

# Statistical Consulting at Liberal Arts Colleges

## Mellon Foundation Workshop Report

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### Executive summary

There has been a steady increase in the complexity and sophistication of statistical methods used in all fields of quantitative research. At the same, there has been dramatic growth in the amount and type of research by faculty and students at liberal arts colleges. These two trends have led to increased need for statistical consulting to help ensure that research at liberal arts colleges is on an appropriate footing.

A group of statisticians and social science researchers from a variety of institutions met to address models for the provision of statistical consulting at liberal arts colleges. While models exist to address the varied needs of researchers needing consulting support (both faculty and students) as well as those providing consulting (including provision faculty and students supervised by faculty members) they require substantial institutional support in the form of salary support, teaching release, and/or staffing to be effective and sustainable over the long-term.

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# 1 Background and Introduction

There have been dramatic changes in the use of statistical methods in research. The growing sophistication has key implications for liberal arts colleges, where research is increasingly important. This workshop addressed how to support statistical consultation beyond traditional statistical methodologies for faculty and students, as well as how to foster changes to the introductory and intermediate statistics curriculum to facilitate interdisciplinary research grounded in appropriate methods.

Statistics are a key component of the research methods utilized in many disciplines, and the complexity and sophistication of the approaches and techniques used have grown dramatically in recent years (Horton and Switzer, 2005). In intermediate and advanced courses in their major, students are reading papers that are both increasingly quantitative and involving increasingly sophisticated statistical methods.

Recent developments in statistical methodologies sometimes leave faculty advisors incapable of conducting their own analyses or providing statistical oversight for their students. While many faculty members in liberal arts colleges collaborate with colleagues on their research, there is often minimal involvement of statisticians in research projects. In addition, student projects often require statistical assistance and support to be successful.

The growth in research activity at liberal arts colleges involves moderate sized projects of the type more typically associated with Research-I universities as well as research undertaken primarily by undergraduates (and everything in between). Such work, typically interdisciplinary, requires institutional support of various types (e.g. grants management, human subjects protection, access to expensive equipment). Equally important for many studies is support for statistical consulting on design and analysis issues, to ensure that institutional and external research support lead to interpretable and justifiable conclusions. This growth of research, in conjunction with the complexity of statistics, has exacerbated the need for statistical consulting at liberal arts colleges.

## 1.1 Definition of statistical consulting

Boen and Zahn (1982) discuss a variety of definitions of consultation. We focused on the variety of relationships ranging from the quick visit lasting ten minutes or less to interactions spanning weeks with multiple visits as well as involvement in data analysis and interpretation.

Examples of statistical consulting of the form that we considered include:

- helping a student undertaking a senior honors thesis with questions regarding design, analysis and interpretation of their study
- assisting a faculty member who is trying to address a statistical reviewer's comment or suggestion on a paper in revision
- providing appropriate references for a faculty-student collaboration using modern statistical methodology
- consultation on a power and sample size calculation for a grant submission to a federal agency
- assistance in data management, analysis and interpretation for a senior faculty member with little quantitative training

We distinguished consulting from long-term collaborative relationships (often supported through external grants) where statisticians are provided with salary support for ongoing intensive support of a research investigation. We also exclude interactions where the primary motive is to motivate new statistical methodologies. While collaborative relationships and methodological research are key components of statistics, mechanisms to support those activities already exist.

The workshop focused on shorter-term consulting, where tangible advice and support is provided to faculty and/or student researchers. Access to statistical consulting is often critically important for the researcher seeking support, in the same manner as access to a machine shop or reference librarian. In contrast to many other forms of faculty collaboration that occur at liberal arts colleges, consultation is often one-sided, with primary benefit accruing to the researcher while little recognition or other direct benefit goes to the statistical consultant. Unlike the machine shop or the reference librarian, the statistical consultant is typically a tenure-line faculty member with competing demands on their own research and teaching program.

We acknowledge that there are often indirect benefits to the statistician related to the provision of consulting, realizing that many collaborations or new statistical methods derive from these initial consultations. However, the direct benefit to the statistical consultant is often unclear, while the opportunity costs for a faculty researcher are often non-negligible (particularly during their probationary period).

## 1.2 Issues and goals

Workable models to appropriately nurture and support statistical consultation at liberal arts colleges are not readily apparent. Major open questions include how to compensate faculty for their time, provide

appropriate release time, and evaluate consulting work in tenure, review, and promotion decisions. In addition, there is a lack of clarity about how to create models that meet needs for faculty and student research support while ensuring a successful career trajectory for statisticians at liberal arts colleges.

The workshop was intended to address important questions of how to best structure statistics education, training, and consulting in the liberal arts college environment, while addressing the challenges of increasing statistical sophistication and pressures on faculty research.

## 2 Structure and organization of the workshop

A group of statisticians and social science researchers from a variety of institutions (see list in Section 5) met for 3 days (July 25-27, 2007) at Reed College in Portland, OR, in order to address models for statistical consulting at liberal arts colleges.

Because of the heterogeneity of these schools, even amongst the Mellon 8, we acknowledged the need to consider a variety of flexible approaches to the provision of consulting. Invited guests from other institutions described models (e.g., the grant funded structures at St. Olaf College, course-based approaches at Cal Poly San Luis Obispo or university structures at Duke).

### 2.1 Session 1: Introduction and goals

The first session reviewed the goals of the workshop, introduced participants, and addressed logistical issues.

### 2.2 Session 2: Consulting models with students

Three of the workshop participants shared their experience with different consulting models.

Julie Legler from St. Olaf College described her NSF grant-funded year-long program which involves matching undergraduate students with a set of research projects from the college community. A group of two or more statistics students works at the Center for Interdisciplinary Research and participates in all aspects of the project. Four or five projects are running each year, coordinated by the Center. Julie described this work as *long-term collaboration*, to distinguish it from the type of consultation being discussed in the workshop.

John Walker from Cal Poly San Luis Obispo described their consulting course for students. The one quarter course is designed to teach students some of the skills necessary when consulting with clients. It was noted that little consulting was undertaken by the students in the course (the course was structured with mock-consulting with researchers played by statistics faculty members).

Michael Lavine described the Duke Consulting Center that he ran for many years (he began a new appointment as a Professor of Mathematics and Statistics at the University of Massachusetts/Amherst in February, 2008). The Center was centrally funded, with strong connections to many departments, particularly in the natural and environmental sciences.

## **2.3 Session 3: Consulting models without students**

Albyn Jones described his work consulting with the faculty and students (primarily senior thesis students) at Reed College. He works with faculty and students across the campus at a variety of levels. Sometimes he simply points the person in the right direction, while in other cases his involvement may be substantial and over an extended period of time. Many of these collaborations fall in between. At Reed, Albyn's consulting effort is supported by a one course reduction in his teaching load.

Historical experiences of staff support for statistics within an IT group or quantitative skills center was described by several participants. While this model has some advantages (namely avoiding the competing demands of consulting for a tenure-line faculty member), there are high costs and difficulty in recruiting and retaining a (preferably doctorally trained) statistician with broad exposure to statistics with the ability to interact with a diverse group of researchers across the curriculum. Another possibility is the institutional research office, though typically that staff person is kept very busy with their primary responsibilities.

## **2.4 Session 4: How do courses interact with consulting?**

The group discussed which courses would be most valuable in an undergraduate curriculum that prepared students for consulting. Ideally, we would be able to teach our students dozens of topics, but practically, we agreed that a solid grounding in linear models was minimally sufficient. Most of the workshop participants agreed that linear models provide a frame from which almost all other topics can be built. There was a consensus that the typical liberal arts curriculum does not provide sufficient coursework in statistics to prepare a student with the necessary breadth and depth of knowledge to serve as an independent statistical consultant.

## **2.5 Session 5: Non-course models with students**

We discussed the practicality of running a consulting program without student course credit. One example was cited of support during the summer provided by research students. When a (faculty or student) client asked for assistance, the faculty statistician involved the research students in the consultation as a teaching experience. At times, the question would be resolved satisfactorily by a single visit. At other times, the statistics students would be charged with undertaking some analysis, review or related work, under the direct supervision of the faculty member. This model was quite effective in providing support for faculty and student research, as well as providing valuable practical statistical knowledge to students, but required extensive time commitment by the faculty member providing the support.

The model of student consulting 'office hours' has been a modestly successful model for some workshop participants, though also requiring non-trivial faculty time commitment to ensure that consulting guidance and advice was correct. In retrospect, the provision of support would often have been easier to provide without student involvement. The primary benefit of this model may be the consulting experience for the students, rather than efficient provision of statistical advice.

## 2.6 Session 6: Course models for consulting with students

Building on the models introduced by Julie Legler and John Walker, we discussed models that would work in our own individual circumstances. The structure of several statistical consulting courses and textbooks were reviewed. In general, these courses were successful at teaching consulting, not providing consulting to other members of the college or university community.

There was a consensus that even the most talented of our undergraduate students were unable to provide quality consulting support without direct supervision (in fact, this is also true of masters and doctoral students in statistics).

## 2.7 Session 7: Assessing, justifying, selling and promoting consulting

As a group, we identified factors of a consulting program that would be important in order to make it successful for both the consultant and consultee (as well as palatable for the Provost, for whom there would be the need for considerable resource support).

For the consultant, it would be important to be recognized for the work (in terms of scholarly acknowledgement, criteria for promotion and tenure decisions as well as financial remuneration or course credit, as appropriate).

For the consultee, the program should be straightforward to access, timely, high-quality, consistent and regularly evaluated.

A series of models, informed by experiences within the Mellon 8 institutions, are described in the next section.

# 3 Proposed models and recommendations

## 3.1 Faculty course release to organize consulting

**Description:** Hire a doctorally trained tenure-line faculty member with broad knowledge of statistics and application areas (including behavioral, biological and social sciences) to provide statistical support for student and faculty researchers. Regular office hours to be posted as well as other outreach to faculty and student researchers. Some analysis provided, though application of routine methods and data entry/management/cleaning not generally supported.

**Cost:** Partial commitment of faculty FTE to consulting activities

**Main advantages:** Provides sustainable model for consulting to college community without putting undue demands on the faculty consultant

**Main disadvantages:** Needs regular evaluation and review, may limit curricular options due to reduced course load for the statistician

### 3.2 Staff support to organize consulting

**Description:** Hire a doctorally trained staff member with broad knowledge of statistics and application areas (including behavioral, biological and social sciences) to provide statistical support for student and faculty researchers. Regular office hours to be posted as well as other outreach to faculty and student researchers. Some analysis provided, as well as training on statistical packages and similar workshops. Application of routine methods and data entry/management/cleaning not generally supported.

**Cost:** Expense of supporting staff member

**Main advantages:** No competing demands between research agenda and consulting support

**Main disadvantages:** Very difficult to recruit and retain a consultant with appropriate technical and people skills to interact with faculty and students across the curriculum

### 3.3 Consortial arrangements to provide consulting

**Description:** Institution contracts with consortium to provide onsite (part-time) consultant (e.g. supervised statistics doctoral student) as well as access to senior consultants (by email or videoconference) for support of faculty and student projects.

**Cost:** Moderate

**Main advantages:** Provides consistent and sustainable support for a variety of disciplines, frees on-campus statistician for collaborative projects consistent with their research agenda, complements collaborative research

**Main disadvantages:** Costly, somewhat less convenient than having a local resource

### 3.4 Course to provide consulting

**Description:** Students who need statistical support for a project enroll in a special course. While enrolled, they are eligible to meet with the consulting statistician regarding their project (currently done at a large Research-I university that lost central support for statistical consulting).

**Cost:** Similar to faculty course release

**Main advantages:** Clear link between teaching and consulting

**Main disadvantages:** Provides consulting support only during the term the course is offered

### 3.5 Large-scale research projects (St. Olaf model)

**Description:** Statistics faculty join one or more ongoing research projects along with two or more statistics students. The group meets weekly to move the project along, and interacts at other times as needed.

**Cost:** Modest time commitment, minimal costs

**Main advantages:** Provides excellent opportunities for students involved in projects as well as some support (via collaborative publications) for consulting faculty

**Main disadvantages:** Doesn't support projects outside the scope of the existing projects, no support for faculty release time

### 3.6 Minimal support for consulting

**Description:** Statisticians decline helping with most consulting queries outside their research area.

**Cost:** No direct costs, indirect costs include lower quality research experiences for students, faculty research projects and grant proposals handicapped.

**Main advantages:** Doesn't require much time commitment for faculty member (besides time to say 'no')

**Main disadvantages:** Difficult to implement for tenure-track statistician, leaves institution at competitive disadvantage

## 4 Recommendations and conclusions

Students often seek out liberal arts colleges for the opportunity to undertake mentored research experiences with faculty members. Faculty research is growing at our institutions. Research grounds our teaching in our disciplines and raise the profiles of our institutions. Data analysis and sophisticated statistical methodologies are an increasingly important component of much of this research. It is imperative that models for statistical consulting be developed, deployed and evaluated to address the particular needs of our institutions.

We have addressed several models, realizing that each of our institutions has different needs, requirements and academic environments. While not cheap, the provision of statistical consulting support is a key component of a research enterprise. Providing such consulting helps fill an important gap and provide competitive advantage to our institutions for grant funding, admissions, and faculty recruitment and retention.

## 5 Participants and organizers

Workshop organizers were:

**Jo Hardin (Pomona College)** Professor Hardin received her doctorate from the University of California, Davis in 2000. She has published in *Bioinformatics*, *Computational Statistics and Data Analysis*, *The Journal of Computational and Graphical Statistics*, *Statistical Applications in Genetics and Molecular Biology*, *STATS*, *CHANCE*, and *Functional Ecology*. Dr. Hardin collaborates with biologists at Pomona College and Harvey Mudd College as well as medical researchers at Cancer Research and Biostatistics (in Seattle, WA.) She is a member of the American Statistical Association, the Institute of Mathematical Statistics, the Caucus for Women and Statistics, and Phi Beta Kappa. She serves as a representative-at-large for the Statistics Education Section of the American Statistical Association.



**Nicholas Horton (Smith College)** Professor Horton received his doctorate from Harvard University in 1999. His work has appeared in *Biometrics*, *Journal of the Royal Statistical Society-Series A*, *The American Statistician*, *The American Journal of Public Health*, *CHANCE* and other journals. Dr. Horton collaborates with investigators at Smith College (Biological Sciences, Psychology, Engineering), Harvard University, Boston Medical Center, Pavlov Medical University (St. Petersburg, Russia), the University of Washington and the University of Auckland, New Zealand. He is a member of the National Council of Teachers of Mathematics/American Statistical Association Joint Committee on Probability and Statistics, and the Statistics Education Section of the American Statistical Association.

**Albyn Jones (Reed College)** Professor Jones received his doctorate from Yale University in 1986. His work has appeared in various journals and proceedings, including *The American Statistician*, *CHANCE*, *Neuron* and *Heredity*. Professor Jones has collaborated and consulted in numerous academic fields, as well as medical, industrial and legal settings. He is a member of the American Statistical Association, The Institute of Mathematical Statistics and serves on the Ratings Committee of the United States Chess Federation.

Participants included:

### **Mellon 8 institutions**

**Amherst College** Katharine Tranbarger

**Pomona College** Jo Hardin, John Kloke

**Reed College** Albyn Jones

**Smith College** Nicholas Horton

**Wesleyan University** Daniel Long, Wendy Rayack

**Williams College** Richard DeVeaux

### **other institutions**

**Cal Poly San Luis Obispo** John Walker

**Duke and UMass/Amherst** Michael Lavine

**Lewis and Clark College** Yung-Pin Chen

**St. Olaf College** Julie Legler

**University of Portland** Meike Niederhausen

## **6 Resources**

1. American Statistical Association Section on Statistical Consulting (<http://www.amstat.org/sections/cnsl>)

2. American Statistical Association Undergraduate Statistics Education Initiative (<http://www.amstat.org/Education/index.cfm?fuseaction=usei>)
3. Cal Poly San Luis Obispo Statistical Consulting Course (Stat 465) (<http://www.calpoly.edu/~stat/EC0/465-074.pdf>)
4. St. Olaf College Center for Interdisciplinary Research (<http://www.stolaf.edu/academics/cir>)
5. Duke University Statistical Education and Statistical Consulting Centers <http://www.stat.duke.edu/secc>)
6. St. Olaf College Center for Interdisciplinary Research (<http://www.stolaf.edu/academics/cir>)
7. Statistics in the Community (STATCOM) ([http://www.stat.purdue.edu/external\\_relations/statcom](http://www.stat.purdue.edu/external_relations/statcom))
8. Statistical consulting courses for undergraduates: Fortune or folly? (<http://www.amstat.org/publications/jse/v15n3/boomer.pdf>)

## 7 Bibliography

### References

- Boen, James R. and Zahn, Douglas A. (1982). *The human side of statistical consulting*, Wadsworth Publishing.
- Horton, Nicholas J. and Switzer, Suzanne S. (2005). Statistical methods in the Journal, *New England Journal of Medicine*, 353(18):1977-1979.