

**COVER SHEET FOR PROPOSAL TO THE
NATIONAL SCIENCE FOUNDATION**

HUM-NSF-6023-94

July 1993

For Consideration by NSF Organization Unit(s) <small>(Indicate the most specific unit known, i.e. program, division, etc.)</small> SBER/SSTS/EVS		For NSF Use Only NSF Proposal Number		
Program Announcement/Solicitation No./Closing Date 91-109 Ethics and Values Studies 8/1/93				
Date Received	Number of Copies	Division Assigned	Fund Code	File Location
Employer Identification Number (EIN) or Taxpayer Identification Number (TIN) 54-6001796	Show Previous Award No. if This is: <input type="checkbox"/> A Renewal or <input type="checkbox"/> An Accomplishment-Based Renewal	Is This Proposal Being Submitted to Another Federal Agency? YES ___ NO <u>X</u> If YES, List Acronym(s)		
Name of Organization to Which Award Should be Made: University of Virginia		Address of Organization, Including Zip Code Office of Sponsored Programs P. O. Box 9003 Charlottesville, VA 22906		
Institutional Code (if known) 0037457				
Is Submitting Organization: <input type="checkbox"/> For-Profit Organization; <input type="checkbox"/> Small Business; <input type="checkbox"/> Minority Business; <input type="checkbox"/> Woman-Owned Business				
Branch/Campus/Other Component (Where work is performed, if different)				Institutional Code (if known)
Title of Proposed Project Environmental Ethics and Invention: A Case Study				
Requested Amount \$ 53,666	Proposed Duration (1-60 months) 24 months	Requested Starting Date 1/1/94 (1/1/94 - 12/31/95)		
Check Appropriate Box(es) if This Proposal Includes Any of the Items Listed Below:				
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Country/Countries				
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NOTE: The FULLY SIGNED Certification Page must be submitted immediately following this Cover Sheet.				
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CERTIFICATION PAGE

Certification for Principal Investigators and Co-Principal Investigators:

I certify to the best of my knowledge that:

- (1) the statements herein (excluding scientific hypotheses and scientific opinions) are true and complete, and
- (2) the text and graphics herein as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or individuals working under their supervision. I agree to accept responsibility for the scientific conduct of the project and to provide the required progress reports if an award is made as a result of this application.

I understand that the willful provision of false information or concealing a material fact in this proposal or any other communication submitted to NSF is a criminal offense (U.S. Code, Title 18, Section 1001).

Name (Typed)	Signature	Date
PI/PD Michael E. Gorman		
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Certification for Authorized Institutional Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding Federal debt status, debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grants for Research and Education in Science and Engineering (GRESE), NSF 92-89. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

Debt and Debarment Certifications

(If answer "yes" to either, please provide explanation.)

Is the organization delinquent on any Federal debt?

Yes ___ No X

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency?

Yes ___ No X

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding \$100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding \$150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

AUTHORIZED INSTITUTIONAL REPRESENTATIVE	SIGNATURE	DATE
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Project Summary

This proposal, if funded, would produce a course module that could be used in a wide variety of classes across the curriculum to illustrate how ethical concerns, especially environmental ones, can be integrated into the invention process. The module would include a case-study of an inventor of solar heating systems who was motivated both by environmental and market concerns. Students would also work in groups to design their own environmentally-appropriate technology, then reflect on the role of ethics in the design process, using readings and discussion to hone their ability to analyze ethical issues. This module would be piloted and evaluated in a special course on invention and design intended for students from both engineering and the liberal arts. Materials would then be prepared for dissemination and use nationwide.

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Project Description

We propose to develop a course module that can be used in a wide variety of classes to illustrate how environmental ethics can be integrated into the invention and design process. The module will begin with a case-study of an inventor of solar heating systems who is motivated both by environmental and market concerns. Students will then be given a chance to design their own environmentally-appropriate technology and analyze their own design processes, focusing especially on the role of ethical concerns. To determine its effectiveness, this module will be piloted and evaluated in a special course on invention and design intended for students from both engineering and the liberal arts. It will then be prepared for dissemination to instructors nationwide.

I. Desired Outcomes

From this case, students should learn the following:

- (1) How ethical concerns can shape the invention process. As Melvin Kranzberg has noted, "Technology is neither good nor bad--nor is it neutral." By building in ethical concerns from the start, one can create technologies that are more likely to be beneficial.
- (2) That ethical concerns can lead an inventor to create new markets. The profit motive can be combined with the desire to do good.
- (3) That accepting ethical constraints on design does not limit one's imagination. The desire to create a sophisticated new technology is often as great a motive for an inventor as fame and fortune (Pacey, 1989). Adding the constraint that this technology be environmentally appropriate creates new opportunities for innovative thinking.
- (4) Skills for analyzing and reflecting on ethical issues in design: Ethical decision-making does not come 'naturally'; indeed, ethical problems are frequently hard to recognize until it is too late and one has made a chain of decisions that are hard to unravel (cf. Pritchard). This course will teach students how to recognize and analyze ethical issues in design.

II. Background: A Course on Invention and Design¹

This case will be introduced into a course on invention and design which sets-up a collaborative learning environment; students and faculty from a variety of disciplines explore issues in design together. Standard university curricula tend to compartmentalize engineering, humanities and social sciences. But real world engineering decisions defy such compartmentalization, as students discover when they take this course.

Currently, we use three modules in the course--the invention of the telephone, the computer and the design of a medical diagnostic system. All cases involve ethical considerations and these are discussed in the course. For example, the medical case involves students in developing an expert system to diagnose cases of sexual assault. Students have to make sure that their system is capable of keeping all client information confidential. They also have to deal with the politics of providing diagnoses for insurance purposes. Is it ethical to label a client in accordance with an insurance code, simply in order to obtain payment? Could an expert system eventually be used to make diagnosis and treatment more 'efficient', thereby robbing abuse victims of the necessary human contact and empathy?

The ethical issues in these other cases have more to do with the impact of the technology than its design. We would like to add a module which focuses specifically on the role of environmental ethics in invention and design.² Ethical concerns are often seen as implications or results of designs; we want students to see that ethical decisions are embedded in an invention.

The goal is not just to develop a module for use in this course, however. The course is itself a kind of laboratory for testing ideas which can be used in other classes across the curriculum. All the modules used currently are being prepared for wide dissemination; this one would be no exception. (See Final End Products, below).

¹Development of this course was supported by the Leadership in Science and Humanities program of the NSF, NEH and FIPSE.

²Cases have been used to teach engineering ethics at a number of institutions, including the Center for the Study of Ethics in Society at Western Michigan and the Center for the Study of Ethics in the Professions at the Illinois Institute of Technology.

III. Structure of the Module

The module we have selected involves three components:

(1) A case-study of a modern inventor of solar heating systems.

A.C. Rich decided to work in the solar energy field because he saw it as one solution to problems like global warming. During his college years, he became active in the environmental movement, organizing and participating in senior seminars and conferences.

After graduating in 1979, he worked as a district manager for a solar company that went out of business when the tax-credit for alternate energy was repealed. In order to stay in the solar industry, he became a one-person sales and servicing company, working with the existing technology. Constant interaction with consumers made him increasingly aware of the shortcomings of existing designs; from these perceived shortcomings, he developed a set of constraints which guided the development of a new solar water heater.

Why a water heater? Because Rich thought that the way water was heated in homes was monumentally inefficient, from an environmental standpoint. Why generate power from a distant source that generated pollution and acid rain when the sun could heat water right at the remote location? Obviously, standard technology would have to be used as a back-up, but the amount of power consumed could be drastically reduced.

Rich went on to develop a design that was a radical departure from current practices in the solar industry, involving two patents and wholesale substitution of materials--for example, instead of glass he used plastic and instead of copper pipe, polypropylene. His goal was to develop a low maintenance, low cost system that would last for twenty or more years and could be installed and operated in virtually any climate zone within the United States.

Therefore, this case complements the emphasis on technological creativity that is the main theme of the course while adding an important ethical

component. It also incorporates some of the business and management aspects of inventing. Rich had to survive a severe recession in the solar industry; his company is still struggling, held together in part by his Utopian dreams of a day when millions of people are using the sun to heat their water. Therefore, his case allows us to raise the issue of sustainable development.

Rich was invited to speak to the Invention and Design class this last semester, and also interacted with an undergraduate research team studying inventors. Therefore, we have video-taped him discussing his process and acquired copies of his research materials, patents and business plans. He has agreed to be an active collaborator in this project.

By the end of this case, students will have learned that there is an important ethical component to invention and design. An inventor can be driven by a desire to improve the world, and this desire has practical consequences, both in terms of her or his design process and the way he or she struggles to create markets for sustainable technologies.

(2) Background Readings and Discussion

To put this issue into broader context, we would use articles like Michael Davis' "Explaining Wrongdoing" and "Thinking Like an Engineer: The Place of a Code of Ethics in the Practice of a Profession" and selections from Martin & Schinzinger's (1989) *Ethics in Engineering*, Pritchard's *Teaching Engineering Ethics: A Case Study Approach.*, Schmidheiny's (1992) *Changing Course* and Kennedy's (1993) *Preparing for the Twentieth Century*.

(3) Design Component

Every case in this course has a design component, in which the students work in groups on an invention problem consonant with the goals of the unit. In this unit, we would ask students to come up with a design that promoted sustainable development in an area of their own choosing. Groups would have to begin with problem definition: what major environmental problem could they begin to alleviate with a feasible design? Their goal would be to 'sell' their idea to a panel of judges that would include faculty with expertise in energy, resources and the environment. They would have to both describe how their design would benefit the global environment and how it could be marketed

without relying on heavy subsidies from governments. They could use Rich's process as an example--and even try to improve on his invention--but they could not simply imitate an existing invention.

(4) Reflection and analysis:

For a design exercise to be effective, it must be followed by analysis: students need to reflect on and compare their design processes. In this module, this reflection will include a detailed consideration of ethical issues. How did groups deal with the ethical components of this design? What guidelines or strategies could ethical designers follow?

To promote this sort of reflection, each group will be asked to prepare a narrative of its design process and present it to the class. Then groups will be encouraged to compare their different approaches to environmentally-conscious invention. The result should be students who are more capable of recognizing and analyzing the ethical aspects of invention and design.

IV. Implementation

This module will be tested in two environments:

(1) In the spring of 1994, we propose to introduce this module into a university course on Invention and Design offered to majors from any discipline at the three or four hundred level. In practice, this means the course is taken mostly by third or fourth year students, though we have had first and second year students in it.

(2) In the summer of 1994, we propose to test this module in a secondary course for gifted students run by the Summer Enrichment Program at the University of Virginia. Students from a wide variety of backgrounds will be sought. In this intense, three-week seminar, students will be exposed to the telephone module before the one listed here. Development and implementation of this summer course was supported by a grant to the PI by the Geraldine R. Dodge Foundation (see Current and Pending Support). The foundation has not supported the development of this module, only costs associated with implementation of the course. This module would make an excellent addition to that course; it would require no additional resources from the NSF to

incorporate it. The secondary students will serve as a useful pilot audience for potential use of this module in first-year courses at the university level.

V. Evaluation

The original grant for the Invention and Design course funded an extensive and thorough evaluation of this course. This proposal includes funding for a similar evaluation of this specific case that would include three major components:

(1) A survey administered at the beginning and the end of this case. Students would be asked questions about whether and to what extent they thought inventors factored ethical concerns into their designs, and whether ethics ought to play an important role in the earliest stages of the invention process, or enter later when the questions of use and marketing come into play. The goal of this measure is to assess whether students think differently about ethical and environmental considerations in design as a result of taking this course. Questions could be adapted from existing surveys and scales that measure development in ethical thinking (see Rest et al., 1986, for an overview).

(2) Focused interviews: Selected students would be interviewed to look for issues that were missed in the surveys and questionnaires. In particular, we would be trying to find out more about the process of change in views of design and ethics across the unit. This would mean doing several interviews with the same students, a strategy often used to track ethical and intellectual development over longer time periods (cf. Perry, 1970).

(3) Video-taping: All class sessions and all group meetings outside of class would be taped for later analysis. We would focus specifically on the ways in which ethical or environmental decisions affected the invention process, and also students' plans to market their designs.

(4) Design notebooks: Every student would be required to keep an inventor's notebook, in which she recorded her ideas and experiments during the design component. These notebooks would be one of our most important records of students' problem-solving processes. Students are taught how to keep such records as part of the course; such documentation is extremely important in invention and discovery.

(5) Student papers: Each group would prepare a proposal that described its design, the environmental benefits that would accrue if it were adopted, and a strategy for marketing it. Individual students would be required to submit papers in which they compared their groups' processes to A.C. Rich's and to those of other groups. (Again, this parallels assignments done for the other modules in the course).

This combination of measures will allow us to assess whether students have attained the desired outcomes noted in the first section.

VI. Final End Products

One end-product would be a module that could be used in a wide variety of courses, following the Ethics Across the Curriculum model used at the Illinois Institute of Technology.³ For example, all first-year engineering students are required to take a course on engineering design. Every fourth-year engineering student takes a course that incorporates both design and ethics. We intend to write-up this module so it can be adapted for use in both of these courses.

But it could also be used in a variety of other courses outside of engineering, e.g., in business and science-technology studies. We will keep these other audiences in mind as we prepare the module for dissemination.

The module would include the following:

- (1) A document for students that gives them background material on A.C. Rich and his invention process and sets-up the students' design problem.
- (2) A teaching note that gives instructors advice on how to run this module, including goals, information on assignments and additional background information and reading.
- (3) A set of supplementary lectures and a syllabus from a course on Invention and Design that would allow instructors to see how this module could fit into a number of contexts. These materials would include notes on the invention and design process, using other inventors as examples.

³See Michael Davis, "Integrating Ethics into Technical Courses: IIT's Experiment in its Second Year", paper presented at the 1992 Frontiers in Education Conference.

This module could be distributed via the case service affiliated with the American Society of Engineering Educators and also through the Darden Business School, which has an extensive catalogue of cases. (We are currently making arrangements for dissemination of other modules used in the Invention and Design course).

Another end-product would be a series of articles describing the case and its use in the classroom, in journals like *Science, Technology and Human Values* and the *Journal of Engineering Education*.

VII. Results from Prior NSF Support

The principal investigator, Michael E. Gorman, has been awarded three NSF grants, in collaboration with W. Bernard Carlson. "The Cognitive Style of American Inventors: A Comparative Study of the Telephone, 1870-1880" (No. DIR-8722002) was awarded by the program in History and Philosophy of Science and Technology for the period 1 September 1988 to 31 August 1991. This grant permitted the PIs to establish a framework and methodology for studying invention and design and assemble original, archival materials for applying these tools to a comparison of early telephone inventors. We also began at that time, to assemble a multi-disciplinary undergraduate research team to assist us.

A second NSF grant, "Technological Innovation as a Cognitive Process: A Comparative Study of Telephone Inventors" (DIR-9012311), also from HPST, permitted us to implement a computerized system that charts or maps an inventor's path to her or his invention.

A third NSF grant, "Mapping the Invention Process: An Integration of Cognitive and Social Approaches to the Invention of the Telephone, 1870-1880" (DIR-9100424) allowed Drs. Carlson and Gorman to begin writing a book on the telephone.

This project has facilitated a number of publications, including:

Gorman, M.E. and Carlson, W.B. (1990). "Interpreting invention as a cognitive process: The case of Thomas Edison, Alexander Graham Bell and the Telephone." *Science, Technology and Human Values*, Vol. 15: 131-164.

W. Bernard Carlson and Michael E. Gorman, "Understanding Invention as a Cognitive Process: The Case of Thomas Edison and Early Motion Pictures, 1888-1891," *Social Studies of Science*, 1990, Vol. 20, pp. 387-430.

Gorman, M.E. (1992) *Simulating Science: Heuristics, Mental Models and Technoscientific Thinking*. Bloomington: Indiana U. Press.

Gorman, M.E., Mehalik, M.M., Carlson, W.B. & Oblon, M. (1993). Alexander Graham Bell, Elisha Gray and the speaking telegraph: A cognitive comparison. *History of Technology*, Vol. 15, pp. 1-56.

The last of these is co-authored with two undergraduate engineering students, both of whom are doing undergraduate theses related to our work. We are currently working on another major paper in which an undergraduate biology major will play a major role. Therefore, our prior NSF support has had a direct effect on the education of several undergraduates, transforming them from consumers into producers of knowledge.

The NSF has also funded the PI of the current proposal to develop a course which is based on this research. "Using Case Studies to Teach Invention and Design" (DUE-9252587) was funded by the Leadership in Science and Humanities program, which includes NEH and FIPSE as well as NSF. This course includes a module based on the telephone, taught by the PI, as well as modules on the computer and on a medical diagnostic system, taught by three of his engineering colleagues who are co-PIs on the grant. The environmental ethics module outlined in this proposal will be piloted in this class, and will be prepared for wide dissemination like the other modules in this course.

To summarize, the current proposal is a natural outgrowth of the PI's prior support from NSF. Three grants have allowed the PI to gain an intimate

understanding of the invention process; a fourth has allowed him to develop a course based on this understanding. This proposal will permit him and his colleagues to build a strong ethical component into this course, and to explore the role of ethical concerns in the design process.

VIII. Bibliography

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Schmidheiny, Stephan (1992). *Changing Course: A Global Business Perspective on Development and the Environment*. Cambridge: MIT Press.

Biographical Sketches

Michael E. Gorman has spent five years developing a cognitive framework and applying it to the invention of the telephone, in collaboration with W. Bernard Carlson and a team of undergraduates. He has just published a book, *Simulating Science*, on technoscientific thinking. He has taught a wide range of interdisciplinary courses, including courses on scientific and technological creativity. In the last year, with support from the NSF, FIPSE and NEH, he designed a new course on invention and design, coordinating a team of engineering colleagues. (See attached vita for more details).

A.C. Rich invented and patented the solar "SKYLITE"tm water heater and is the founder and president of AMERICAN SOLAR NETWORK, Ltd., a corporation now based in Sacramento. He has received numerous grants and awards for his socially-responsible innovations.

Patricia H. Werhane is the Ruffin Chair in Business Ethics in the Darden School at the University of Virginia. She is an internationally recognized expert on business ethics who has authored or co-authored eight books on this topic, is on the editorial board of five journals, and is a founding member and past President of the Society for Business Ethics. (See attached CV for more details).

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B. Selected Articles Related to Current Project:

Gorman, M. E., Mehalik, M., Carlson, W. B. and Oblon, M. (1993). Alexander Graham Bell, Elisha Gray and the speaking telegraph: A cognitive comparison, History of Technology, Vol. 15, pp. 1-56.

Gorman, M. E. & Carlson, W. B. (1990). Interpreting invention as a cognitive process: The Case of Thomas Edison, Alexander Graham Bell and the telephone. Science, Technology and Human Values, 15, 131-164.

Carlson, W. B. & Gorman, M. E. (1990). Understanding invention as a cognitive process: The case of Thomas Edison and early motion pictures, 1888-1891. Social Studies of Science, 10, 387-430.

Carlson, W. B. & Gorman, M. E., (In Press) Using A Cognitive Framework to Understand Invention. In B. Weber & D. Perkins, The Inventing Mind (Oxford University Press).

Book:

Gorman, M. E. Simulating Science: Heuristics, Mental Models and Technoscientific Thinking. Bloomington: Indiana University Press, 1992.

Selected Additional Publications:

Gorman, M. E. (1989). Beyond strong programmes: How cognitive approaches can complement the sociology of scientific knowledge. Social Studies of Science, 19 (3), pp. 643-653.

Gorman, M. E. (In Press) Psychology of Science In W. O. Donohue & P. Kitcher(Eds) Psychology and Philosophy. (Allyn & Bacon).

Gorman, M. E. (1992). Simulating social epistemology: Experimental and computational approaches. In R. Giere (Ed.) Minnesota Studies in the Philosophy of Science: Vol. 15 (University of Minnesota Press).

Gorman, M. E. & Carlson, W. B. (1989). Can experiments be used to understand experimental science? Social Epistemology, 2, pp. 89-106.

Gorman, Michael E., Stafford, A. & Gorman, Margaret E. (1987) Disconfirmation and dual hypotheses on a more difficult version of Wason's 2-4-6 task. Quarterly Journal of Experimental Psychology, 39, 1-28.

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1969-1972: Instructor of Philosophy, University of Maryland
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1972-1975: Professor of Philosophy, American
College of Switzerland, 1854 Leysin,
Switzerland

1975-1976: Lecture in Philosophy, Loyola
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1976-1982: Assistant Professor of Philosophy,
Loyola University of Chicago

1982-1987: Associate Professor of Philosophy,
Loyola University of Chicago

1982-1987: Associate Dean, College of Arts and
Science, Water Tower Campus Loyola
University of Chicago

1987- Professor of Philosophy, Loyola
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1988-1989: Rockefeller Fellow, Ethics
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1989- Henry J. Wirtenberger Professor of
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ACADEMIC HONORS AND GRANTS:

Wellesley Scholar, Wellesley College
Danforth Foundation Fellowship, 1963-64
North Carolina Humanities Council Award Paper, 1986
Rockefeller Fellowship to the Ethics Institute, Dartmouth College,
1988-1989
1976-1986: 5 Mellon Foundation-Loyola Grants: Lecture series,
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1977, 1984: 2 Mellon Foundation-Loyola Grants: Symposia and
publications in aesthetics.
1990: Mellon-Loyola Grant: Symposium on teaching Ethics Across
the Curriculum

1992: NSF Grant (With Dartmouth College, MIT, Cal Tech, IIT and the Acadia Institute): "The production of Educational Modules for the Teaching of Research Ethics"

B. PUBLICATIONS:

Ethical Issues in Business: A Philosophical Approach, co-edited with Thomas Donaldson (Englewood Cliffs, N.J.: Prentice-Hall, Inc., Fourth Edition, 19992.)

Persons, Rights, and Corporations (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1985)

Adam Smith and his Legacy for Modern Capitalism (New York: Oxford University Press, 1991.)

A Framework for Moral Management (New York: McGraw-Hill Book Company, 1993).

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"The Compatibility of Freedom and Equality," Freedom Equality and Social Change, ed. Creighton Peden and James P. Sterba (Lexington, N.Y.: The Edwin Mellen Press, 1989).

"Sexual Static and the Ideal of Professional Objectivity," It Comes With the Territory: An Inquiry Concerning Work and The Person, ed. A.R. Gini and T. Sullivan (New York: Random House, 1989), pp. 170-179.

"Ethical Reasoning," co-authored with Thomas Donaldson, in Peter Windt., et. al., eds, Ethical Issues in the Professions (Englewood Cliffs: Prentice Hall, Inc., 1989).

"Engineers and Management: The Challenge of the Challenger Incident," Journal of Business Ethics, 10 (1991), pp. 605-16.

"Individualism, Obligations, and Rights: A community-Based Notion of Rights," Reading in Social Philosophy (Lexington, NY: Edwin Mellen Press, 1993), forthcoming.

C. David Ozar, Philosophy, Loyola University of Chicago, Mark Waymack, Philosophy, Loyola University of Chicago, Bernard Gert, Dartmouth College.

D. David Mouton (deceased), Eliseo Vivas (retired, Northwestern University), Robert Browning (deceased)

- 1988 - 1993, Invented, Patented, Prototyped and Manufactured the award winning solar "SKYLITE"™ water heater.
- Founder and President of AMERICAN SOLAR NETWORK, Ltd., Herndon, VA, a socially responsible innovative technology company which manufactures the solar "SKYLITE" water heater. (1988)
 - Won DOE National Award for Energy Innovation as a result of a New Hampshire Governor's Energy Office Grant Award. (10/92)
 - One of less than 580 out of over 30,000 applicants to be recognized by the DOE Energy Related Inventions Program (ERIP) (6/92) and to be approved for a \$100K Grant Award.
 - Completed 27 unit HUD contract in Norton, VA at record low cost.
 - First in the nation to receive national Solar Rating and Certification Corp. (SRCC) OG300 system ratings. (6/92)
 - Applied for a second Patent on the collector in March 92.
- 1979 - 1993, Founder: AC-RICH & SUN, Solar: R&D, sales, consultation, installation, service & training. (7/79)
- Granted California Solar contractors licence in July 1992.
 - Moved factory and family to Carmichael, CA in Jan. 93 because of the Sacramento Municipal Utility District (SMUD) Program.
- 1986 - 1993, Secretary of the Sacramento Chapter of the Nat. Solar Energy Ind. Assoc. (SEIA) Member: National SEIA; CALSEIA; SACSEIA; International Solar Energy Society (ISES); American Solar Energy Society (ASES); American Society of Heating, Refrigerating and Air-Conditioning Engineers, (ASHREA); International Association of Plumbers & Mechanical Officials (IAPMO) - on IAPMO solar committee.
- Consultant and Contractor to: Rockwell International, Energy Technology Engineering Center; Solar Energy Research Institute for DOE; National SEIA; SANDIA National Laboratories.
 - Assisted in US Senate Subcommittee Hearings.
 - Installed White House Ellipse "Pageant of Peace" PV system.
- 1981 - 1985, District Manager for SEARS Solar, (ASK) Herndon, VA branch; demonstrated excellence in team building, motivation and profitability; trained and managed 53 employees.
- President, Cambridge Alternative Power Company.
 - Chair-person of the NESEA Bay Chapter Solar DHW Committee.
 - Speaker for NESEA on Solar DHW, at MIT, Cambridge, MA.
 - Member, Gov. Dukakis Energy Advisors Committee, Boston, MA
 - Member and organizer, Earth Day Committee, Boston, MA.
 - Entrepreneurship speaker at Babson College, Wellesley, MA.
- 1977 - 1982, Consultant and trainer for companies entering Solar.
- Held professional sales and installation seminars.
 - Marketed & Improved Heliophase, a unique solar DHW system.
 - Installed the first two solar systems for the U.S. Navy.
 - Member Board of Directors, NH Solar Energy Assoc.
 - Studied under Bruce Anderson, author of "The Solar Home Book".
 - Member: Senior Environmental Seminar; Planner: "Living Lightly" lifestyles conference; Installed Solar Thermal Air Panels (TAPs); founded "Think Tank Table". (1978-79)
 - Studied solar technology, methane gasification, composting, and water rams at New Life Farm, Drury, Missouri.
 - Installed "Trickle Down" pool heater, Buena Vista, Co. (1977)

Personal: Born 2/8/50, wife: Susan, Children: Ashley 5, Katherine 3 and Clark 1, Education: Principia College, Elsah, Il. BA 1979; Poli-Sci. and Research Processes.

SUMMARY PROPOSAL BUDGET

Organization		For NSF Use Only			
		Proposal No.		Duration (months)	
Principal Investigator / Project Director		Award No.		Proposed	Granted
University of Virginia					
M. E. Gorman					
A. Senior Personnel: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Personnel		Funds Requested By proposer	Funds granted by NSF (if different)
		Cal	Acad		
1. M. E. Gorman, P. I.		1.5		\$ 7,498	\$
2. P. H. Werhane, Faculty Participant			.25	2,639	
3.					
4.					
5.					
6. () Others (List individually on budget explanation page)					
7. (2) Total Senior Personnel (1 - 6)		1.5	.25	10,137	
B. Other Personnel (Show numbers in brackets)					
1. () Post Doctoral Associates					
2. () Other Professionals (Technician, Programmer, etc.)					
3. (1) Graduate Students				8,580	
4. () Undergraduate Students					
5. () Secretarial - Clerical					
6. () Other					
Total Salaries and Wages (A + B)				18,717	
C. Fringe Benefits (if charged as direct costs)				1,946	
Total Salaries, Wages and Fringe Benefits (A + B + C)				20,663	
D. Permanent Equipment (List item and dollar amount for each item exceeding \$1,000.)					
Total Permanent Equipment					
E. Travel				1,630	
1. Domestic (incl. Canada and U.S. possessions)					
2. Foreign					
F. Participant Support Costs					
1. Stipends \$ _____					
2. Travel _____					
3. Subsistence _____					
4. Other _____					
() Total Participant Costs					
G. Other Direct Costs					
1. Materials and Supplies				500	
2. Publication Costs/Documentation/Dissemination					
3. Consultant Services A. C. Rich				900	
4. Computer (ADPE) Services					
5. Subcontracts					
6. Other Tuition remission 2,180; Copying & communications 500				2,680	
Total Other Direct Costs				4,080	
H. Total Direct Costs (A through G)				26,373	
I. Indirect Costs (Specify Rate and Base)					
52% of Modified Total Direct Costs to 6/30/94;					
Total Indirect Costs 53% effective 7/1/94				12,701	
J. Total Direct and Indirect Costs (H + I)				39,074	
K. Residual Funds (If for further support of current projects see GPM 252 and 253)					
L. Amount of This Request (J) or (J minus K)				\$ 39,074	\$
PI/PD Typed Name & Signature*		DATE	For NSF Use Only		
Institutional Representative Typed Name & Signature*		DATE	Indirect Cost Rate Verification		
			Date Checked	Date Of Rate Sheet	Initials - DGC

SUMMARY PROPOSAL BUDGET

Organization		For NSF Use Only				
		Proposal No.		Duration (months)		
University of Virginia		Award No.		Proposed	Granted	
				Principal Investigator / Project Director		Award No.
M. E. Gorman						
A. Senior Personnel: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Personnel		Funds Requested By proposer	Funds granted by NSF (if different)	
		Cal	Acad	Sumr		
1. M. E. Gorman, P. I.				1	\$ 5,133	\$
2. P. H. Werhane, Faculty Participant				.25	2,771	
3.						
4.						
5.						
6. () Others (List individually on budget explanation page)						
7. (2) Total Senior Personnel (1 - 6)				1.25	7,904	
B. Other Personnel (Show numbers in brackets)						
1. () Post Doctoral Associates						
2. () Other Professionals (Technician, Programmer, etc.)						
3. (1) Graduate Students Funded by UVA - see cost share letter						
4. () Undergraduate Students						
5. () Secretarial - Clerical						
6. () Other						
Total Salaries and Wages (A + B)					7,904	
C. Fringe Benefits (if charged as direct costs)					633	
Total Salaries, Wages and Fringe Benefits (A + B + C)					8,537	
D. Permanent Equipment (List item and dollar amount for each item exceeding \$1,000.)						
Total Permanent Equipment						
E. Travel		1. Domestic (incl. Canada and U.S. possessions)				
		2. Foreign				
F. Participant Support Costs						
1. Stipends \$ _____						
2. Travel _____						
3. Subsistence _____						
4. Other _____						
() Total Participant Costs						
G. Other Direct Costs						
1. Materials and Supplies					500	
2. Publication Costs/Documentation/Dissemination						
3. Consultant Services A. C. Rich						
4. Computer (ADPE) Services						
5. Subcontracts						
6. Other Copying & communications					500	
Total Other Direct Costs					1,000	
H. Total Direct Costs (A through G)					9,537	
I. Indirect Costs (Specify Rate and Base)						
Total Indirect Costs 53% of Modified Total Direct Costs					5,055	
J. Total Direct and Indirect Costs (H + I)					14,592	
K. Residual Funds (If for further support of current projects see GPM 252 and 253)						
L. Amount of This Request (J) or (J minus K)					\$ 14,592	\$
PI / PD Typed Name & Signature*		DATE	For NSF Use Only			
			Indirect Cost Rate Verification			
Institutional Representative Typed Name & Signature*		DATE	Date Checked	Date Of Rate Sheet	Initials - DGC	

Cumulative: 1/1/94 -12/31/95

SUMMARY PROPOSAL BUDGET

Organization University of Virginia		For NSF Use Only			
		Proposal No.		Duration (months)	
		Award No.		Proposed	Granted
Principal Investigator / Project Director M. E. Gorman					
A. Senior Personnel: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)		NSF Funded Personnel		Funds Requested By proposer	Funds granted by NSF (if different)
		Col	Acad	Sumr	
1. M. E. Gorman, P. I.			1.5	1	\$ 12,631
2. P. H. Werhane, Faculty Participant				.5	5,410
3.					
4.					
5.					
6. () Others (List individually on budget explanation page)					
7. (2) Total Senior Personnel (1 - 6)			1.5	1.5	18,041
B. Other Personnel (Show numbers in brackets)					
1. () Post Doctoral Associates					
2. () Other Professionals (Technician, Programmer, etc.)					
3. (1) Graduate Students					8,580
4. () Undergraduate Students					
5. () Secretarial - Clerical					
6. () Other					
Total Salaries and Wages (A + B)					26,621
C. Fringe Benefits (if charged as direct costs)					2,579
Total Salaries, Wages and Fringe Benefits (A + B + C)					29,200
D. Permanent Equipment (List item and dollar amount for each item exceeding \$1,000.)					
Total Permanent Equipment					
E. Travel					1,630
1. Domestic (incl. Canada and U.S. possessions)					
2. Foreign					
F. Participant Support Costs					
1. Stipends \$ _____					
2. Travel _____					
3. Subsistence _____					
4. Other _____					
() Total Participant Costs					
G. Other Direct Costs					
1. Materials and Supplies					1,000
2. Publication Costs/Documentation/Dissemination					
3. Consultant Services A. C. Rich					900
4. Computer (ADPE) Services					
5. Subcontracts					
6. Other Tuition remission 2,180; Copying & communications 1,000					3,180
Total Other Direct Costs					5,080
H. Total Direct Costs (A through G)					35,210
I. Indirect Costs (Specify Rate and Base)					
Total Indirect Costs					17,756
J. Total Direct and Indirect Costs (H + I)					53,666
K. Residual Funds (If for further support of current projects see GPM 252 and 253)					
L. Amount of This Request (J) or (J minus K)					\$ 53,666
PI / PD Typed Name & Signature*		DATE	For NSF Use Only		
Institutional Representative Typed Name & Signature*		DATE	Indirect Cost Rate Verification		
			Date Checked	Date Of Rate Sheet	Initials - OGC

Budget Justification

Support for the PI: In order to prepare and supervise the introduction of this new case, the PI would need one-sixth released-time, or the equivalent of one course out of the six he teaches each year. To supervise the evaluation and write-up the results for dissemination, he would need an additional month of summer support.

Consultants: A.C. Rich has already agreed to serve as a consultant on this unit. We would like to fly him out from California to conduct an extended seminar with the students. They would have studied materials regarding his case in advance, and would be able to ask him focused questions about his invention process and the politics of marketing environmentally-appropriate technology.

Faculty Participants: Patricia Werhane, who will be on the faculty of the Darden Business School, is a nationally-recognized expert on business ethics; she is currently Henry J. Wirtenberger Professor of Business Ethics at Loyola University of Chicago. She has also done significant work with programs that specialize in engineering ethics, particularly at the Illinois Institute of Technology, where she conducted faculty workshops. She will help the PI draft module materials that force students to reflect on and analyze ethical issues. She has agreed to sit-in on portions of the course as the module is being taught, playing an active role in class discussions. She will also assist in preparation of materials for dissemination, and will be offered the opportunity to be a co-author on publications describing the module and its impact.

Graduate Student: To conduct the evaluation under the PI's close supervision, a graduate student is necessary. The PI cannot, for obvious reasons, conduct confidential interviews, distribute surveys and videotape groups in a course he is coordinating. A graduate student in Systems Engineering has spearheaded the evaluation of the initial phase of this course; this student or another could be hired for a semester and three months of the summer to complete a thorough evaluation of the environmental ethics unit, both in the university course and the summer enrichment course for secondary students. An additional benefit is that this engineering graduate student will receive training in ethics.

The School of Engineering and Applied Science has agreed to support a graduate teaching assistant to help specifically with this module in the Spring of 1995. Part of this student's duties will be conducting an evaluation of the second use of this module in the Invention and Design class

Supplies and Other:

These categories include the cost of obtaining and reproducing Rich's invention notebooks, patents, business plans and also the cost of videotapes and other materials related to the evaluation.

Schedule:

The module will be implemented in the Invention and Design course in the spring of 1994. A version of it will also be tried on gifted secondary students in the summer of 1994. Results of the evaluation will be used to prepare an improved version of the course, which will be implemented in the spring of 1995. The PI will devote a month of the summer of 1995 to writing-up the results of both iterations of the course, in cooperation with Professor Werhane. The result will be materials that are ready for use in a wide range of courses across the curriculum where the role of ethics in design ought to be considered.

Budget Notes

- * Faculty - Appointments are generally effective calendar year (CY) beginning July 1 or Academic Year (AY) beginning September 1. M. E. Gorman: Year 1 - 16.7% effort AY; Year 2 - 1 mo. summer. P. H. Werhane: 25%, 1 mo. summer each year.
- * Graduate Research Assistants (GRAs) and Undergraduate Research Assistants (URAs) - Costs are estimated (by hourly rate times number of hours) based on the minimum and maximum payments for the academic year established by the University Office of the Vice-President and Provost. All compensation in SEAS proposals are within these guidelines. One GRA, year 1: \$13.00/hr. x 88 hrs./mo. x 7.5 mos.
- * Salary Increases - A 5% salary increase is applied to this proposal, effective 7/1/94 or 9/1/94, and is accumulated annually from these dates. Faculty increases are based on contributions in academic and research areas and are approved by the State of Virginia Budget Office. Staff increases are based on State of Virginia proficiency guidelines. New salaries are given as soon as they are available.
- * Fringe Benefits - The University of Virginia's fixed fringe benefit rates, as they apply to sponsored programs, have been approved by DHHS for 7/1/92 through 6/30/93 at 22.5% for faculty and senior professional staff, 26.5% for classified staff, and 8% for wage employees and for summer effort by faculty with AY appointments. Although not yet approved by DHHS, the University estimates future rates as follows: effective 7/1/93 - 22% for faculty and senior professionals, 27.5% for classified, and 8.0% for wage and summer faculty; effective 7/1/94 - 24.5%, 32.5%, and 8%; effective 7/1/95 - 25%, 33.5% and 8.0% for wage and summer faculty. Fringe benefits do not apply to graduate and undergraduate research assistants.
- * Travel - For consultant A. C. Rich, from Sacramento, CA to Charlottesville, VA for 3 days. Airfare - \$1,300; Lodging - \$75/night x 2 nights; Subsistence - \$35/day x 3 days, Auto rental - \$75.
- * Materials and Supplies - Educational materials.
- * Consultant - A. C. Rich, \$300/day x 3 days.
- * Tuition Remission - Effective September 1, 1990, it is the policy of the University of Virginia to provide tuition for graduate research assistants in lieu of partial compensation for services. A 10% increase per year is applied for each succeeding year.
- * Other Costs - Estimated costs for photocopying, communications, etc. are based on prior SEAS research experience.
- * Indirect Costs - The University of Virginia's negotiated MTDC Indirect Cost rates with DHHS per agreement of 7/30/92 are 52% of the Modified Total Direct Costs for "on campus" and 23.5% "off campus" for 7/1/92 through 6/30/94; effective 7/1/94 until further amended, rates are 53% and 23.5%. (Note: The MTDC base consists of total direct costs less individual equipment items in excess of \$500, all subcontracts and subgrants, alterations and renovations, patient care costs, stipends, tuition remission and rental costs of off-campus facilities.)