

3/9/2001

March 9, 2001 DRAFT

Dear Dr. Pellegrini,

Thank you for inviting Augsburg College to make a more detailed presentation to the W. M. Keck Foundation. Augsburg College is committed to an interdisciplinary integration between the sciences, the humanities, the social sciences and the professions. Our proposal clearly reflects the spirit of Augsburg 2004 – our vision for undergraduate education.

We appreciate your affirmative response to our first phrase proposal for reforming statistical education at the undergraduate level. Our colleagues at Harvard and UCLA stand beside us in that regard. Professor Donald Rubin, Chair of the Statistics department at Harvard, will be teaching a “core” course on statistical causality to undergraduates for the next two years. Professor Judea Pearl, Department of Computer Science at UCLA, is prepared to offer workshops to undergraduate statistics teachers on path-based formal inference of statistical causation.

There may seem to be major differences between two parts of this proposal. Augsburg’s approach involves informal inference – the philosophical approach used in inductive arguments for centuries. The Harvard and UCLA approaches both involve formal inference: the language of mathematics and science. These differences reflect the science-liberal arts interdisciplinary aspects of our proposal. Furthermore, these differences are necessary given our overarching goal: *to expand statistical education to include “observational” causation*: the causation observed in nature as opposed to the man-made causation in a controlled experiment.

The goal of this project is larger than that of a single college or university. This goal involves changing an entire discipline! Statistics has a long history of avoiding non-experimental causation. Given this history together with the size and decentralized nature of statistics as a discipline, it will take a great impact at a variety of levels to introduce the teaching of non-experimental causation into statistics. This is why the diversity in our proposal is necessary.

Augsburg is prepared to do its part in two ways. First, by coordinating these separate activities so as to maximize the opportunity for changing the teaching of statistics everywhere. Second, by being an incubator for developing statistical literacy as a new discipline: (1) by bringing together faculty in various areas to obtain a variety of viewpoints on the appropriate goals and topics of such a course, (2) by developing teaching materials that are useful to students and usable by faculty, and (3) by training faculty in various disciplines to teach this kind of material.

This goal and these activities are almost more ambitious that Augsburg can do on its own. Foundations were critical in bringing about the development of Quantitative Literacy in the 1990s. The W. M. Keck Foundation can play a similar role in bringing about the development of Statistical Literacy at the beginning of the twenty-first century. We look forward to working together on this most propitious opportunity for entrepreneurship that can significantly improve undergraduate education.

Sincere yours,

William Frame, President

AUGSBURG PROPOSAL

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Completed and signed by Augsburg's chief executive officer.

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2. Rubin, Donald (1999). *Teaching Causal Inference in Experiments and Observational Studies*. ASA 1999 Proceedings of the section on Statistical Education. Presented in a session of the ASA Joint Statistical meeting organized and chaired by Dr. Milo Schield.
3. Review of Dr. Pearl's book, "Causality" from *Chance* magazine.

THE SIGNIFICANCE OF THIS PROJECT

The goal of this project is to set a new direction in statistical education at the undergraduate level. If successful, this project can affect teaching in both the liberal arts and in the sciences.

From a science perspective, this project is extremely important. The idea of obtaining formally valid statements about probabilistic causes is a breakthrough akin to that of a new technology. New tools of thought have a power that is often much greater than that of mere machines. This project does not request money to research and develop these breakthrough ideas: they have already been developed. The goal of this project is to disseminate these ideas to teachers in statistical education so that they have broad social benefit.

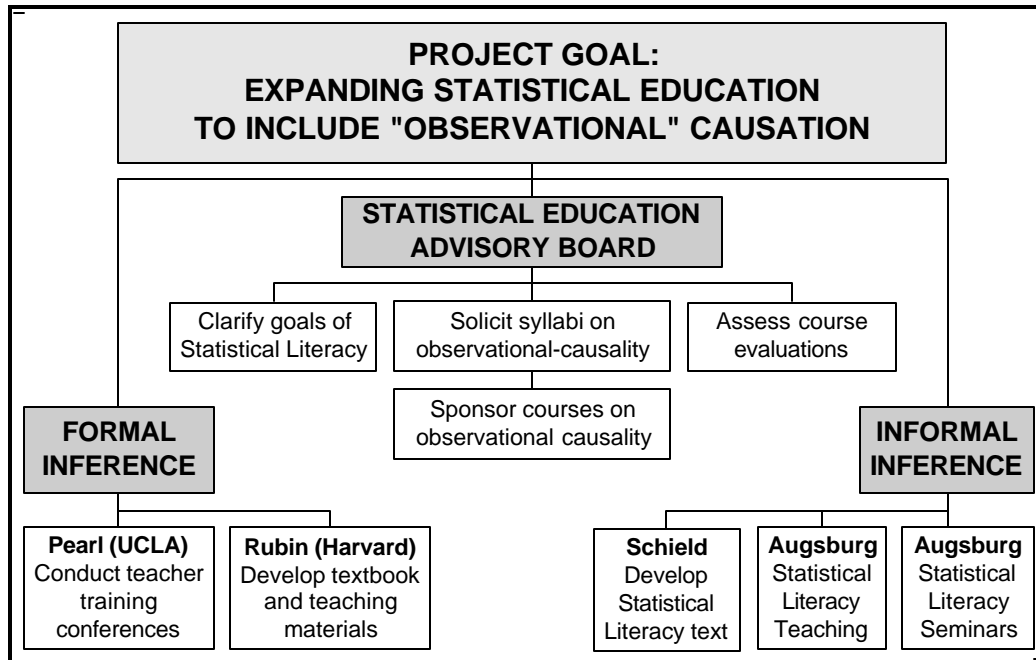
From a liberal arts perspective this project is extremely important. The deep divide between the humanities and the social sciences is largely about methods of knowing the causes and effects of things. So long as statistical tests are the criteria (as in experimental psychology), the humanities have little standing. In the humanities, observational studies – not experiments – are most common. Traditional statistics has no tests for bias or confounding in such studies. So historically, statistics has little to say in support of arguments about causation in observational studies. This statistical silence about causation affects history, sociology, large parts of economics and business as well as large parts of medicine, law, social work and even education. The goal of this project is to open new directions in the teaching of statistics that will ultimately benefit every citizen who must deal with statistical data obtained from non-experimental studies as evidence about causes and effects.

If successful, this project could lead to a rapprochement between the humanities and the social sciences. This project will introduce new ways of thinking about age-old problems into statistical education and ultimately into all of undergraduate education.

The goal of this project is to expand the content of statistical education. During the past thirty years, statistical education has changed in terms of pedagogy: the use of computers, projects, real world data, relevant data, interesting data, group projects, active learning, web-based data, resampling, etc. But statistical education has not changed in terms of content: probability, sampling distributions, confidence intervals and hypothesis tests. This project aims to bring about a fundamental change – a change in what is taught in undergraduate statistical education.

This project is extremely entrepreneurial. It is not relying on just one approach; this project involves numerous approaches. And rather than have the principals impose their particular vision on statistical education, it calls for the creation of an advisory board who will solicit and review new course proposals and will provide support for those who wish to include more on observationally-based causation in their own courses.

This project is bold. Bold in terms of its goals, bold in terms of its diversity, and bold in what it attempts to deliver. But it is not pure speculation. Each of the principals has spent years developing their unique approach and materials to the point that it can be taught to undergraduates and shared with other teachers. The timing is right for this project to succeed.

PROJECT OVERVIEW: ORGANIZATION AND ACTIVITIES

This figure presents a graphical overview of the goals, organization and activities of this project. In presenting the goal of the project, we use “expand” rather than “reform” because there is nothing wrong with the existing content of traditional statistics. We use “observational” causation as a shorthand to designate “non-experimental” or “observationally based” causation.

The science aspects of this project are most clearly visible under “formal inference”: the new approaches to formal inference by Rubin and Pearl. Formal inference involves deductive validity. Both of their approaches involve new ways of thinking about familiar concepts. Dr. Rubin will be developing teaching materials while teaching a “core” course at Harvard. Dr. Pearl will be presenting workshops to statistical educators in California on a path-based approach to causality.

The liberal arts aspects of this project are most clearly visible under “informal inference”: the Statistical Literacy approach by Dr. Milo Schield. Informal inference involves the strength of arguments. Statisticians are typically better suited to teach formal inference rather than informal. Dr. Schield will develop teaching materials to assist statisticians in moving from formal arguments to informal reasoning while remaining focused on the role of statistics in arguments. These materials will be field tested in the classroom at Augsburg by teachers in a wide variety of disciplines. The results of these classroom experiences will be shared with others in statistical education at yearly statistical literacy seminars to be held at Augsburg College each summer.

The outreach aspects of this project are most clearly visible under the “Statistical Education Advisory Board”. An advisory board of educators will work on clarifying the goals of statistical literacy, will formulate and advertise for proposals on new courses featuring observationally-based causation and will allocate funds for selected proposals. This group will also oversee the independent assessment activity of all teaching during as part of this grant.

PROJECT CHALLENGE

Achieving the goal of this project may be quite difficult.

Changing statistical education will be difficult because the discipline is so large. Each year, there are an estimated 5,000 college teachers teaching introductory statistics in various departments.¹ To bring about change on this scale will be quite difficult.

Changing statistical education will be difficult because the discipline has been relatively static. The examples in textbooks may change, but the statistical tests (the content of statistics) has changed very little in the last 50 years. In many ways, statistics is more of a formal discipline (like probability and mathematics) than a material discipline that studies a particular subject in reality such as business, sociology, biology, etc. To bring about change in a discipline that has a long history of being rather static will be quite difficult.

Changing statistical education will be difficult because textbooks tend to be very uniform in content. Most introductory statistics texts discuss descriptive statistics, probability, binomial and normal distributions followed by sampling distributions, confidence intervals and then hypothesis tests. Chi-squared tests, ANOVA and non-parametric tests are introduced last. To bring about change in the face of such broad based uniformity will be quite difficult.

Changing statistical education will be difficult because of the history of the discipline. More than one hundred years ago, statistics was in its infancy as a discipline. In those times, statistics were often used to argue about causation. Statisticians of that time made a concerted effort to reform statistics as a mathematical science and in so doing diligently removed any discussion of causation. Aside from the acceptance of 'causation' in the case of randomized experiments, the discipline has maintained that stance for over a century. There was, however, one exception. In 1959, statisticians concluded that smoking caused cancer based on observational studies. Today, there is almost no trace of that finding in most introductory statistics texts. Overcoming this history of this discipline will be quite difficult.

Changing statistical education will be difficult because the language of the discipline already seems so inductive. Statisticians talk of inference, of generalizing from samples to populations, and of estimating. All this sounds inductive. But in the end, what statisticians derive is deductive; the size of a 90% confidence interval is 100% certain. To introduce truly inductive reasoning (to generalize from cross-sectional association to a longitudinal association involving a controlled change in one of the variables) will be quite difficult.

Finally, changing statistical education will be quite difficult because many statisticians are not actively seeking to change their discipline. Enrollment in statistics is still growing. Students may be complaining, but they have always complained. There is no problem that is driving statisticians to change their discipline. Again, changing statistical education will be quite difficult.

¹ If one million US college students study statistics each year, and if the average class size is 33 to 50, then that means there are some 20,000 to 30,000 sections of statistics being taught each year. If the average number of sections taught per teacher is 5, this means there are some 4,000 to 6,000 college-teachers teaching statistics each year.

PROJECT FIT AT AUGSBURG.

The statistical literacy component of this project will be housed at Augsburg College for three reasons. First, that is where Dr. Schield, a leader in statistical literacy, is located. Second, Augsburg has committed itself to interdisciplinary education. Third, Augsburg has already committed itself to offering courses in statistical literacy.

Dr. Milo Schield has been recommended for promotion to full professor this year. Milo was the designer of the Augsburg course (GST 200) Quantitative Reasoning (Statistical Literacy). This course has been taught at Augsburg for the past three years. Milo has also taught statistical literacy in the Department of Business Administration (MIS 379) for over six years. The business course contains more emphasis on chance than does the quantitative reasoning course. Milo has the insight and creativity to create new materials, to collaborate with colleagues and to manage this project.

Augsburg's commitment to interdisciplinary teaching is featured in Augsburg's Vision for 2004. [JOHN]

Augsburg has committed itself to offering courses in statistical literacy – not as some future event that may or may not happen – but as a matter of record. The Department of Business Administration took the lead in offering Statistical Literacy as a greater part of their traditional statistics course (MIS 379). This modified course contained a mixture of statistical literacy (half) and statistical inference (half). This course served as the seedbed for the development of the statistical literacy course taken by majors in the humanities (GST 200).

PROJECT SUPPORT BY STATISTICAL EDUCATORS

The success of this project is related to the degree of support given by statistical educators. A great deal of effort has been spent in developing the relations necessary to obtain that support. As a result, we have expressions of interest from a wide group of teachers.

The President of the American Statistical Association, Dr. Richard Scheaffer, wrote, "We (ASA) may be looking at some efforts on redefining what a modern undergraduate curriculum in statistics should be, and your effort [expanding statistical education] could fit into that picture."

The chair of the Quantitative Literacy Initiative of the National Council on Education and the Disciplines, Dr. Lynn Steen, said, "Statistical Literacy may be as different from traditional statistics as traditional statistics is from probability."

A past President of the American Statistical Association, and a reviewer of this grant proposal, Dr. David Moore, said in his ASA Presidential address that we must learn to view statistics more as an art than just as a science.

500,000 TOTAL PROPOSAL

95,000	A. ADVISORY BOARD & STATISTICAL EDUCATION	
29,000	A1. To direct discipline-related activities	
	\$1,000	Form Advisory boards on statistical literacy and critical thinking
	\$5,000	Advertise and analyze course goals and topics
	\$10,000	Obtain syllabi on statistical literacy
	\$13,000	Determined by Advisory Board
50,000	A2. To encourage innovation in teaching related materials by others.	
	\$50,000	Direct grants for teaching a statistics course with "observational" causality
16,000	A3. Assessment (Garfield, Univ. Minnesota)	
	\$8,000	Instrument design
	\$8,000	Program review based on student assessment results
100,000	B. HARVARD & UCLA	
50,000	B1. (Harvard) Develop materials for teaching formal reasoning on observational causality	
	\$50,000	Developing and presenting teacher-training materials (Dr. Donald Rubin)
50,000	B2. (UCLA) Train teachers on path-based formal reasoning	
	\$50,000	Three conferences (Dr. Judea Pearl) run by ASA Centre for Statistical Education
255,000	C. AUGSBURG	
69,000	C1. Schield: Deliver an introductory text on statistical literacy that is useful and usable.	
	\$24,000	Summer pay for development of materials (3 years)
	\$25,000	Course release: 2001-2002 (5 courses)
	\$10,000	Course release: 2002-2003 (2 courses)
	\$10,000	Course release: 2003-2004 (2 courses)
89,000	C2. Train teachers from various disciplines to teach statistical literacy efficiently and effectively.	
	\$18,000	Course development in non-chance statistical literacy (6 teachers in GST 200)
	\$21,000	Course development in statistical literacy with chance (7 teachers in MIS 379)
	\$50,000	Pay for two teachers team-teaching 4 sections per year for 2.5 years
21,000	C3. Center for Statistical Literacy at Augsburg	
	\$21,000	Three summer conferences
76,000	C4. Other	
	\$25,000	Editing Statistical Literacy textbook
	\$16,000	Present papers on statistical literacy at national/international conferences
	\$35,000	Web site plus two videos on Statistical Literacy: Overview and Teaching
50,000	D. PROJECT MANAGEMENT	
43,000	D1. Project supervision	
	\$15,000	1 course release per year for Schield (in addition to course releases above)
	\$4,000	Project accounting
	\$24,000	Assistant Manager and Coordinator (8K / year)
7,000	D2. Expense reimbursement for project-related expenses	
	\$1,500	Direct expenses in preparing proposals
	\$5,500	Related expenses for having attending conferences (ICME, ASA), etc.

As shown on the budget page, this project is organized around four budget centers:

- A. Advisory Boards and Statistical Education
- B. Harvard and UCLA
- C. Augsburg
- D. Project Management

Monies for the first two activities are not used at Augsburg in any way although Augsburg will be responsible for seeing they are handled in accordance with this grant proposal. Monies for the last two activities will be used primarily at Augsburg.

The following provides detail for the budget items shown on the previous page.

This budget is based on these commitments by Augsburg College.

1. **COURSE-RELEASE FEE:** Augsburg agrees to give a course release for a fee of \$5,000.
2. **COURSE SUPPORT:** Augsburg agrees to offer GST 200 four times a year (two in day and two in Weekend College) for the next three years regardless of the size of the class. The project manager will promote this class with student advisors to insure a minimum class size of at least 6 students. Augsburg will also offer at least four sections of MIS 379 during the day school and three in Weekend College each year. These are typically full classes since they are required courses rather than electives.
3. **SEPARATE ACCOUNT:** Augsburg agrees to place the funds in a separate bank account established specifically and exclusively for this grant. Any release of funds by check, cash or transfer will require two signatures: that of the project manager and that of a representative of the college. All funds that do not involve Augsburg employees or activities involving Augsburg will be paid directly from the account. All interest accruing from funds in this account will remain a part of this grant.
4. **MATCHING:** Augsburg agrees that funds for course release will be charged at the time(s) they are to be paid out to a substitute teacher.

Augsburg, in turn, understands that Dr. Schield will be receiving additional compensation of \$8,000 per summer for working three summers. All other benefits involve either course release time or expense reimbursement for actual related expenses.

Activity A: \$95,000: ADVISORY BOARDS AND STATISTICAL EDUCATION

This outreach activity is extremely important to the success of the project. This project is not a research or development project. This project is a marketing project to get teacher acceptance in teaching observationally-based causation. If we expect statistical educators to agree, they must have a voice in the process: the design, analysis and evaluation of different attempts to achieve this goal. To attempt to argue there is only one way to introduce observationally-based causality is premature when the discipline has no consensus on that matter. This activity is designed to stimulate involvement by authors and early-adopter teachers.

A1a. \$1,000: Form advisory boards. In order to maximize the involvement of those in statistical education, this proposal plans the formation of three different advisory groups. The first is a statistical-education advisory board: a board consisting of those nationally active in statistical education. This board will set policy on matters related to statistical education as a discipline. This board will advertise for course proposals involving observational causality and select those they choose to fund. The second is a local board of statistics teachers who will give feedback and advice on matters of statistics in the classroom. The third is a local board of non-statistics teachers who will give feedback and advice on matters of critical thinking in the classroom. This budget will cover costs of communications with the national group. Board members will be expected to attend summer meetings at Augsburg on Statistical Literacy.

A1b \$5,000: Advertise and analyze course goals and topics. The board will review the ads for new course development. These ads will invite teachers at the high school and college level to submit course syllabi that feature observationally based causation. This topic must be relevant to either the high school or undergraduate level. Once the syllabi are received, project staff will summarize the proposals and send out a summary report to the full board. The board will review the proposals, analyze the relation between topics and goals, and prepare a summary report for presentation at a summer conference.

A1c. \$10,000. Obtain syllabi on observationally based causation. Syllabi must state the goals of the course and indicate how the choice and order of topics is determined by that goal. Assessment techniques must be indicated along with sample questions, exercises, reports and projects. Expected outcomes must be indicated along with what measures are believed to show most improvement after having taken this course. The more complete the description and integration, the more likely the advisory board is to regard the submission highly. The Advisory Board will identify which syllabi qualify under the guidelines and will select the amount to be paid for qualified submissions (within the overall budget for this activity). The Board may decide that giving an award for this activity is unwarranted and instead use this money to fund course development in A2. Those submitting syllabi will also be asked to indicate what amount of funding would be necessary for this course to be taught in the next two years.

A1d. \$13,000: To be designated by the Advisory Board.

This amount is reserved for use by the statistical education advisory board as they see fit in accordance with the goals of this project. Allowing an arms-length board to determine what it thinks should be done may be at least as important as any particular activity that can be selected in advance.

A2a. \$50,000: Teaching “Observational” Causality Statistics.

From those who submit syllabi, the statistical education advisory board will select those whose class-proposals best use or integrate “observational” causality as part or all of a statistics course and the amount of funding involved. Funding may vary based on the reality of different opportunities at different schools for teaching courses that are experimental or are significantly modified. Those receiving monies must agree to follow the syllabi they have presented and to provide copies of the teaching materials including tests, quizzes and assignment including any projects. In addition recipients must agree to obtain assessment data from the students in the class (as specified by the project assessor), to prepare a final report (reflecting on their choice of course goals and topics and making recommendations for improvements) that can be hosted on the Statistical Literacy web site, and to deliver a report on their experience at a summer Statistical Literacy conference.

A3a. \$8,000: Course Assessment: Instrument Design.

Dr. Joan Garfield, University of Minnesota, will be responsible for designing the assessment instrument. A preliminary instrument will be ready for testing by September 1, 2001 and will be used for students in both traditional statistics that fall. A finalized instrument will be available by February 1, 2002 and will be used on students in both statistical literacy and in traditional statistics for the balance of the project.

A3b. \$8,000: Assessment Analysis.

In early June, Dr. Joan Garfield will analyze the data acquired during the academic year just completed for 2002, 2003 and 2004. After the end of the project in June 2004, Dr. Garfield will produce a summary report including an evaluation of the programs and recommendations for future work.

B. \$100,000: DR DONALD RUBIN AND DR. JUDEA PEARL**B1. \$50,000: Dr. Donald Rubin: To develop and present teaching-related materials**

Dr. Donald Rubin, is scheduled to teach an undergraduate “core” course at Harvard for the next two academic years. Dr. Rubin is prepared to introduce the basic ideas of identifying observationally-based causation to this entry-level audience. Dr. Rubin will make the teaching related materials including syllabi, handouts, tests, etc. available and will present these materials to those interested in statistical education during the annual Joint Statistical Meeting of the American Statistical Association as part of either a half-day or full-day workshop.

B2. \$50,000: Dr. Judea Pearl: To conduct training seminars in California

Dr. Judea Pearl has agreed to conduct at least three workshops (teaching seminars) on understanding and teaching path-based non-experimental causality for statisticians and statistical educators. These would be at least two-day long workshops to allow the participants time to fully engage with the new ways of looking at things and to focus on the teaching of these materials. The ASA Centre for Statistical Education (CSE) has been asked to organize these activities including the selection of the exact date (probably in January) and place (probably Anaheim). The

CSE will be responsible for advertising the event, taking the registrations, mailing out information, managing the conference and obtaining conference evaluations from the participants.

C. \$250,000: AUGSBURG COLLEGE

C1. 69,000: Dr. Milo Schield for developing a text in Statistical Literacy

Dr. Schield will be responsible for producing a statistical literacy text that is useful to students and usable by faculty in various disciplines. The first phase is to produce a text that focuses exclusively on confounding. The second phase is to include the elements of chance (confidence intervals and hypothesis tests) in arguments about causation involving observational studies.

The money for course release (\$45,000) will be paid to Augsburg College (at \$5,000 per semester course) in exchange for course release from the college's normal teaching load (The current load for full-time faculty is seven courses per year). The money for summer work (\$24,000 at \$8,000 per summer) will be paid directly to Dr. Schield working as an independent contractor.

C2. \$89,000: Train teachers in, and test materials for, teaching statistical literacy.

This phase is critical to the success of the statistical literacy component of this project. The textbook created by Dr. Schield cannot be deemed usable by faculty in various disciplines without actual classroom testing. Teachers at Augsburg have expressed their interest in teaching these materials. These teachers on the statistics side are in mathematics, statistics and space physics. Those on the critical thinking side are in communications, quantitative journalism, English and religion.

Of this amount, \$39,000 is for course development at a rate of \$3,000 per teacher. Teachers will observe another teacher teaching statistical literacy for an entire semester. They will dialog with their mentor on the course goals, the teaching materials, the tests, the homework assignments and any projects. They will modify the course so long as the overall course goals are maintained and the materials from the Statistical Literacy textbook are used in a significant portion of the course. After they have taught the course and have mentored other observers in their course, they will write up their assessment of their course given their goals indicating what did and did not work as expected. They will make recommendations for future changes if they were to teach the course again. They will also be expected to present a talk on their experience at a summer Statistical Literacy conference.

Of this amount, \$50,000 will be used to allow 10 other teachers to team-teach with Dr. Schield. (This will cost \$5,000 per semester course and will be paid directly to Augsburg.) Team teaching is an extremely powerful way of providing an interdisciplinary presence in a classroom, but it is very expensive. This activity is considered vital to the success of the statistical literacy portion of this project since this is where the 'friction' is most likely to develop. Those accustomed to the right-wrong aspects of mathematics and statistics will have more difficulty with the stronger/weaker aspects of inductive reasoning. Those accustomed to inductive reasoning, will have more difficulty with the purely mathematical aspects of this approach. The goal of this activity is to identify the most difficult aspects for each group and to search for creative ways to help both groups teach statistical literacy efficiently and effectively.

C3. \$21,000: Center for Statistical Literacy Summer Conferences at Augsburg.

Augsburg will host three summer conferences (\$7,000 each) on statistical literacy. These teaching conferences will involve the presentation of assessment results by Dr. Garfield, the results of various advisory board activities by members of the advisory boards plus talks by faculty who have taught the course for the first time. Discussions will be held on the advantages and disadvantages of different approaches to the goals of statistical literacy. Conference proceedings will be generated and published on the internet. Videos may be made of selected talks for use by others. The amount budgeted will cover the advertising of these conferences in the *ASA Amstat News* and related publications, the reservation of adequate facilities at Augsburg college, the reservation of rooms in the dorms, the reservation of meals, the processing of reservations, the reimbursement of some travel expenses for invited presenters, and other conference expenses. These conferences will be video taped for inclusion in the training video, *Teaching Statistical Literacy*.

C4. \$76,000: Other Related Activities.**C4a. \$25,000 Editing Statistical Literacy Textbook.**

The goal of the statistical literacy portion of this project is to produce a textbook that is useful to students and usable by a wide variety of teachers. The careful editing of this textbook is crucial to helping students and teachers deal with these materials. The organization of materials, the utility of diagrams, stories and data tables, the quality of exercises and problems, and the general readability of the material will be reviewed by a trained editor.

C4b. \$16,000 Present Statistical Literacy Papers at Conferences.

Dissemination of the ideas being developed at Augsburg in Statistical Literacy is an important goal toward influencing others to expand their emphasis on non-experimental causation. These funds cover direct travel expenses for presenting papers at conferences. Dr. Schield will present papers related to statistical literacy at three Joint Statistical Meetings of the American Statistical Association, at the Conference on Critical Thinking at Sonoma State College, at the Making Statistics Effective in Schools of Business, and at the International Conference on Teaching Statistics in South Africa. Funds not used for this purpose may be applied to the preceding activity (C4a) or the subsequent activity (C4c).

C4c. \$35,000 Videos, Web site and Conference Proceedings

Two videos are planned. The first video (*Statistical Literacy at Augsburg*) is on the nature of the Statistical Literacy aspects of the project and the relation of statistical literacy to Augsburg's mission and goals as stated in Augsburg 2004. This video (3 to 5 minutes) will summarize the idea of Statistical Literacy and Augsburg's role as a leader in this area. This video would be completed by and shown at the first summer conference in June 2002. The second video (*Teaching Statistical Literacy*) would be completed by and shown at the last summer conference in June 2004. This video (20 – 40 minutes) would summarize feedback from student assessments, from teachers on both the statistical and the critical thinking sides. It would contain statements by advisory board members and by those who pioneered in innovative statistical literacy courses at other institutions. This video would be made available through the American Statistical Association as part of their videotape resources.

A separate statistical literacy web site will be formed to support this project. Part of that web site will be the maintenance of a newsgroup for those interested in teaching these materials. The proceedings of conferences, copies of assessment reports and faculty reports on their teaching experiences would be featured on this web site.

A hard-copy report of the entire project may also be prepared after the close of the project and if so would be made available at a reasonable price.

D. \$50,000: PROJECT MANAGEMENT**D1. 43,000: Project Supervision**

D1a. 15,000 Project Manager fee. Augsburg provides one course release per year for Project Manager (Milo) for three years. The project manager is responsible for maintaining the integrity of the project in relation to the overall goals as stated in this proposal and as interpreted by subsequent communications with the W. M. Keck Foundation. In those cases in which the Project Manager is also a party to a dispute, then either the associate project manager or a member of the advisory board will serve in that capacity. The project manager has ultimate responsibility for insuring timely submission of project accounting reports, reports on task status, comparison of actual with plan and revisions to the plan.

D2a. \$4,000 Project Accounting. This includes the expense of maintaining proper accounting for this project. This includes monitoring cash receipts and disbursements, insuring that expenses claimed are in accordance with the originating grant, and preparing financial reports for the advisory board and for the W. M. Keck Foundation.

D2. 7,000: Related Expenses

D2a. 1,500: Proposal Preparation. The preparation of these proposals has involved some direct costs: business calls from Spain to the US to obtain replacement reviewers plus payments to knowledgeable readers (Donald Macnaughton, Tom Burnham and Julie Naylor) to review the ideas in these proposals.

D2b. 5,500: Expense Reimbursement: Dr. Schield has invested significantly from his own funds to develop and publicize statistical literacy. Dr. Schield's expenses in presenting the ideas of Statistical Literacy at the International Conference of Mathematics Educators in Tokyo last summer were paid from his own pocket. Dr. Schield has also invested his own time and money in preparing this proposal, assembling the support of his colleagues and in selling the idea to all those involved. This money will be used strictly for reimbursement of expenses directly related to the dissemination of the idea of Statistical Literacy, for research on related aspects of Statistical Literacy such as the grammar of rates and percentages, and for the scanning of text materials to build a relevant corpus for studying the use of statistical terms in ordinary use.

This section presents the specific project timelines on the aforementioned activities. If this proposal is funded, these timelines would be converted into a full project management chart showing dependencies, milestones, resources needed, etc.

Activity A: \$95,000: ADVISORY BOARDS AND STATISTICAL EDUCATION

A1a. \$4,000: Form advisory boards.

National Statistics advisory board:

- July 1 Send out announcement to all those who have indicated their interest.
Indicate what is expected (attending three summer conferences, advertising for course syllabi, analyzing the se syllabi, and funding courses that exemplify the project goals.
- August 7 Distribute second announcement at the JSM Stat Education meeting
- August 30 Project manager issues invitations to prospective advisors.

Local Advisory Board for Statistics and for Critical Thinking

- July 1 Send out announcement to all those who have indicated their interest.
- August 30 Project manager issues invitations.

A1b \$5,000: Advertise and analyze course goals and topics.

July 2001. Develop advertising. Prepare for submission to *Amstat News* by August 1. Disseminate at the 2001 ASA Joint Statistical Meeting in Atlanta. Submission deadline is 31 January 2002. The assistance project manager will compile submissions and prepare a preliminary ranking for a screening review by selected members of the advisory board.

A1c. \$10,000. To obtain syllabi on observationally based causation. Syllabi must state the goals of the course and indicate how the choice and order of topics is determined by that goal. Assessment techniques must be indicated along with sample questions, exercises, reports and projects. Expected outcomes must be indicated along with what measures are believed to show most improvement after having taken this course. The more complete the description and integration, the more likely the advisory board is to regard the submission highly. The amount shown will be divided among those who submit as determined by the Advisory Board. One way would be to divide this amount among those submitting syllabi that are relevant and reasonable.

A1d. \$10,000: To be designated by the Advisory Board.

The use of these funds would be reviewed at each of the three summer Statistical Literacy conferences at Augsburg.

A2a. \$50,000: Stat Literacy Course Development at other schools.

As mentioned previously, applicants must submit course proposals by January 31, 2002. Selections from these applicants will be selected and notified in March so they can adjust their plans accordingly with their home institution for the following year. If funds remain, then this process might be repeated at a later time. Funds will be released on the following schedule: The first third will be paid following the first day of class on receipt of evidence that the class is being held along with the final syllabus which must contain the elements relevant to this proposal. The second third will be paid after the course is completed upon receipt of all the teaching materials used in the course including tests, quizzes, assignments, projects, etc. plus student responses to

the project-designated questionnaire following the end of the course. The final third will be paid following completion of three items: (1) receipt of a written assessment of the course (that can be posted on the Statistical Literacy web site) in terms of the course goals and methods, (2) presentation of this summary at a summer statistical literacy conference, and (3) a video-taped interview on the entire experience.

A3a. \$8,000: Course Assessment: Instrument Design.

Work will begin immediately on receipt of this grant. \$6,000 will be paid immediately for the design of a preliminary instrument for testing by September 1, 2001. It will be used for students in both traditional statistics in fall, 2001. A finalized instrument will be available by February 1, 2002 and will be used on students in both statistical literacy and in traditional statistics for the balance of the project. The remaining \$2,000 will be paid on delivery of the final instrument along with an assessment of the reliability, validity and value of this instrument that can be published on the Statistical Literacy web site. .

A3b. \$8,000: Assessment Analysis.

Assessment analysis will begin on receipt of the necessary data. \$2,000 will be paid in June of 2002, 2003 and 2004 following the submission of a report for presentation at the summer Statistical Literacy conference at Augsburg. The final \$2,000 will be paid on receipt of the final summary report including an evaluation of the programs and recommendations for future work. This report is due within three months after the end of the contract (e.g., by September 30, 2004).

B. \$100,000: DR DONALD RUBIN AND DR. JUDEA PEARL

B1. \$50,000: Dr. Donald Rubin: To develop and present teaching-related materials

Work will begin immediately upon receipt of this grant. In July 2001, \$30,000 of this amount will be paid immediately to Dr. Rubin for work done during July. In August 2002, 2003 and 2004, \$5,000 will be paid to Dr. Rubin for participating in Continuing Education workshops (half day or full day) to be organized by the project manager as part of the ASA Joint Statistical Meetings. Dr. Rubin will present the results of his experience in teaching an undergraduate "core" course at Harvard including all syllabi, handouts, tests, etc. available and will present these materials to those interested in statistical education. The final payment of \$5,000 will be paid

B2. \$50,000: Dr. Judea Pearl: To conduct training seminars in California

Planning for these workshops will be being immediately on receipt of this grant. The ASA Centre for Statistical Education is expected to organize and manage these workshops. Preliminary advertising for the event will be completed by the time of the ASA 2001 Joint Statistical Meeting. Final advertising will be distributed for publication in *Amstat News* by September 1 assuming the first conference is held the following January. to be hold in This money is budgeted for workshops (two or three days) to be held in the LA area by Dr. Judea Pearl. Three workshops are currently planned, but this may need to be adjusted. Participants will be asked to pay a fee in addition to the expenses budgeted here. The ASA Centre for Statistical Education (CSE) has been asked to organize these activities including the selection of the exact date (probably January) and place (probably Anaheim). The CSE will be responsible for budgeting these monies,

advertising the event, taking the registrations, mailing out information, managing the conference and obtaining conference evaluations from the participants. Any unused funds will be returned to the general project.

C. \$250,000: AUGSBURG COLLEGE

C1. 69,000: Dr. Milo Schield for developing a text in Statistical Literacy

Budget expenditures for summer funds (\$8,000 per summer) will be paid in July of 2001, 2002 and 2003. The money for course release (\$45,000) will be paid to Augsburg College (at \$5,000 per semester course) in exchange for course releases from the college's normal teaching load (The current load for full-time faculty is currently seven courses per year). The money for summer work will be paid directly to Dr. Schield working as an independent contractor.

C2. \$89,000: To train teachers and test materials in teaching statistical literacy.

Of this amount, \$39,000 is for course development at a rate of \$3,000 per teacher. Teachers will observe another teacher teaching statistical literacy for an entire semester. They will dialog with their mentor on the course goals, the teaching materials, the tests, the homework assignments and any projects. They will modify the course so long as the overall course goals are maintained and the materials from the Statistical Literacy textbook are used in a significant portion of the course. After they have taught the course and have mentored other observers in their course, they will write up their assessment of their course given their goals indicating what did and did not work as expected. They will make recommendations for future changes if they were to teach the course again. They will also be expected to present a talk on their experience at a summer Statistical Literacy conference.

Of this amount, \$50,000 will be used to allow other faculty to team-teach with Dr. Schield in his courses. (This will cost \$5,000 per semester course and will be paid directly to Augsburg.) Team teaching is an extremely powerful way of providing an interdisciplinary presence in a classroom, but it is very expensive. This activity is considered vital to the success of the statistical literacy portion of this project since this is where the "friction" is most likely to develop. Those accustomed to the right-wrong aspects of mathematics and statistics will have more difficulty with the stronger/weaker aspects of inductive reasoning. Those accustomed to inductive reasoning, will have more difficulty with the purely mathematical aspects of this approach. The goal of this activity is to identify the most difficult aspects for each group and to search for creative ways to help both groups teach statistical literacy efficiently and effectively.

The student-related impact of this project will be assessed by an independent party who has outstanding credentials in both assessment and in statistical education.

The assessment of the teaching aspects of this project will be designed, conducted and evaluated by Dr. Joan Garfield.

Dr. Garfield is well known in statistical education for her leadership in assessment and in statistical literacy. She is a co-editor with Ido Gal of *The Assessment Challenge in Statistics Education*, 1997 IOS Press and International Statistical Institute. She is one of the organizers of the international conferences on Statistical Reasoning, Thinking and Literacy (SRTL). Dr. Garfield is Vice President of the International Association of Statistical Education. For more details on her background, view her web site at <http://www.coled.umn.edu/EdPsych/faculty/Garfield.html>.

Dr. Garfield will design the assessment instrument to be used in evaluating the course being taught by all those receiving money from this grant. This instrument will be used in all undergraduate courses taught by those working in relation to this grant.

The design for gathering data will allow for a longitudinal data collection plan. Students will be asked to complete the questionnaire on completion of the course and will be asked if they agree to being contacted later for a longitudinal follow-up.

Dr. Garfield will receive copies of all the data collected along with instructor reports on their courses (syllabi, tests, projects, etc.). She will be responsible for compiling this information.

Dr. Garfield will analyze the data and write a summary report on the project in relation to the goals of the project. Information gathered about the effectiveness of various approaches in helping students develop statistical literacy will be written up for presentation and publication. This report will also speculate on what actions might be supported by this data. A copy of this report will be submitted to the Project Manager within three months after the completion of work done under this grant.

The discipline-related impact of this project will be summarized and evaluated by the project manager, Dr. Milo Schield (or his designee), based on the statements provided by those who have taught these new topics. A copy of that report and of Dr. Garfield's report will be submitted to the W. M. Keck Foundation within six months after the completion of work done under this grant.