective of some personal characteristics of the client. Paradoxically, as the consultant assumes the role of scientific gate-keeper, reactance is elicited from the client and the consultant's effectiveness as a "champion of science" is decreased.

When each of the apparently conflicting goals we have reviewed is examined, one can see that the conflict can be resolved when the goal is more clearly defined or is defined within the context of the broader goal we propose. Thus, for example, the goal of using consultations to generate research ideas and the goal of providing service are feasible when the broader goal of increasing the quality of the information disseminated is preeminent. Implicit in this broader goal is also a broader time frame that requires the consultant to consider how one must effectively promote high standards of scientific inquiry in an entire field rather than limiting one's influence by adopting an antagonistic role in a single study.

Based on our own experience with consulting, we find that the basic goal of supporting other disciplines in improving the quality of the information disseminated is most frequently achieved when there is a cooperative relationship between the consultant and the client. This view was borne out in discussions with consultants who seem satisfied with their work and who are regarded as effective statistical consultants by the profession. We view client satisfaction and scientific rigor as compatible. Effective consulting can occur with clients who have multiple motives for doing their studies (e.g., promotion, graduation, increased profits) when a skilled consultant evokes the desire to "make a difference" which, we observe, underlies the client's original decision to work in a chosen field. Finally, we find that the greatest barriers to effective statistical consulting stem from consultant attitudes, expectations, and goals rather than client or project deficiencies.

It became clear to us that to design a statistical consulting training program that would achieve the goal we had stated, it would be necessary to delve into the interpersonal complexity of statistical consulting, including philosophical and attitudinal barriers to effective consulting. We incorporated into the course a "point of view" about consulting in which the
consultant's job includes such nontraditional tasks as inspiring a client to recommit his/her energies to strive for the potential benefits of a project rather than to compromise to immediate exigencies. These points of view are reflected in the curriculum explicitly in discussions as well as implicitly in the choice of interpersonal skills to be trained and in the approach to the entire consulting course sequence.

4. THE PRECONSULTING COURSE

Our goal in the preconsulting course is to teach effective statistical consulting skills as efficiently as possible. Inherent in this goal is the assumption that students are competent in several basic areas when they enter the course. We expect students to have elementary statistical skills (a good list can be found in ASA (1980)). We expect students to have minimal computer skills including the ability to use one or two statistical "packages," to interpret computer output and to create simple data files. In the course we emphasize clarity in writing and explaining statistical ideas and we therefore expect students to have sufficient oral and written communication skills. These basic abilities are necessary to achieve our course goals since students will use them in the acquisition of new skills presented in the preconsulting course.

While developing this course, we watched video tapes of many consulting sessions. We noticed that the skills required in consulting sessions could be separated into five categories described in the next subsection.

4.1 Segments of a Consulting Session

In a consulting session, the consultant must first deal with a person. The consultant must establish a working relationship such that the client understands that the consultant is there (1) to provide a service rather than to judge and evaluate and (2) to facilitate the emergence of cooperative working relationship. The consultant must be able to identify the needs of the client and to communicate his or her understanding of those needs effectively to the client.

A second task facing the statistical consultant is organizing the consulting session. The consultant must decide when the problem has been identified and formulated to the extent that it is possible to move on to other tasks, such as problem solution and summary discussions.

Third, the consultant must translate the client's questions into a statistical framework. This involves the operationalization of ideas, as well as some basic scientific research design.

Next the consultant must devise solutions to the formulated statistical problem. We call this segment "applied statistics problem solving" in which the task to be done is working with the client to develop a plan of action which is appropriate to the statistical problem, given the constraints of the
client, consultant, and the problem to be solved.

The last segment is general problem solving, that is, the consultant must have techniques available for solving problems of all sorts. These problem-solving skills are similar to those described by Polya (1957, 1962). The material taught is based largely on Wickelgren (1974), which is in the spirit of Polya's books but not restricted to solving only mathematical problems. Given this structure that we repeatedly observed in consulting sessions, we divided the preconsulting course into five sections:

1. general problem solving,
2. applied statistics problem solving,
3. problem formulation,
4. session management,
5. interpersonal relations.

Actually the chronological order in which these occur in a consulting session is often the reverse of the above. We have explored teaching this material in both orders, segment one to segment five and vice versa. The order listed here seems to work better for a variety of reasons. Segments one, two, and three relate naturally to the rest of the statistics graduate student's courses, whereas segments four and five are quite different and are met with more skepticism if taught first. Also, teaching segments one to three first offers ample opportunity to demonstrate the importance of segments four and five. In the next subsection, we describe how we teach the five sections of the preconsulting course.

4.2 Teaching Activities

General problem solving. We begin the course by teaching general problem solving. First, basic terms in problem solving (givens, operations, goals, problem state, solution, action tree) are defined and then each of several problem-solving methods (inference, classification of action sequences, state evaluation and hill climbing, subgoals, contradiction, working backwards, solving a simpler problem, solving a more general problem) is presented. Nonstatistical and statistical examples are included for each method. After the entire group of methods has been presented, the class discusses the relative merits of each, focusing on characteristics of problems which make specific techniques especially useful. The class then practices jointly on a set of problems. This segment of the course is tested by a homework assignment in which the students are asked to identify the elements of a set of problems (goals, givens, etc.) and to solve them. They also write down their thought processes and the problem-solving methods used while solving the problem. This information is used in subsequent class discussions to expose the students to different ways people have of thinking about the same problem.

Applied statistics problem solving. The second segment of the course is applied statistics problem solving. In this segment, the general problem-solving methods are brought to bear on the specific problem -- "What is
appropriate advice to give or actions to recommend to the client?" The necessity for this segment of the course is argued for eloquently by Feinstein (1970):

The preparation for work as a consultant thus contains antipodal contrasts in the education of clinicians and statisticians. A clinician is taught to identify and formulate patient's problems in a carefully structured manner; but he is then left to develop diverse tactics of "judgment" for managing the outlined problems. A statistician is taught a carefully organized set of mathematical structures for managing an outlined problem; but he is left to develop diverse judgmental methods for identifying and formulating the problem. The clinician may emerge able to express the right questions but unable to find the answers; the statistician may emerge with the right answers but unable to select the questions.

Kimball (1957) also argues along these lines, defining errors of the third kind as those in which a consultant gives the right answer to the wrong problem. We believe more time should be spent in statistics programs teaching students to apply statistics rather than just teaching applicable statistics. We approach this segment by pointing out the differences between the formal (puzzle) problems on which the general problem solving methods were illustrated and the applied statistics problems. Some of these differences are:

1. The goals of the problem are not as well-defined as in a formal problem.

2. Alternate solutions will exist at different levels of expertise of the client.

3. Constraints on the resources of the consultant and the client will play a large role in determining the practical solutions.

4. It will be more difficult to decide when a solution has been reached.

Using the general problem solving methods as a base, we next present an expanded model of problem solving that can be used on statistical problems encountered in a consultation. Following are the steps in this model.

1. Determine the nature of the problem

   1.1 Identify characteristics of the problem
   1.2 Make a preliminary classification of problem characteristics

2. Determine the scope of the problem

   2.1 Identify prior actions and outcomes
   2.2 Identify constraints and limitations
3. Determine solution requirements
   3.1 Identify desired outcomes
   3.2 Define requirements the solution must meet

4. Determine resources
   4.1 Define client resources and constraints
   4.2 Define consultant resources and constraints
   4.3 Define alternative resources and constraints

5. Propose solution alternatives
   5.1 Determine relevance to solution requirements
   5.2 Determine feasibility of solutions, given resources and constraints on them

6. Recommend a solution

For this segment of the course we illustrate use of the model on some real consulting problems. The students are evaluated by asking them to identify the steps of the model while attempting to solve applied statistical problems. In this segment students also read Kimball (1957) and begin sitting in on consultations of experienced consultants.

Problem formulation. The third segment of the course is on problem formulation and the scientific method. We illustrate the operationalization of vague ideas (e.g., what does the client mean by "related to" or "look at differences") using several real consulting problems; we discuss several examples demonstrating how it is that many statistical problems get formulated in terms of means, proportions or correlations. Discussion of problem formulation and the kinds of conclusions that are possible from an experiment leads naturally to a discussion of research design, experimental design and scientific methods. Some basic terminology (experimental unit, confounding, replication, etc.) is reintroduced and illustrated on good or poor experimental design.

The students' performance on problem formulation is evaluated using a written simulation: The students are given the barest background to a real problem (actually the information form required from the client before the first consultation at the Florida State University Counseling Center) and are asked to begin formulating the problem. They also are required to list information they need and questions they would like answered about the consulting project. The evaluation then proceeds in a sequential manner, with more information being given to the students, who then attempt to formulate the problem again, etc. This simulates an actual consulting session but removes most of the interpersonal elements so the students can concentrate on problem formulation and "asking the right questions." The students' performance on research design is evaluated by asking the students to criticize and improve
several designs on a homework set.

Session management. In the fourth segment of the course, session management is discussed. We identify in what order various consulting activities occur and how to proceed or backtrack. This segment introduces another consulting activity, called "summary discussions" by Zahn and Isenberg (1983), during which implementation of the chosen solution is discussed. The student's performance on this segment is evaluated by asking them to view videotapes of consulting sessions and identify and classify the consulting activities that have been discussed as of this point in the course.

Interpersonal relations. The last segment of the course provides a combined didactic and experiential learning unit (Tyler, Kalafat, Boroto & Hartman, 1978) on interpersonal relations in a statistical consultation. The didactic component addresses the necessity for paying attention to nonstatistical aspects of a statistical consultation. The didactic component also presents some tools used to recognize characteristic problems of a consultation and strategies for effectively handling such problems. The experiential component includes making and viewing videotapes, doing roleplays, and participating in exercises designed to produce some psychological experience or state likely to be encountered in a consultation, e.g., interpersonal anxiety, evaluation apprehension, or seductiveness (Zahn & Boroto, 1981). The issues covered, although obvious to an experienced consultant, are not obvious to the novice.

The first task in this part of the course is to convince the apprentice consultants, through the use of videotapes of consulting sessions performed by experienced consultants, that nonstatistical aspects of the session can determine the ultimate efficacy of a consulting hour (Figure 1). We demonstrate that the attitudes and biases of both the client and the consultant have a powerful effect on the consultation's direction and ultimate outcome. A videotape that students view initially in this section of the course shows a client who was sent by the major professor to work out an experimental design to do hypothesis testing. The client, however, was ill equipped either to conceptualize or implement the project. The client's basic aim was to fulfill demands of the major professor. The consultant, on the other hand, was insulted that he was expected to provide pat answers to difficult questions in such a way that the client might satisfy degree requirements without mastering the rudiments of research design and basic statistics. Parts of the videotaped interaction were sadly comical. It should be pointed out that this was a real consultation with an experienced statistical consultant.

------------------
Insert Figure 1 about here
------------------

Next, a communication model is presented that focuses on identifying the motives and intentions of both the client and the consultant at any point in time in a consulting session. The student has numerous opportunities to
observe how consulting sessions become ineffective when the client's and the consultant's intentions or personal and professional goals conflict.

Finally, students participate in a series of roleplays to give them practice in dealing with a range of problem situations that occur in consulting interactions. Topics of these roleplays include situations in which the client questions the consultant's credentials or expertise, makes unreasonable demands, wants to develop a passive-dependent relationship, presents an amorphous problem for which a specific answer is expected, or demands a solution requiring far more statistical expertise than the client (or, perhaps, the consultant) has. In the roleplays, students have an opportunity to play both the client and the consultant. The opportunity to play the client's role increases students' empathy with the client and understanding of the dilemma. Playing the consultant provides them with an opportunity to explore various problemsolving techniques at both a strategic and verbal level.

The interpersonal component of the course is evaluated on several levels. Prior to the dissemination of any content, students view a videotape of a statistical consultation session. Two- to three-minute segments of the tape are identified; for each segment, students respond to a general question, "What has taken place in this segment?" and several more specific questions such as: "What are the tasks confronting the consultant at this point?"; "At this point in the session, what are the goals of the consultant and the client?"; "Which are congruent?"; and "Which are incongruent?"

At the conclusion of the interpersonal section, students view a different videotape and respond to similar questions. The answers to these questions are evaluated in terms of the concepts presented in the interpersonal section of the course. In addition to this pre-post evaluation, roleplays performed within the section are evaluated, giving feedback immediately after the roleplay. The roleplay is reenacted until the basic lesson has been mastered. The roleplays often raise so many questions that only a small fraction of them can be explored in the class time available. Even with the time limitation, the process works because common problems will reoccur until they get discussed and resolved.

5. THE SUPERVISED CONSULTING COURSE

The supervised consulting course is a repeatable, semester-long course in which the students do actual consulting and extend and sharpen the skills learned in the preconsulting course. The students schedule two hours of consulting per week and are required to videotape all consulting sessions. The course has three additional types of meetings per week: supervision, case conference and new material sessions.

In the Supervision sessions, segments of the videotaped consulting sessions are reviewed by the instructor and two or three students, including the consultant. A student selects specific sections of a tape based on his or
her questions about the session. If there are not specific segments of the tape to be studied, the student is asked to replay four short segments of the tape: the beginning, the end, a spot where the session was going well, and a spot where the session was going poorly. This is sufficient to generate useful discussion. Given the limited time available, it is usually necessary to pick among several potential issues to consider. The students in the course are expected to offer constructive comments on the videotape segments. The discomfort that videotapes evoke is initially quite strong. The instructor has the responsibility to create and maintain an environment in which comments are given and received in a supportive manner.

The Case Conferences provide a forum for the discussion of difficult or unusual statistical problems. The student whose consulting problem will be discussed distributes a summary of it to each member of the class one day in advance. The class then meets to discuss the problem, with the presenting student acting as moderator and guiding discussion towards solution to the problem. In addition to receiving suggestions, the student gets practice in writing about and summarizing statistical problems and in running a technical group discussion.

The New Material sessions are reserved for discussions or presentations of new material relating to any segment of the course, from applied statistical procedures not covered in other courses to interpersonal relationship material. By presenting one or two topics to the class, the students gain experience in explaining statistical procedures and also practice in identifying and exploring sources of material on statistical procedures. (These sessions only provide an introduction to the topic.)

Finally, each student is required to do a project consisting of an extensive report on the statistical and nonstatistical aspects of his or her interaction with one client.

6. ISSUES IN IMPLEMENTING OUR PROGRAM

6.1 Organization of Consulting Activities

The anxiety which students naturally experience as they begin consulting can be reduced by standardizing policies and procedures to minimize uncertainty and confusion. Features which aid students (and consulting faculty) include:

• A clear policy statement which tells clients what services we do and do not provide. The statement eliminates many misunderstandings before an initial meeting.

• A Client Information Form submitted by every new client at least 24 hours before the initial appointment. The form helps the client clarify the problem and assistance needed and allows the consultant to prepare for the session. Frequently student con-
sultants encounter statistical problems which require a quick introduction to some unfamiliar statistical topic.

- A Release Form submitted with the Client Information Form in which the client agrees to permit videotaping and to fill out an evaluation of the session. The release informs and protects the rights of the client.

- A file containing standardized information on clients from previous semesters. This file reduces the confusion which can result when client problems span semesters.

- A designated consulting room with the videotaping equipment in place and conveniently accessible. A consultant with minimal advance preparation needs only to press one button just before admitting the client, eliminating needless distraction of both the participants.

6.2 Videotaping

Videotaping the student's sessions is an essential part of the course. By providing a complete account of what happens in a session (rather than information via selective recall by one participant) the taping sessions have benefits to the training program that offset the disadvantages of videotaping. These disadvantages include an increase in the level of consultant and client anxiety that occurs as a reaction to the taping and other, more physical costs, such as the time to adjust the equipment at the beginning of the session, teach videotaping, establish and monitor the security of the system, and maintain the equipment, (Figure 2). Though anxiety levels may be higher, we have noted that after five or ten minutes in many sessions, the consultant and client appear to pay no attention to the camera. The camera is unobtrusive, having been placed in a cabinet in the corner of the consulting room (Figure 3).

Insert Figure 2 and Figure 3 about here

Though the camera initially distracts some individuals, both consultants and clients, we have not made its use elective. We know of four clients over the past three years who have objected to the videotaping of their sessions. Any adverse effects of videotaping from the client's point of view are outweighed by the more accurate and helpful input the student consultant receives from the faculty supervisor reviewing the tapes. The taping also signals the clients that we take the supervision process seriously.

6.3 Supervision

Supervision sessions have been one of the hardest parts of the program to implement because they require of statistics faculty skills in identifying
interpersonal events on videotapes that interfered with the statistical work being done. These are skills that were new to the statisticians involved in our program, and, we suspect, to other statisticians starting such a program.

Supervision is a complex task. While supervising, one is watching a tape of a session with the student consultant and two or three of his or her peers present. The supervisor must identify effective and ineffective parts of the session. This information must be delivered to the apprentice in a constructive, helpful manner which clearly communicates that the purpose of the whole endeavor is to help the apprentice learn how to consult better. We have already noted that it is often useful to have a psychologist or other counseling professional on the team to help us learn to identify interpersonal aspects of the sessions that are interfering with statistical progress and to teach us some effective strategies for dealing with some of the more common and problematic interpersonal situations that arise in consulting sessions.

We have noticed a tendency on both the student consultant and supervisor's part to shy away from potentially uncomfortable discussions of interpersonal material by focusing on familiar and comfortable statistical topics. This must be guarded against. Case conferences are the place for the extended statistical discussions which are necessary in most consulting problems.

The optimal length of time for supervision class sessions is to some degree dependent upon class size. With six people in the class, we recommend having 60 minute supervision sessions. We suggest adding approximately 10 minutes of supervision time for each additional student included in the class. The maximum length of time that sessions should be is two hours: students will tire and lose interest if the sessions exceed this limit. These recommendations are based upon our experiences with supervising students in different class sizes.

6.4 Beginning to Consult

Some students who have completed the preconsulting course are still not sufficiently prepared for their first "actual" client. Even after doing the practice consulting roleplays, these students are very uneasy about obtaining statistical information from a stranger. Additional steps we are considering for the program to alleviate this include making more extensive use of roleplays and pseudoclients (individuals from other departments who present practice sessions) in the preconsulting course and starting off the supervised consulting course by having the supervisor actually sit in on a student's first few sessions, with the student having the responsibility to be the lead consultant.

In our review of videotapes, we are surprised to find that the students' capacity for processing statistical information is still much weaker than expected. Students often seem "overwhelmed" by statistical problems that they see as being unsolvable. We plan to add more activities in the preconsulting course that will show students how they can gather and evaluate statistical
information and to make recommendations within their statistical ability before they begin to consult.

6.5 Time Constraints

One of the major constraints we have encountered in developing this program is the limited time available in the master's degree curriculum. (We advise doctoral students to take the sequence in their second or third year). Some are very uneasy about consulting with a client, even after "practicing" in the preconsulting course; no amount of practice will totally eliminate the apprehension associated with this step. Students are uneasy about the amount of statistics they know when they begin to consult in the Summer Semester. However, we have found that students can make a substantial contribution to the problems of most graduate student clients they see. The videotaped sessions and subsequent supervision help to identify when they are "in over their heads" and then assistance is given by one of the faculty members of the Consulting Center.

We encourage longer-term students to repeat the supervised consulting in that there are so many things to be learned as one is starting to consult. By beginning to train students in interpersonal aspects of consulting, we have substantially increased the number of topics to be taught. One semester is not enough time to ingrain in students new ways to handle a difficult interpersonal situation that they may have frequently experienced. Under stress, a person tends to revert to long-established habits, rather than to use newly learned skills. For example, a student may find it difficult to say "No" to a request, even when the request is for a service the Consulting Center does not provide. Tendencies like this which may have been going on for years will often show up in roleplays in the preconsulting course where we can offer suggestions and practice in ways to say "No." However, when encountering an unrealistic request in the heat of a consulting session from, say, a domineering client who is years older, the student is likely to revert to the old behavior of saying "Yes" when he or she would rather say "No."

Experience from the training of therapists suggest that it could take as much as three or four years of supervision to replace habits such as this one with new skills. Thus, we must be realistic in our expectation about how much progress students can make in these areas while in statistics graduate programs. Our aim is to help them identify their major habits or viewpoints which interfere with the effectiveness of their consulting. Then we offer some alternatives to their habitual response and help them to see, in the very least after-the-fact on videotapes, how these alternatives could be used.

6.6 Generalists vs. Specialists

In our program students are exposed to a general selection of problems from a variety of disciplines. We choose to expose our students to many disciplines during their training since they do not know where they will specialize later. An in-depth knowledge of a limited number of fields certainty
is also useful. The course structure described here could be equally well used in a program which exposes students in depth to a few applications areas.

6.7 Videotape Equipment

The initial capital investment for the consulting program in 1980 consisted of a Hitachi color camera (Model DX-1640), a Sony Betamax videorecorder (Model SLO-323), a Sony programmable remote control (Model RX-353), a Sony color monitor (Model KV1513), a set of four Keystone quartz lamps (Model 100-09), a tripod, camera adaptor, and tripod dolly, and 40 Beta I format videotapes. Included in our expenditures was the refurbishment of a metal storage cabinet to house the video equipment and the installation of deadbolts in our conference room where the cabinet is stored. Our total outlay was $6400 for the equipment and supplies. Since 1980 the cost of video equipment has dropped considerably. Today one can purchase a minimal video system consisting of a high-quality camera, recorder, and monitor for less than $2000 retail.

6.8 Curriculum Issue

An important question that we considered while developing our curriculum was how to make room for the consulting courses in the masters and/or doctoral programs. Our decision was to have students take two fewer elective or statistical "tool-type" courses (e.g., sample surveys, nonparametrics, applied multivariate analysis, applied time series analysis). We reasoned that students who have taken basic mathematical statistics, probability, and other courses would be able to increase their knowledge of comparable statistical methods and applications in the supervised consulting course or through self-study. The consulting courses offer students the added opportunity of practicing what they have learned in their formal curriculum and applying this knowledge to real-world problems.

The concepts taught in this course will continue to be important even as statistical computer programs increase in their usefulness and popularity. In actuality the trend towards the use of computers will open up more opportunities for "user-friendly" and "interactive" statisticians to assist clients in operating and interpreting sophisticated computer software.

6.9 Faculty

We recommend that faculty who plan to develop and implement a program similar to ours be willing to learn and teach topics such as interpersonal relations. They must be willing to deal directly with anxiety in students and faculty who are videotaped. Further, colleagues may be skeptical of the course's value and appropriateness to a statistics curriculum. We have found that most statistics professionals respond favorably to the theme of the course: the improvement of the quality of statistical information disseminated in other fields.
To create our program we assembled an interdisciplinary team consisting of three statisticians and statistical consultants (McCulloch, Meeter, & Zahn), an instructional design expert with statistical consulting experience (Polland), and a psychologist (Boroto). We now realize that there are a number of aspects of the psychologist's background which have been critical to the development of our program. In particular, he is experienced in psychological consulting and in training psychological consultants in a university setting. Furthermore, he is an active research psychologist, with substantial statistical training who frequently employs statistical methods in his own research. Psychologists with comparable interests and experiences are present in most university settings.

We recognize that the instructor is the key component in this program. We also recognize that we cannot adequately describe in print how the instructor should create the optimal learning atmosphere. The task of training instructors to teach consulting cannot be accomplished by text alone. For a training program for instructors to be successful, it must include a combination of textual and visual material as well as guided experiences in observing and participating in consulting activities.

All five of the authors were involved in the consulting course during its development. Currently, each course is taught by one faculty member as part of his regular teaching assignment.

6.10 Class Sizes and Client Types

From 1981 to 1984, the enrollments in the preconsulting and consulting courses have ranged from six to twelve and four to nine, respectively. We now feel that we have developed the technology to the level that we could effectively teach twenty in the preconsulting class and four per section (one instructor, three hours per week) of the consulting class.

In our opinion, the program works well with students seeing all types of clients. Allowing them to see an unselected set of clients gives them an opportunity to work in the supervision environment with the wide range of clients they will see in the work environment.

7. EVALUATION

There are several forms of evaluation that are used to judge the progress of the student and time effectiveness of the instruction.

The first of these is the Consultant Checklist: a forty-item questionnaire that students complete as they review their videotapes during supervision sessions. Students use the checklist to rate themselves and their classmates on how well they managed their consulting sessions, interacted with their clients, and made statistical recommendations. The course instructor also uses this checklist to rate the videotape of the student's performance.
Another measure of student effectiveness, the Client Feedback Questionnaire, is a twenty-item survey administered by computer to the client immediately after meeting with the consultant. Clients are asked to assess the consultant's understanding of their problem and the amount of interest shown by the consultant. Clients are also asked to judge the appropriateness of the consultant's recommendations, how much confidence the consultant has placed in those recommendations, and how feasible it will be for the client to carry them out. Each student whose videotaped consulting session is reviewed in supervision receives input from four different sources: the student's self evaluation, the instructor's evaluation, the peer evaluation, and the client's evaluation.

We use two methods of determining course impact. At the end of the Introduction to Consulting Course and the Supervised Consulting Course, students receive a Course Evaluation Form that asks for their feedback on the quality and effectiveness of the instructor and the course activities. Students are also asked for their views on how to improve and/or reorganize the course.

A second form of program evaluation is a follow-up study of former graduates of the Statistics Department and the consulting program. The purpose of this survey is to determine what kinds of consulting activities former students are performing in their jobs and what role the supervised consulting program has had in preparing them for actual consulting.

For the follow-up evaluation completed in 1983, former Masters and Doctoral students in Applied Statistics who completed the consulting program in 1981 and 1982 were contacted via phone. Only students currently employed full-time were included in the survey. Eighteen out of 24 students met this criterion. Of the eighteen identified, fourteen students (78%) were available by phone for the survey.

The students were interviewed by the Administrative Assistant for the Statistics Department. The following is a list of the questions asked in the interview:

What is your official position title?
How long have you worked at that position?
What are some of your daily routine tasks?
How many hours a week do you spend consulting?
What are some of the difficult issues that arise in your consulting sessions?
What do you remember about the consulting course at FSU?
How would you describe the purpose of the course to a colleague?
What do you think was the orientation of the course?
What were some of the unique aspects of the course?
Respondents were also given a list of consultant characteristics and asked to rate the importance of each characteristic to their consulting activities and to rate the effectiveness of their instruction on each characteristic.

At the end of the interview, graduates were again asked to describe the purpose and orientation of the consulting course and to say whether it facilitated or inhibited their performance as consultants.

7.1 Results of the 1983 Follow-Up Evaluation

The fourteen graduates of the program were divided among several types of positions: most notably assistant professors (four) and senior systems analysts (three). Except for three of the graduates in academic positions, all indicated that computer programming was one of their main job tasks. Research, data analysis, model building, and teaching were the other main tasks reported.

When asked to describe the purpose of the consulting course, a majority of graduates said that the course gave them an opportunity to gain experience in actual consulting, to learn more about applied statistical problems, and to learn how to work with nonstatisticians. Foremost in their recollection of unique aspects of the course was the videotaping experience. Most students noted that videotaping added to their understanding of the nonstatistical aspects of consulting. On the negative side, some students recalled a certain amount of disorganization in how the course was structured. Their assessment of disorganization is a valid one and corresponds to a period when the course was being developed and undergoing rapid changes.

The median amount of time that the graduate consultants spend in consulting is 3.5 hours per week. Eight of the fourteen graduates consult 2 or fewer hours per week. Only one graduate indicated that he consults "all of the time." Many of the graduates who spend little time consulting didn't respond to the subsequent question on the "Difficult issues that arise in consulting." In general, those who did list issues (43% of the respondents) included in their lists several nonstatistical factors that influence the consulting session; e.g., time limitations, budget constraints, political pressures, and interpersonal interaction.

Graduates were asked to rate the importance of each of ten consultant characteristics to their consulting activities. Responses were scored on a five-point scale where five means that the characteristic was "Essential to their consulting" and one means that it was "Not important at all." The list of characteristics was also rated for how well the consulting course taught that particular skill. Graduates were asked to rate their instruction using the standard grading scale of A, B, C, D, and F where an "A" is worth four points and an "F" counts as zero points. A summary of their responses appears in Table 1.

The three characteristics rated highest were "Identifying and solving problems," "Communicating effectively with clients," and "Working cooperati-
vely with others." The characteristic receiving the highest grade was "Recognizing interpersonal anxiety." The high grade is reassuring given the emphasis we have placed upon the nonstatistical aspects of consulting. The lowest grade the course received was for "Extending and developing statistical methodology," a topic which was not covered explicitly in the course. Many of the statistical problems that students encountered in their consulting required the application of methods quite unfamiliar to them. Students often remarked on their end-of-course evaluation that they would have liked to have had at their disposal a larger "arsenal" of statistical procedures. We anticipate that this problem will be alleviated by the introduction of two new advanced applied statistics courses in the new four-semester Masters Degree program described in the next paragraph.

7.2 Comments on Evaluation

That the consulting course got a low grade for "Extending and developing statistical methodology" is not surprising since this activity is not a goal of the course; it is addressed in other parts of the program. However, feedback from students and others regarding deficiencies in the program in this area relates to a concern frequently voiced about our program, namely that to add nonstatistical aspects of statistical consulting to the program, one must sacrifice coverage of some statistical topics. There is always the question of how much time to spend on these two aspects of training consultants. The solution we decided on was to extend the Masters Degree program from three to four semesters, adding 13 semester hours of credit to the program, four in statistical consulting, six in advanced topics in applied statistics and three in another elective course, probably in the area of quality assurance.

The follow-up evaluation did not ask students to define statistical consulting. It is quite possible that amount of consulting time they reported may be an underestimate in light of our broad definition of consulting. Students may perceive consulting as only that time spent in a scheduled consultation. In future follow-up surveys, we will investigate the amount of time our graduates spend on each of the tasks that we consider to be consulting activities.

At the end of the semester, students receive a report summarizing the evaluation data from the Client Feedback Questionnaire. The report contains their average rating on the twenty items and the average rating on their classmates and the consulting faculty for all clients seen that semester. Although students do not immediately receive the data on their client's perceptions of the session, the instructor can review this information following viewing of the corresponding videotaped session and use the data in subsequent supervision recommendations.

The Consultant Checklist has proven to be a valuable instructional tool. In addition to its evaluative function, the Checklist serves as an outline for managing consulting sessions. Since the Checklist is only a sample of the many possible activities that occur in consulting sessions, instructors should
guard against its use as a "cookbook" approach to consulting.

Evaluation is an integral part of our course development. We view evaluation as a continuous, iterative process that incorporates the evaluative data into our curriculum design in the form of course improvements and modifications. Without some sort of evaluation, needed course refinements cannot be identified and later validated.

8. **SUMMARY**

In this article we have described a comprehensive consulting curriculum that systematically incorporates training in statistical and nonstatistical aspects of statistical consulting. We have discussed the limitations of internship and trial-and-error methods of training statistical consultants in time-limited university programs and have proposed a broader definition of consulting with a specific goal to be achieved. We have stated our general philosophy of statistical consulting and have contrasted our philosophy with several existing ones. Key parts of our program are:

1. A preconsulting course which systematically trains skills required for consulting not currently taught in statistics programs.

2. A supervised consulting course having videotaped consulting experiences, sessions involving supervision, case conferences and presentations of new material.

3. An evaluation of competencies achieved at each stage in the program.

Because of the innovative philosophy and technology of our program, we have made a wide range of recommendations intended to aid others in the implementation of a similar program. Finally, we have included the results of our initial efforts to evaluate the effectiveness of the program.
9. REFERENCES


Table 1

Results of Evaluation Survey

<table>
<thead>
<tr>
<th>Importance</th>
<th>Median Grade</th>
<th>Characteristics of Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.71</td>
<td>3.05</td>
<td>Identifying and Solving Problems</td>
</tr>
<tr>
<td>4.85</td>
<td>3.25</td>
<td>Communicating Effectively with Clients</td>
</tr>
<tr>
<td>3.60</td>
<td>2.30</td>
<td>Extending and Developing Statistical Methodology</td>
</tr>
<tr>
<td>3.50</td>
<td>2.80</td>
<td>Managing Consulting Sessions</td>
</tr>
<tr>
<td>3.25</td>
<td>3.64</td>
<td>Recognizing Interpersonal Anxiety</td>
</tr>
<tr>
<td>4.00</td>
<td>2.80</td>
<td>Negotiating Responsibility with Clients</td>
</tr>
<tr>
<td>4.06</td>
<td>3.00</td>
<td>Understanding the Realities of Statistical Practice</td>
</tr>
<tr>
<td>4.00</td>
<td>2.67</td>
<td>Using Computers to Solve Problems</td>
</tr>
<tr>
<td>4.00</td>
<td>2.64</td>
<td>Adapting Quickly to New Challenges</td>
</tr>
<tr>
<td>4.57</td>
<td>3.08</td>
<td>Working Cooperatively with Others</td>
</tr>
</tbody>
</table>
Figure 1. Videotapes are discussed.
Figure 2. The equipment is mounted in a lockable cabinet.
Figure 3. The camera is unobtrusive during the session.