COVER SHEET FOR PROPOSAL TO THE NATIONAL SCIENCE FOUNDATION

FOR CONSIDERATION BY NSF ORGANIZATION UNIT(S)
(Indicate the most specific unit known, i.e., program, division, etc.)
Instrumentation and Laboratory Improvement, Instrumentation Projects

FOR NSF USE ONLY
NSF PROPOSAL NUMBER

PROGRAM ANNOUNCEMENT/SOLICITATION NO./CLOSING DATE
NSF93-164, November 14, 1994

DATE RECEIVED	NUMBER OF COPIES	DIVISION ASSIGNED	FUND CODE	FILE LOCATION
34-1011998				

EMPLOYER IDENTIFICATION NUMBER (EIN) OR TAXPAYER IDENTIFICATION NUMBER (TIN)

SHOW PREVIOUS AWARD NO. IF THIS IS:
☐ A RENEWAL OR
☐ AN ACCOMPLISHMENT-BASED RENEWAL

IS THIS PROPOSAL BEING SUBMITTED TO ANOTHER FEDERAL AGENCY? YES ___ NO X IF YES, LIST ACRONYM(S)

NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE:
Youngstown State University

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING ZIP CODE:
Youngstown, OH 44555

AWARDEE ORGANIZATION CODE (IF KNOWN):
PUBL

NAME OF PERFORMING ORGANIZATION, IF DIFFERENT FROM ABOVE

ADDRESS OF PERFORMING ORGANIZATION, IF DIFFERENT, INCLUDING ZIP CODE:

PERFORMING ORGANIZATION CODE (IF KNOWN):

IS AWARDEE ORGANIZATION (Check All That Apply): (See GPG For Definitions)
☐ FOR PROFIT ORGANIZATION ☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ WOMAN-OWNED BUSINE

TITLE OF PROPOSED PROJECT:

Restructuring the Physics Lab: A Remote Interactive Approach

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE:
$ $19,388	24 months	September 1995

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW:

☐ VERTEBRATE ANIMALS ☐ NATIONAL ENVIRONMENTAL POLICY ACT ☐ FACILITATION FOR SCIENTISTS/ENGINEERS WITH DISABILIT
☐ HUMAN SUBJECTS ☐ PROPRIETARY AND PRIVILEGED INFORMATION ☐ RESEARCH OPPORTUNITY AWARD
☐ HISTORICAL PLACES ☐ DISCLOSURE OF LOBBYING ACTIVITIES ☐ INTERNATIONAL COOPERATIVE ACTIVITY:
☐ BEGINNING INVESTIGATOR (See GPG SECTION I)
☐ GROUP PROPOSAL
☐ SMALL GRANT FOR EXPLORATORY RESEARCH (SGER) (SEE GPG SECTION II. C. 12) Country/countries

PI/PD DEPARTMENT
Physics

PI/PD POSTAL ADDRESS
Department of Physics and Astronomy
Youngstown State University
Youngstown, OH 44555

PI/PD FAX NUMBER
(216) 742-3121

NAMES (TYPED)	Social Security No.*	High Degree, Yr	Telephone Number	Electronic Mail Address
PI/PD NAME Sturrus, William G.	300-54-5385	PhD/1988	(216) 742-3616	FR199101@YSUB.YSU.EDU
CO-PI/PD Hanzely, Stephen	521-52-6747	PhD/1969	(216) 742-3616	FR080201@YSUB.YSU.EDU
CO-PI/PD				
CO-PI/PD				
CO-PI/PD				

NOTE: THE FULLY SIGNED CERTIFICATION PAGE MUST BE SUBMITTED IMMEDIATELY FOLLOWING THIS COVER SHEET.

*SUBMISSION OF SOCIAL SECURITY NUMBERS IS VOLUNTARY AND WILL NOT AFFECT THE ORGANIZATION'S ELIGIBILITY FOR AN AWARD. HOWEVER, THEY ARE AN INTEGRAL PART OF THE NSF INFORMATION SYSTEM AND ASSIST IN PROCESSING THE PROPOSAL. SSN SOLICITED UNDER NSF ACT OF 1950, AS AMENDED.

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 William G. Sturrus	William G. Sturrus	July 24, 1995
Co-PI/PD Stephen Hanzély	Stephen Hanzély	July 24, 1995
Co-PI/PD		
Co-PI/PD		
Co-PI/PD		

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 statue, debarment and suspension, drugfree workplace, and lobbying activities (see below), as set forth in the Grant Proposal Guide (GPG), NSF 94-2. 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___

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___

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
NAME/TITLE (TYPED)		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

Curriculum Vitae

Stephen Hanzély

Professor of Physics and Astronomy
and
Director of Faculty Relations

Youngstown State University
Youngstown, OH 44555

Education

B.S., Kent State University, 1962
M.S., The University of Toledo, 1964
M.S., New Mexico State University, 1967
Ph.D., New Mexico State University, 1969

Academic Experience

Member of the faculty of the Department of Physics and Astronomy at Youngstown State University since September, 1968.
Chair, Department of Physics and Astronomy, July 1974-September 1979
Appointed to newly-created position of Director of Faculty Relations, April 1993

Publications

"An X-Ray View of the Valence Bands in Nickel, Cobalt and Iron," S. Hanzély and R.J. Liefeld in Bulletin of the American Physical Society, Series II, **13**, 575 (1969).

"X-Ray Spectrometric Properties of Potassium Acid Phthalate Crystals," R.J. Liefeld, S. Hanzély, T.B. Kirby and D. Mott in Advances in X-Ray Analysis, **13**, 373 (1970).

"An L-Series X-Ray Spectroscopic Study of the Valence Bands in Fe, Co, Ni, Cu and Zn," S. Hanzély and R.J. Liefeld in Proceedings of the 3rd IMR Symposium, *Density of States*, National Bureau of Standards (U.S.), Spec. Pub. 232 (1970).

"Optimization of Storage Size for Solar Water Heating," S. Hanzély and J. Taft in Proceedings of the 12th Annual Pittsburgh Conference on Modeling and Simulation, University of Pittsburgh, April 30-May 1, 1981.

"The Physics of the Drive in Golf," W.M. MacDonald and S. Hanzély, American Journal of Physics, **59**, 213-218 (1991); selected for inclusion in *The Physics Teacher's CD-ROM Toolkit*, an NSF-supported project sponsored by the American Association of Physics Teachers (AAPT).

Papers Presented

"Valence Band X-Ray Spectroscopy at Threshold Excitation," Ohio Section-American Physical Society, Fall 1970.

"Some K, L and M Series Excitation of Atoms in Metals by Electrons of Threshold Energy," International Conference on Inner Shell Ionization Phenomena, Atlanta, Ga., April 1972.

"Physics Olympics Competitions in Northeastern Ohio," S. Hanzély and K. Crowley, Winter Meeting of AAPT, Chicago, Il., January 1980.

Papers Presented (continued)

"The Physics of Sports," Fall 1990 meeting of the Ohio section of the AAPT, Lakeland Community College.

Grants Received

National Science Foundation, Pre-College Teacher Development in Science Programs, Grant #SPI-7902061, Summer 1979

National Science Foundation, Pre-College Teacher Development in Science Program, Grant #SPI-8000067, Summer 1980

American Association for Higher Education (AAHE), to fund the activities of the Youngstown Area school/college alliance project for 1991-92

Martha Holden Jennings Foundation, to fund the activities of the Youngstown Area school/college alliance project for 1992-93, 1993-94, and 1994-95

Ohio Department of Education, equipment and training grant to improve the skills of high school science teachers, 1993-94, matched by additional grant from Martha Holden Jennings Foundation

Awards Received

Awarded 1994-95 J. William Fulbright Foreign Scholarship award; spent September-December 1994 lecturing at the University of Chemical Industry in Veszprem, Hungary; shared experience with using microcomputers in undergraduate physics education

Selected to participate in the American Association for the Advancement of Science-NSF College Teacher Short Course on Alternate Energy Technologies

Selected to participate in the AAAS-NSF College Teacher Short Course on Food, Energy and Society, 1979-80

YSU Distinguished Professor, 1981 (10 selected from a faculty of 400)

Faculty Service Award, YSU Chapter-Ohio Educational Association, 1983

YSU Centurians' Outstanding Professor, 1984-85

Recipient of a one-year sabbatical leave to study the use of microcomputers in introductory physics courses. Spent the 1988-89 academic year at the University of Maryland, College Park, as a member of the MUPPET group and one week at Dickinson College observing "Workshop Physics."

YSU Distinguished Professor in Teaching, 1990 (5 selected from a faculty of 400)

Other Current or Recent Professional Activities

President, YSU Chapter of the Ohio Education Association, 1985-87

Coordinator, Annual YSU Physics Olympics Competition for high school students since 1979

Coordinator, Annual Northeastern Ohio Education Association Professional Day program for pre-college teachers of science

Instructor of Physics segment for Governor's Summer Institute for Gifted and Talented High School Students, Summer 1986, 1987, 1990, 1991

Member of the review panel for *Thought and Action*, the biannual journal of higher education of the National Education Association, 1988-91

Other Activities (continued)

Served on NSF's review panel to review grant proposals on laboratory instrumentation, January 1990

Initiated a "YSU's Mr. Wizard" program for the public in 1987. It has been presented annually since then to both public and school groups. Member of the YSU contingent to the regional task force on the state-wide PROJECT DISCOVERY to improve the quality of science teaching at the middle- and high-school levels in Ohio

Co-director of a school/college alliance project for Youngstown-area physical science teachers since 1987. These "Sharing Sessions" are held monthly during the school year and alternate between YSU and a local high school.

Professional Memberships

American Physical Society - Life Member

American Association of Physics Teachers

National Education Association, Ohio Education Association and the YSU Chapter of the Ohio Education Association

Sigma Xi - Life Member and twice treasurer of the YSU Chapter of Sigma Xi

Miscellaneous

Faculty advisor to the YSU Soccer Club from 1989 to 1991

Helped establish the YSU Recycling Program and continue to serve as a member of the University's ad-hoc recycling committee

Treasurer, Board of Directors of the Refugee Resettlement Home operated by the Hungarian Presbyterian Church of Youngstown, Ohio

Personal

Born on December 30, 1940 in Sátoraljaújhely, Hungary

Unites States Citizen

Height: 5'10" (178 cm) Weight: 175 lbs (80 kg)

Health: Excellent

Married (happily!) and father of two daughters

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.

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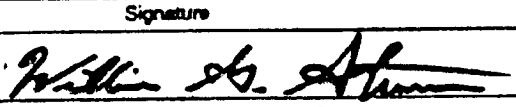
Name (Typed)	Signature	Date
PI/PD William G. Sturrus		11/10/94
Co-PI/PD William R. Cochran		11/10/94
Co-PI/PD		
Co-PI/PD		
Co-PI/PD		

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AUTHORIZED INSTITUTIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME/TITLE (TYPED)		

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PI/PD		
Co-PI/PD		
Co-PI/PD		
Co-PI/PD		
Co-PI/PD		

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AUTHORIZED INSTITUTIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME/TITLE (TYPED)		

TELEPHONE NUMBER	ELECTRONIC MAIL ADDRESS	FAX NUMBER

INFORMATION ABOUT PRINCIPAL INVESTIGATORS/PROJECT DIRECTORS

Submit only ONE copy of this form with your proposal. Attach it on top of the cover page of the copy of your proposal that bears the original signatures. Leave the back of the page blank. *Do not include this form with any of the other copies of your proposal, as this may compromise the confidentiality of the information.*

Please check the appropriate answers to each question for all principal investigator(s)/project director(s) listed on the cover page, using the same order in which they were listed there:

	Principal Investigator/ Project Director	First Additional PI/PD	Second Additional PI/PD	Third Additional PI/PD	Fourth Additional PI/PD
1. Is this person					
Female	☐	☐	☐	☐	☐
Male	☒	☒	☐	☐	☐
2. Is this person a					
U.S. Citizen	☒	☒	☐	☐	☐
Permanent Resident	☐	☐	☐	☐	☐
Other non-U.S. Citizen	☐	☐	☐	☐	☐
3. Which one of these categories best describes this person's ethnic/racial status? (If more than one category applies, use the category that most closely reflects the person's recognition in the community.)					
American Indian or Alaskan Native	☐	☐	☐	☐	☐
Asian	☐	☐	☐	☐	☐
Black, not of Hispanic Origin	☐	☐	☐	☐	☐
Hispanic	☐	☐	☐	☐	☐
Pacific Islander	☐	☐	☐	☐	☐
White, not of Hispanic Origin	☒	☒	☐	☐	☐
4. Does this person have a disability* which limits a major life activity?					
Yes	☐	☐	☐	☐	☐
No	☒	☒	☐	☐	☐
Check here if this person does not wish to provide some or all of the above information	☐	☐	☐	☐	☐
Required: Check here if this person is currently serving (or has previously served) as PI, Co-PI or PD on any Federally funded project.	☐	☐	☐	☐	☐

AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America and who maintains cultural identification through tribal affiliation or community recognition.

ASIAN: A person having origins in any of the original peoples of East Asia, Southeast Asia or the Indian subcontinent. This area includes, for example, China, India, Indonesia, Japan, Korea and Vietnam.

BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa.

HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

PACIFIC ISLANDER: A person having origins in any of the original peoples of Hawaii; the U.S. Pacific territories of Guam, American Samoa, and the Northern Marinas; the U.S. Trust Territory of Palau; the islands of Micronesia and Melanesia; or the Philippines.

WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa, or the Middle East.

*Disabled: A person having a physical or mental impairment that substantially limits one or more major life activities; who has a record of such impairment; or who is regarded as having such impairment.

WHY THIS INFORMATION IS BEING REQUESTED:

The Federal Government has a continuing commitment to monitor the operation of its review and award processes to identify and address any inequities based on gender, race, ethnicity, or disability of the proposed principal investigators/project directors and co-principal investigators. To gather the information needed for this important task, you should submit a single copy of this form with each proposal; however, submission of the requested information is not mandatory and is not a precondition of award. Any individual not wishing to submit the information should check the box provided for this purpose. (The exception is information about previous Federal support, the last question above.)

Information from this form will be retained by Federal agencies as an integral part of their Privacy Act Systems of Records in accordance with the Privacy Act of 1974. These are confidential files accessible only to appropriate Federal agency personnel and will be treated as confidential to the extent permitted by law. Data submitted will be used in accordance with criteria established by the respective Federal agency for awarding grants for research and education, and in response to Public Law 99-383 and 42 USC 1885c.

APPENDIX I

NATIONAL SCIENCE FOUNDATION
Division of Undergraduate Education

PROJECT DATA FORM

The instructions and codes to be used in completing this form begin on the next page.

1. Program to which the Proposal is Submitted: ILI-IP

2. Type of Submission: PR

3. Name of Principal Investigator/Project Director (as shown on the Cover Sheet):
William G. Sturrus, William R. Cochran

4. Name of Submitting Institution (as shown on the Cover Sheet)
Youngstown State University

5. Other institutions involved in the project's operation:
None

PROJECT CODES

A. Major Discipline Code: 13 Subfields: General & Introductory

B. Academic Focus Level of Project: LD

C. Highest Degree Code: D

D. Category Code: — —

E. Business/Industry Participation Code: — —

F. Audience Code: — — — —

G. Institution Code: PUBL — —

H. Environmental Education Code: — —

J. Estimated Number of Undergraduate Students to be Directly Affected by the Activities of the Project During its Operation: 1,000

K. Estimated Number of Pre-college Students to be Directly Affected by the Activities of the Project During its Operation: _____

L. Estimated Number of College Faculty to be Directly Affected by the Activities of the Project During its Operation: 10

M. Estimated Number of Pre-college Teachers to be Directly Affected by the Activities of the Project During its Operation: 20

N. Total Non-NSF Contribution: $25,037

Project Summary:

The Project Summary should be a concise description of the project limited to 22 lines of 12-point (standard pica type) or larger font on plain white paper.

PROJECT SUMMARY

Traditional introductory physics laboratories require the student to take specified data and perform specified calculations. While this is an efficient method for introducing large numbers of students to science in the brief time allotted to laboratory study each week, it omits important aspects of scientific research, including preliminary analysis of a problem, design of methods for probing the problem, group interaction and discipline, and discovery by the student. It is planned to restructure the mechanics laboratory, the first in a three-course laboratory sequence for beginning students. The current nine traditional experiments will be replaced by three, each focusing on one of the three fundamental approaches to mechanics: force and motion, energy, and momentum. Each experiment will continue over a period of three weeks, during which students will target their own conceptions of the topic through an initial computer-assisted assessment, will then decide how best to test their conceptions using portable data collection hardware outside of the idealized classroom setting, will perform their tests using subjects and environments familiar from everyday experience, and report back to the laboratory to analyze results and repeat the assessment of their conceptions, comparing initial conceptions with final conclusions. Such student-initiated comparisons, coupled with evaluations of corresponding performance in lecture courses, will provide a basis for examining the effectiveness of the approach. While students will work in groups of three, interaction among groups will be facilitated using data from one group to challenge the others to provide interpretations. This new remote-interactive approach to the beginning laboratory is designed to produce meaningful thought by the student rather than learning by rote, and is expected to increase student understanding of basic physics as well as produce in the student a better appreciation both of physics in particular and the scientific approach in general.

ILI-IP DETAILED BUDGET

Item	How Many	Unit Price (List)	Unit Price (Discounted)	Total Cost (Discounted)
A. Scientific Equipment				
(1) Calculator-Based Laboratory Module with power adapter (TI-9201)	17	200	200	3,400
(2) TI-85 Calculators	17	119	119	2,023
(3) TI-Graph Link	17	55	55	935
(4) Motion Detector (Vernier MD-CBL)	17	94	94	1,598
(5) Student Force Sensor (Vernier SFS-DIN)	17	99	99	1,683
(6) Accelerometer (Vernier ACC-DIN)	17	99	99	1,683
(7) Adaptor CBL-DIN for sensors SFS-DIN and ACC-DIN	34	5	5	170
			subtotal	11,492
B. Computing Equipment				
(1) Personal Computers (Gateway P5-90XL)	8	3,699 3025	3,699	29,592 24,200
(2) Printer (HP-4P)	1	999	999	999
(3) Graphic Analysis Software GA-IBM with site license	1	50	50	50
(4) Personal Computer (Gateway DX2-50 Powerbook)	1	2,299 2733	2,299	2,299 2733
(5) Computer Projection System (Proxima Ovation model 820)	1	5,120	5,120	5,120
			subtotal	38,060 33,10
C. Shipping and Insurance				523
			Total Project Cost: 50,075	45,117

Rich DeLisio
3167

Non-NSF contribution
(including any overmatch): 25,038

NSF request: 25,037

TABLE OF CONTENTS

NARRATIVE

THE CURRENT SITUATION

The Institution

Youngstown State University is an urban state-assisted university located in Youngstown, Ohio, approximately halfway between Cleveland and Pittsburgh. Established in 1908 as a private college, it became part of the Ohio state system in 1967. Since that time programs and enrollment have steadily expanded, and the University now serves more than 17,000 students. It is primarily an undergraduate institution, comprised of eight colleges providing programs which lead to bachelor degrees in arts and science, engineering, education, business, fine arts, and applied science and technology. It also offers a program leading to the MD degree through the Northeast Ohio Universities College of Medicine, a consortium of Youngstown, Akron, and Kent State universities. The University is on the quarter system and is accredited by the North Central Association of College and Secondary Schools. A recently-instituted University Scholarship program and expansion of dormitories is changing the character of what has been a commuter campus. The administration has committed itself to producing a fully electronically-integrated campus within the next few years. This ambitious program, "The Electronic Campus" is "a bold initiative to move the University into the information age of the 21st century"[8].

The Department of Physics and Astronomy

The Department of Physics and Astronomy is one of 16 departments within the College of Arts and Sciences. Curricula are offered which lead to the degrees of Bachelor of Science and Bachelor of Arts with a major in physics, and to a Bachelor of Science degree with a combined major in physics and astronomy. The department has nine faculty, eight of whom

possess the doctorate degree. There is a strong commitment to rigorous course work, an active program of undergraduate research participation, and a high degree of community service activity. The regional Physics Alliance provides interaction between high school and university faculty, a Governor's Institute summer program for gifted high school students is hosted regularly, and the department helps organize and participates in two major regional science fairs. Faculty members participate in the National Council of Undergraduate Research and Project Kaleidoscope. The department houses a 150-seat planetarium which is used both for instruction and for public shows. Most of our courses serve a range of other programs within the university, and while we generally graduate only two or three majors a year, most continue on to advanced degrees. Undergraduates participate in faculty research, and currently there are students working on diode laser frequency stabilization, nitrogen laser construction, and atomic beam line assembly and design for laser spectroscopy studies.

Three parallel course sequences of introductory physics are offered at the freshman-sophomore level, one for majors in applied sciences and technology, one for physics, engineering and other science majors, and one for students in pre-medical curricula. A single separate sequence of three laboratory courses is offered to parallel the three lecture sequences. While the yearly enrollment in the lecture sequences is approximately 1200 students, not all lecture students are required by their majors to take all three laboratory courses, so the yearly laboratory enrollment is about 400.

The Curricular Deficiency

The three laboratory courses paralleling the introductory lecture sequences are traditional in structure; in the ten-week academic term nine experiments are performed following steps

specified in the student manual, which was developed here. Each lab contains eight work stations, three students working as a group at each station. The apparatus is traditional, much of it built in the department; no computers are used. Once the data are acquired either each student or each group of three students, at the option of the instructor, is responsible for writing a report which must be submitted for grading the following week. While this traditional approach has served generations of physics students reasonably well, our experience and recent pedagogic research[1-5] suggest these weaknesses: (1) The methods of research are not reflected in the current laboratories. The current approach was developed partly to facilitate processing a large number of students within a scheduling structure practicable for a large and diverse university. Even emphasis on the traditional laboratory report has recently been questioned in respected quarters as being "pedagogically dubious"[7]. We believe the laboratories can be restructured to introduce the student more effectively to the true nature of research: study and familiarize oneself with the problem, formulate a possible model to represent the problem, design and perform a test of the model, and analyze the results. The current laboratory approach removes much of the initial study and all of the design. We believe if a student is forced to decide how best to test a model or prediction, that student will of necessity recognize the meaning behind the procedure. The critical question for the science student should not be "What do you know?" but rather "How do you know what you know?"[1]. (2) The approach encourages learning-by-rote, the element of discovery is missing. Most of the students in these courses are not physics majors, but are required to be there. The current laboratory approach permits the student to obtain a passing grade by doing *specified* observations and completing *specified* calculations. Getting students to think about science is a challenge not met by the

current laboratories. (3) There is validity to the criticism that traditional physics courses attempt to teach too much[6]. We have come to believe that while introducing nine separate experiments in ten weeks is useful in connecting lecture presentations to real processes, the central content of the subject can become obscured by too many applications. A discovery-oriented approach would better forestall some of the more common misconceptions of the beginning student. (4) Recent changes in engineering pedagogy have mandated increased emphasis on design throughout the engineering curriculum. Since many of our students are engineering majors, incorporating the design concept into the introductory laboratories would not only parallel the mandated changes in engineering but would serve to justify better the physics requirement in the minds of the students. The current laboratories do not take advantage of this opportunity. The student is hard pressed to complete the required set of measurements in the allotted time, let alone decide what measurements to take and then design a way to take them.

Recent developments at Youngstown State University provide an opportunity to address these shortcomings. The Electronic Campus will "establish YSU as the premier electronically-integrated, state-assisted, metropolitan university in Ohio and in the nation"[8]. While full implementation is not expected for several years, the intra-campus cables are to be laid next year. The plan includes establishment of a generic computer lab within the science building (shared by Physics, Biology, and Chemistry), but no plans are included to fund laboratories dedicated to one discipline. Anticipated heavy scheduling of the computer lab will preclude its use for individual experimental work.

THE DEVELOPMENT PLAN

The Approach

The plan will maintain the existing lecture-laboratory format in which four hours of lecture per week parallel a three-hour laboratory. In reviewing various attempts described in the literature to revise physics instruction, it became apparent that approaches that work well in some college environments are inapplicable in others. At institutions such as Youngstown State a complete transition to a workshop-type approach, for example, would not be possible because of the demands of other departments, some in colleges other than Arts and Sciences, whose majors take our courses; even the practical necessities of uniform scheduling across disciplines precludes radical departures from the traditional lecture setting. In addition it must be recognized that many students do gain understanding in the traditional lecture format. What we propose is a compromise between radical change and traditional inertia.

The plan will restructure the first quarter of the three-quarter introductory laboratory sequence, corresponding to the first lecture course of the sequence, mechanics. The concepts of mechanics are ideally suited to the remote-interaction approach. The other two quarters of the sequence are not as well suited for this approach. *The current nine experiments will be replaced by three, each of the three emphasizing one of the three basic approaches to mechanics* as developed in lecture: Newton's laws of motion, momentum, and energy. Three weeks will be spent on each experiment, the first on establishing and examining the problem using interactive software and becoming familiar with the equipment, the second on designing and implementing tests of hypotheses to explain the problem, and the third on analysis of the results, including a rigorous examination of the consequences of the uncertainties inherent in the methods

chosen for testing. Eight work stations will be established, each consisting of a personal computer and commercial hardware, the Calculator Based Laboratory (CBL) developed by Texas Instruments and the Vernier Software Company. The CBL used in conjunction with the PC facilitates precisely those aspects of the laboratory which are so clearly missing in the traditional approach, interactive group participation and design. The CBL consists of a portable sensor which can monitor motion, force, and acceleration and then interface with a portable calculator to store the data. The data can then be sent to the PC, and the Electronic Campus used to link these data with both data obtained by others and with analytical software. Because of the portability of the CBL the data collection can be done *outside* of the laboratory setting; the second scheduled class meeting will be used for consultation with the instructor who must approve of the student-designed experiment. In addition, each group will be assigned a particular project from a list for which they are to acquire data, each group's project not being divulged to the other groups. In the third laboratory session not only will each group analyze its results using statistical and spreadsheet software, but will be required to determine which projects from the list were assigned to other groups, based on the data presented.

The Advantages

(1) The approach more closely mirrors the methods of research by allowing time for preliminary analysis of the problem and by requiring the student to decide how best to investigate the problem experimentally. (2) Learning by rote is eliminated, the student is forced to think about what is going on, rather than finish and leave as soon as specified data are obtained. (3) The fundamentals of scientific investigation become highlighted. No student could complete such a course without being aware of the three basic approaches to mechanics. (4) The

introduction of design into the experiments serves the needs of the engineering curriculum as well as makes the relevance of the work more apparent to engineering students, who constitute the majority in these classes. (5) The advantages of the traditional lecture, both pedagogical and administrative, are retained. (6) The student is introduced to modern methods of data collection and analysis without obscuring physical processes by technology. (7) The curriculum changes can be accomplished without disruption to other programs or conventional scheduling. (8) The amount of clerical work by both student and instructor is reduced. Nine reports are reduced to three. We are not willing to concede that the traditional report is without pedagogical value, but the common student complaint that the laboratory requires more time than is justified by the academic credit received is not without merit. (9) The approach requires a group effort by the students, both in the laboratory setting and outside; the teamwork of research becomes recognized.

Specifics

The laboratory work in the ten-week academic term is to be distributed as follows:

Week 1, Introduction: Use of the CBL; familiarization with sensors, data storage, and computer software; simple examples of equipment use to convince students of equipment functions.

Week 2, Force and Motion I: Conceptual assessment of student groups. Interactive software (to be developed by the Principal Investigators; see below) will be used by each group of three students to determine their understanding of the concepts of kinematics and dynamics. Simple questions will direct the group to areas of investigation which are least understood; design of tests initiated in

consultation with instructor. Groups are assigned "secret" projects.

Week 3, Force and Motion II: Between Week 2 and Week 3 the students will have been implementing the preliminary tests designed in Week 2. During the laboratory meeting of Week 3 a written plan will be submitted, which will include trial data, sampling rates, and preliminary analysis. The need for further testing and changes in design will be considered in consultation with the instructor.

Week 4, Force and Motion III: Testing revisions implemented, final group report prepared and submitted. Students will repeat the conceptual assessment given in Week 2 and the results of the two assessments compared. Class participation to determine which group had which "secret" project.

Weeks 5 - 7 and Weeks 8 - 10: Weeks 5 - 7 and 8 - 10 will follow the same development schedule as Weeks 2-4, Weeks 5 - 7 implementing studies of energy and energy conservation, and Weeks 8 - 10 implementing studies of momentum and collisions.

The Conceptual Assessment:

Software will be developed to probe student understanding of basic concepts through three types of questions: intuitive, graphical, and quantitative (see Appendix 3). Topics to be probed will target the common misconceptions well documented in the literature.

EQUIPMENT

The Equipment Request

The number of items requested for each workstation is based on the need for two laboratory sections per quarter and the desired flexibility to be provided. A single work station

will require a personal computer, a TI Graph Link to load data onto the computer, a calculator for remote data storage, a Computer Based Laboratory module to take data, a set of three transducers (force, motion, and acceleration with adapters), and the Graphic Analysis software to manipulate the data.

The portable equipment must be duplicated for each lab section. This means each personal computer is used for two sets of transducers and data collection devices. Since the CBL hardware is relatively new, a minor software addition will need to be developed by the Principle Investigators to translate the Graph Link data files (in serial format) into usable (column format) files for the Graphic Analysis software.

The motivation for choosing the CBL hardware for the project is one of portability. The CBL system is unique in its ability to allow students to take an experiment into what they consider the real world. Students will be encouraged to use familiar objects as subjects of their experiments. We expect the results of these experiments to challenge the students with the subtleties found in the non-idealized world. Other systems could be chosen for this project, such as the PC-ULI-transducer system available from Vernier Software, but such systems are bulky and not designed to be portable. A physics laboratory featuring portability is ideal at YSU for two reasons. (1) Many of the students in our courses already possess TI-85 graphing calculators (required in the calculus course sequence). As a consequence, many of the students in the lab are familiar with the operation of the calculators. Also, possession of multiple calculators will allow the students to acquire more data before requiring downloading to the PC. (2) The future convenient access on the fiber optic network will allow students with home PC's to take data at a remote location and analyze and refine their procedures on location. Proficient use of remote

student access to both the computers and the faculty member will result in a substantial time savings for the student.

The equipment request includes one portable setup with sufficient display capabilities to instruct the entire class in the use of the software. We can realistically expect a large number students to become proficient in the use of computer software in a short time only if it is clearly presented to them. The Ovation projection system has adequate screen refresh rates and sufficient brightness for clear visibility throughout the laboratory.

The choice of performance level in the PC's was dictated in part by software considerations and in part by the design of the Electronic Campus. The software requires a 386 or higher level processor. Since the procurement and maintenance of 386 machines are becoming impracticable, it is necessary to consider a higher level machine. Use of the Pentium PC will allow full advantage to be taken of the Electronic Campus in the future; the design of the Electronic Campus is based in part on the use of the Pentium and anticipated successors.

Equipment on Hand for the Project

Laboratory equipment currently on hand, other than physical facilities such as tables, electrical connections, etc., is not designed to accomplish the goals of this project. Major holdings of the department are listed in Appendix 1.

Implementation and Equipment Maintenance

It is expected that released time from teaching will be granted to the Principal Investigators to implement the laboratory restructuring and to train other faculty. University technicians are available for hardware installation of computer laboratory equipment. A full-time machinist and shop are available to the department for mechanical repairs. Computers and other

electronic equipment are serviced by a university shop employing four technicians and a large inventory of parts. Equipment condition is continuously monitored by the laboratory instructors.

FACULTY EXPERTISE

The department faculty consists of seven full professors and one associate professor, each possessing the doctorate, and one assistant professor with a master's degree. All but one of the faculty (the chairman, whose background and expertise is in astronomy) are routinely assigned to teach the laboratory courses, have taught them for many years, and are well equipped to introduce the new method.

William Sturrus, one of the two Principal Investigators, has a research background in Atomic, Molecular and Optical Physics. He is currently pursuing studies, with undergraduate students, of Rydberg states of H_2 with a two-year grant from Research Corporation. He also collaborates with a group at Colorado State University. Several past research projects involved computer-apparatus interfacing. These projects required development of software in the FORTRAN, BASIC and C+ languages. Since joining the YSU faculty, he has participated in physics teaching workshops and the YSU Physics Alliance with area high schools.

William Cochran, the other Principal Investigator, joined the YSU faculty after obtaining the PhD in physics from UCLA in 1969. He introduced data acquisition and control in the upper division laboratories, built the required apparatus, and wrote the controlling software. He has taught courses in the introductory lecture and laboratory sequences since 1969. He designed the course sequence for the medical students, introduced it into the curriculum, and currently teaches it. During the past two years he has reorganized the freshman-sophomore laboratories and written the corresponding laboratory manuals. He also has had primary responsibility for

the upper division courses in Optics, Thermodynamics, Quantum Mechanics, and Statistical Mechanics, and serves as faculty advisor for the Society of Physics Students and Sigma Pi Sigma. He has attended recent workshops in teaching and electro-optics at Lawrence University and Argonne National Laboratories, and has participated in Project Kaleidoscope. He has also received the University Distinguished Teaching Award.

DISSEMINATION AND EVALUATION

Tentative plans include presentation of an assessment of the results in two years to the Ohio Section of the American Physical Society and the American Association of Physics Teachers. A part of this assessment will include a student evaluation which compares the new approach to the old approach. Many of our students take all three quarters of the lab sequence, and so participate in both approaches. In addition, the regional Physics Alliance will be used to introduce the new methods to high school instructors.

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7. Ferdinand V. Coroniti, Chairman, Department of Physics & Astronomy, UCLA, in open letter to alumni, October 1994.

8. *The Electronic Campus*, Youngstown State University, July 1994.

BIOGRAPHICAL SKETCHES

William G. Sturrus:

1961:Born, Grand Rapids, Michigan
1983:B.S., Hope College, Holland, Michigan
1988:Ph.D., University of Notre Dame, Notre Dame, Indiana

Positions Held:

1982-3:Teaching Assistant, Physics Department, Hope College
1983-8:Research Assistant, Department of Physics, University of Notre Dame
1988-91:Postdoctoral Research Associate, Department of Physics, University of Virginia
1992:Visiting Assistant Professor, Department of Physics, University of Notre Dame
1993:Visiting Assistant Professor, Department of Physics, Colorado State University
1991-4:Assistant Professor, Department of Physics & Astronomy, YSU
1994- :Associte Professor, Department of Physics & Astronomy, YSU

Publications:

W.G. Sturrus, P.E. Sobol, and S.R. Lundeen, *Observation of High-angular-momentum Rydberg states of H_2 in a fast beam*, Physical Review Letters **54**, 792 (1985).

W.G. Sturrus, E.A. Hessels, and S.R. Lundeen, *High-resolution microwave spectroscopy of the 10G-10H Rydberg transition in H_2*, Physical Review Letters **57**, 1863 (1986).

E.A. Hessels, W.G. Sturrus, S.R. Lundeen, and David R. Cok, *Measurement of the magnetic fine structure of the 10G and 10H states of helium*, Physical Review A **35**, 4489 (1987).

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W.G. Sturrus, L.P. Ratliff, and D.J. Larson, *Polarization effects in two-colour two-photon detachment from Cl^-*, Journal of Physics B: Atomic, Molecular, and Optical Physics 25 (1992) L359-L365.

Memberships:

American Physical Society
Ohio Academy of Science
National Council of Undergraduate Research
ΣΞ Science Research Society

William R. Cochran:

1940: Born, Kalamazoo, Michigan
1962: B.A., University of California, Los Angeles
1964: M.S., University of California, Los Angeles
1969: Ph.D., University of California, Los Angeles

Positions Held:

1962:Research Physicist, North American Aviation, Downey, California
1962-3:Teaching Assistant, Physics Department, UCLA
1964-6:Research Assistant, Physics Department, UCLA
1967-8:Post-Graduate Research Physicist, Physics Department, UCLA
1968-9:Post-Graduate Research Engineer, Department of Electrical Engineering, UCLA
1969:National Science Foundation Traineeship, UCLA
1969-74:Assistant Professor, Department of Physics & Astronomy, YSU
1974-81:Associate Professor, Department of Physics & Astronomy, YSU
1981-:Professor, Department of Physics & Astronomy, YSU

Publications:

Gruber, J.B., Conway, J., Cochran, W. R., and Nicol, A. T., "Optical Spectra of Tri-postitive Curium-244 in $LaCl_3$", Journal of Chemical Physics 45, 1423 (1966)

Cochran, W. R., "Heterodyne Detection of Brillouin-Scattered Radiation from Solids at 10.6 Microns", Diss. Abs. Inter. 30, 5303-B (1970)

Forrester, A. T., Shelton, J. C., and Cochran, W. R., "Quantum Efficiency from Photomixing of Blackbody and Laser Radiation", Quantum Electronics Conference, Kyoto, Japan (1970)

Cochran, W. R., "Heterodyne Signal-to-Noise Ratios in Acoustic Mode Scattering Experiments", in: Heterodyne Systems and Technology, NASA, 1980, pp. 569-572

Cochran, W. R. (contributing author), The Optics Problem Solver, Research and Education Association, New York, 1982

Cochran, W. R., "Mirror Wall Tile and the Triple Reflector", American Journal of Physics 50, 765 (1982)

Cochran, W. R., "Application of a Commercial Data Acquisition System in the Undergraduate Laboratory", Proc. Conf. Computers in Physics Instruction, Raleigh, 1988

Cochran W. R., Introductory Physics Laboratory, YSU, 1992

Memberships:

American Physical Society
Optical Society of America
Sigma Pi Sigma

APPENDIX 2: COURSES AFFECTED

Physics 501. *Fundamentals of Physics 1.*
A study of the methods of analyzing motion of mechanical systems. The topics treated are kinematics, forces, energy and momentum, rotational kinematics, torque and angular momentum. Not recommended for mathematics, chemistry or physics majors or engineering students. Prereq.: MATH 512 and 520, or equivalent high school algebra and trigonometry. 4 q.h.

Frequency: 4 sections Fall quarter, 3 sections Winter quarter, 1 section Spring
Enrollment: Approximately 150 students per year.
Required of majors? No.

Physics 510. *General Physics 1.*
A course in mechanics; the kinematics and dynamics of masses in translation; Newton's Laws; the conservation laws of energy and momentum. Prereq.: High school physics or PHYS 501. Prereq. or concurrent: MATH 571. 4 q.h.

Frequency: 3 sections Fall quarter, 2 sections Winter quarter, 1 section Spring
Enrollment: Approximately 150 students per year.
Required of majors? Yes.

Physics 601. *General Physics for Applied Medical Studies 1.*
Kinematics and dynamics of translation and rotation; energy, momentum, equilibrium; elasticity and bulk properties of solids. This course is designed primarily for students enrolled in the NEOUCOM-YSU program, and for students enrolled in the pre-medical curricula. Prereq.: MATH 20, or equivalent high school trigonometry. Prereq. or concurrent: MATH 550 or 581H or 572. 4 q.h.

Frequency: 1 section Fall quarter.
Enrollment: 40 students
Required of majors? No.

Physics 510L. *General Physics Laboratory 1.*
Experimental work designed to supplement the General Physics sequence. Three hours per week. Prereq. or concurrent: 510 or 601. 1 q.h.

and

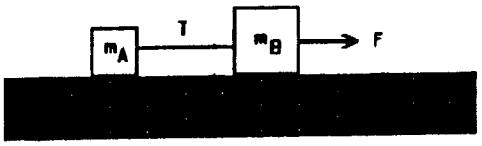
Physics 501L. *Fundamentals of Physics Laboratory 1.*
Experimental work designed to supplement the Fundamentals of Physics sequence. Two hours per week. Prereq. or concurrent: 501. 1 q.h.

Note: Physics 510L and Physics 501L are the same course; they are listed separately in the catalog for university bookkeeping purposes.

Frequency: 2 sections Fall quarter, 1 section Winter quarter, 1 section Spring
Enrollment: Approximately 100 students per year.
Required of Majors? Yes.

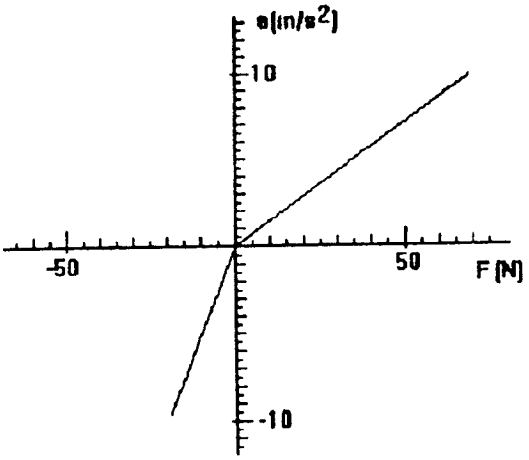
APPENDIX 3: EXAMPLE CONCEPTUAL ASSESSMENTS

(intuitive) 1. Two different masses, m_A=5kg and m_B=2kg are connected by a very long light cord and are placed on a very slippery surface. A horizontal force of magnitude F is applied to mass m_B as shown in the figure. The magnitude of the tension in the cord as the system moves under the action of the force is:



(a) equal to the magnitude of the force F applied to mass m_B.
(b) less than the magnitude of the force F applied to mass m_B.
(c) dependent on the size of mass m_A.
(d) a constant value independent of the magnitude of the force F applied to mass m_B.
(e) not described by any of these responses.

(graphical) 2. The response of the system above can be plotted on a graph of the horizontal acceleration a produced on mass m_B as a function of the horizontal force F applied to mass m_B. Such a graph is shown in the figure. Which of the following statements is true about the features of the graph?



(a) The slope of the upper line represents the total mass in the system.
(b) The slope of the upper line represents the tension in the cord.
(c) The kink in the graph at a=0 occurs when the cord becomes slack.
(d) The difference in slope of the upper and lower lines represents the total mass.
(e) None of these responses is correct.

(quantitative) 3. Which of the following statements is true concerning the system described above?
(a) The magnitude of the acceleration of mass m_A is less than that of mass m_B by T/m_B.
(b) The magnitude of the horizontal force exerted on mass m_A is equal to F-T, for positive values of **F**.
(c) The magnitude of the horizontal force exerted on mass m_B is equal to F+T, for negative values of **F**.
(d) The magnitude of the acceleration of mass m_A is equal to $(F-T)/m_B$, for positive values of **F**.
(e) None of these statements is correct.

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: William G. Sturrus

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] *Transfer of Support

Project/Proposal Title: Measurement of Interseries Mixings in Rydberg States of H_2

Source of Support: Research Corporation, Tucson, AZ

Award Amount (or Annual Rate): $ 38,053 Period Covered: 1994-96

Location of Project: Youngstown State University

Person-Months Committed to the Project. 7 Cal: Acad: Summ:

Support: [ ] Current [ ] Pending [ ] Submission Planned in Near Future [ ] *Transfer of Support

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $ Period Covered:

Location of Project:

Person-Months Committed to the Project. Cal: Acad: Summ:

Support: [ ] Current [ ] Pending [ ] Submission Planned in Near Future [ ] *Transfer of Support

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $ Period Covered:

Location of Project:

Person-Months Committed to the Project. Cal: Acad: Summ:

Support: [ ] Current [ ] Pending [ ] Submission Planned in Near Future [ ] *Transfer of Support

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $ Period Covered:

Location of Project:

Person-Months Committed to the Project. Cal: Acad: Summ:

Support: [ ] Current [ ] Pending [ ] Submission Planned in Near Future [ ] *Transfer of Support

Project/Proposal Title:

Source of Support:

Award Amount (or Annual Rate): $ Period Covered:

Location of Project:

Person-Months Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

APPENDIX 1: MAJOR EQUIPMENT

ITEM	MODEL	ACQ DATE	PRICE
24 Oscilloscopes	Various	1967-89	Various
High Vacuum Evaporator	CVC SC3000	1989	65,155
11 Microcomputers	Various	1980-93	Various
Blackbody Source	IR Industries	1985	4,308
2 Vibration Isolation Tables	Newport	1982,92	5,000
Vacuum Evaporator	Key KV-301	1985	9,400
Laser Power Meter	Coherent 2000	1986	2,270
Data Acquisition System	Keithley 570	1986	2,472
Interferometer	Ealing 25-9085	1990	2,748
Printer	Hewett Packard III	1992	1,737
Data Acquisition System	Keithley AMM2	1992	1,773
Spectrometer	Jarrell Ash 78466	1970	13,645
2 2000 Volt DC Power Supplies	Kepco 2000M	1992	2,000
Dual Ouput Power Supply	Lambda LQD421	1992	1,398
Planetarium Projector	Spitz	1967	19,000
2 Argon Lasers	Aero Tech 16P	1989	6,310
2 5" Spectrometers	Ealing 26-4481	1977	1,026
4 Free-Fall Apparatus	Cenco	1970-93	4,000
4 Coulomb's Law Apparatus	Pacific ES-9070	1993	3,280
2 KV Power Supplies	Pacific SF-9586	1993	1,100
E/M Apparatus	Sargent Welch	1994	4,000
CO_2 Spectrum Analyzer	Macken 16A	1994	2,662
Electrometer	610C	1987	2,971
Oscilloscope	Tektronix SC504	1979	2,058
X-Ray Apparatus	Teltron	1980	3,397
Gamma Ray Apparatus	Gem-18250	1983	7,960
Balance	Sartorius	1988	2,739
Scintillation Counter	WP-2000/1	1988	3,245
15 HeNe Lasers	Various	1985-94	Various
UHF Radiometer	Quasar	1987	2,885
Telescope, 8"	Celestron	1988	4,497
Telescope, 14"	Celestron	1988	12,841
Optical Table, Technical	Newport MST468	1992	2,580
Helium Dewar	Mossbauer 101DT	1969	3,450
XY Recorder	7035B	1983	2,175
Stroboscope	194A	1984	1,904
Preamplifier	Santa Barbara	1984	1,502
IR Detector	Santa Barbara	1984	1,957
Lock-In Amplifier	PAR HR8	1984	1,726
Polarizing Assembly	Gaertner	1985	4,137

REVISED ILI-IP DETAILED BUDGET

A. Scientific Equipment				
(1) Calculator-Based Laboratory Module with power adapter (TI-9201)	17	200	200	3,400
(2) TI-85 Calculators	17	105	105	1,785
(3) TI-Graph Link	17	55	55	935
(4) Motion Detector (Vernier MD-CBL)	17	89	89	1,513
(5) Student Force Sensor (Vernier SFS-DIN)	17	99	99	1,683
(6) Accelerometer (Vernier ACC-DIN)	17	89	89	1,513
(7) Adaptor CBL-DIN for sensors SFS-DIN and ACC-DIN	34	5	5	170
			subtotal	10,999
B. Computing Equipment				
(1) Personal Computers (Gateway P5-120)	8	3,025	3,025	24,200
(2) Printer (HP-5P)	1	821	821	821
(3) Graphic Analysis Software GA-IBM with site license	1	30	30	30
(4) Personal Computer (Gateway DX2-50 Liberty)	1	2,733	2,733	2,733
(5) Computer Projection System (Proxima Ovation model 820)	1	5,120	5,120	5,120
			subtotal	32,904
C. Shipping and Insurance				523

Total Project Cost:	44,426
Non-NSF contribution (including overmatch):	25,038
NSF request:	19,388

SUMMARY REVIEW

PROPOSAL NO: 9552374 INST: Youngstown St University PI: Sturrus

The goal of this project is to provide new remote-interactive approaches to traditional physics laboratories using calculator-based lab packages and eight master Pentium-based lab stations at a cost of $25,000. This program uses student initiated manipulation of experimental topics in mechanics to provide an inquiry based setting for individual investigation.

The panel agreed that the project was fun, innovative and offered a unique perspective to a traditional curriculum. Concensus noted that the Principal Investigators were competent and that the Institutioon was well prepared to support this effort. The equipment configuration selected was appropriate and consistent with existing technology and adequater thought had been given to maintenance and long term support.

It was also agreed that the evaluation section, assessment and dissemination plan were thin and required additional attention, but this deficiency was not seen as a major impediment to the project. One member of the panel had difficulty with justifying CBL type equipment. Another panel member was concerned with the PIs lack of direct training/experience with CBL curriculum and how this would impact implementation of the labs.

What could not be agrreed upon was the efficacy of the student initiated experiments, or how students would be 'guided' through the activities.

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OMB No.3145-0600
NSF Form 1 (5/90)

P R O P O S A L E V A L U A T I O N F O R M

PROPOSAL NO: 9552374 INSTITUTION: Youngstown St University
PRINCIPAL INVESTIGATOR: W. Sturrus
NSF PROGRAM: INSTRUMENTATION AND LABORATORY IMPROVEMENT 22PHY
TITLE: Restructuring the Physics Lab: A Remote Interactive Approach

Please evaluate this proposal, continuing on additional sheet(s) as necessary.

This proposal is somewhat unique in that it wants to take advantage of the University's commitment to "The Electronic Campus", and use it to transmit data to any point on the campus. This is a great idea, but it wouldn't be in place for another few years.

The department is fairly active with the local community, supporting science fairs and public education programs, and undoubtedly will share its modernized laboratory facilities with them.

The physics courses are mostly catered to the non-majors who are required to take the courses.

The proposal is requesting funding for the purchase of computers which will supplement the present laboratory exercises. The PIs want to make a compromise between a radical change and the traditional inertia by restructure only the 1st course in a sequence of three. The equipment being proposed is different, being that hand held calculators will be used to collect data which will then be transferred to a computer, which may eventually be accessible campus wide, via internet.

The project has not been field tested and the PI's don't appear to have a strong background in the type of program they are proposing.

The concept is good, however I cannot justifiably support it in its present form.

OVERALL RATING: Fair

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OMB No.3145-060C
NSF Form 1 (5/9C

PROPOSAL EVALUATION FORM

PROPOSAL NO: 9552374 INSTITUTION: Youngstown St University
PRINCIPAL INVESTIGATOR: W. Sturrus
NSF PROGRAM: INSTRUMENTATION AND LABORATORY IMPROVEMENT 22PHY
TITLE: Restructuring the Physics Lab: A Remote Interactive Approach

Please evaluate this proposal, continuing on additional sheet(s) as necessary.

This proposal advocates radical and exciting change to the introductory mechanics laboratory. The nine traditional labs will be replaced with three (three-week) explorations of key concepts in mechanics. The students will start each lab by making predictions. This will allow students to later confront their preconceptions. The students then test their conceptions by designing their own experiments using every-day experiences, which involve measurements facilitated by the MBL equipment. The students then analyze their data and compare their results with predictions.

This is a truly innovative project. The use of the computer-based laboratory probes allows the students to conduct their experiment at a baseball game, or at the amusement park. This will bring a spark of excitement into the collaborative learning groups. The mystery surrounding the projects of the other groups is also an important innovation. Arnold Aarons and Alan Van Heuvelen advocated the use of Jeopardy problems where students are given the answer and asked to create an appropriate question. In this project, the students know that group A has one of several possible projects, but which is it? Let's look at their graphs to find a clue. With this creative approach, the students are doing so much physics before they ever stop playing!

I feel that more attention needs to be paid to evaluation. Student evaluation is not enough. Indeed, you have a built-in evaluation as the students pre- and post-test in each lab through the questions addressing student misconceptions. This should have been identified as part of the research project.

This is a fun project. I strongly encourage funding.

OVERALL RATING: Very Good

National Science Foundation

OMB No.3145-0600
NSF Form 1 (5/90)

P R O P O S A L E V A L U A T I O N F O R M

PROPOSAL NO: 9552374 INSTITUTION: Youngstown St University
PRINCIPAL INVESTIGATOR: W. Sturrus
NSF PROGRAM: INSTRUMENTATION AND LABORATORY IMPROVEMENT 22PHY
TITLE: Restructuring the Physics Lab: A Remote Interactive Approach

Please evaluate this proposal, continuing on additional sheet(s) as necessary.

This proposal seeks $38,053 for a truly unique application of computers to lab-based courses. The proposed approach, called remote-interactive, will be taught in the traditional lecture/lab format, but is designed to stimulate students to interact with each other and think about physical principles. The proposed plan would call for a restructuring of the first quarter of the three-quarter introductory lab sequence; this would affect the mechanics lab.

The PIs outline a plan that should in fact be fun and foster group learning of physical principles. The traditional stationary lab will be replaced with portable instrumentation that will allow the student to study the principles of mechanics on "real-world" subjects -- outside the laboratory room. At the same time, they will learn about computer interfaces and computer data collection. Unlike some computer-based labs, however, the proposed lab will necessarily get the student involved with the physics.

The PIs are well qualified for implementation and the equipment requested is appropriate. The institution will also be able to support the instrumentation after installation.

The weakness of this proposal is in its lack of treatment of evaluation and dissemination. There is also no discussion of outreach to students from underrepresented groups. Finally, since the lab will be computer/calculator intensive, how will the student not proficient in their use be brought up to speed.

In summary, this is truly an innovative proposal that has the potential of adaptability at other institutions. It has the advantage over some computer based-labs in that the traditional lab format does not have to be dropped. This would have received a rating of excellent had the above omissions been addressed.

OVERALL RATING: Very Good

National Science Foundation

OMB No.3145-0600
NSF Form 1 (5/90

P R O P O S A L E V A L U A T I O N F O R M

PROPOSAL NO: 9552374 INSTITUTION: Youngstown St University
PRINCIPAL INVESTIGATOR: W. Sturrus
NSF PROGRAM: INSTRUMENTATION AND LABORATORY IMPROVEMENT 22PHY
TITLE: Restructuring the Physics Lab: A Remote Interactive Approach

Please evaluate this proposal, continuing on additional sheet(s) as necessary.

The goal of this project is to provide new remote-interactive approaches to traditional physics laboratories. This methodology employs student initiated manipulation of experimental variables for discovery experiences in the topics of mechanics. Each topic's investigation will extend over a three-week period as opposed to the traditional single laboratory session. This model will affect three parallel courses and their accompanying (but not required) laboratories. The laboratory enrollment is about 400 students per year.

The proposed project seeks to remedy deficiencies in research methods, move away from rote-learning type activities and "to uncover less to cover more" by narrowing the scope of the coursework. The proposed remediation is a dedicated physics science lab that will eventually be integrated with the planned "electronic campus."

The equipment configuration requested consists of a microcomputer, Computer Based Laboratory Module, TI Graph Links and Graphic Analysis software. The selected equipment is appropriate and consistent with the department's immediate needs and the University's long range plans. Equipment on hand does not support these activities.

While some might argue that CBL activities are hardly innovative, the approach suggested for applying and integrating these microbased experiences fits this criteria. This does not entirely compensate for the limitations of the dissemination and evaluation sections of the proposal.

There is no plan to present incremental progress of the project before the termination of the funding period. The dissemination is currently limited to regional and one national conference presentation. The PIs may wish to expand this part of the project to include electronic multimedia and Internet, World Wide Web and Gopher type networks and other large audience formats.

There is no evidence of an evaluation plan at this time. With the literature search completed, it seems reasonable that the Principal Investigators should be able to design an appropriate instrument or receive internal assistance for evaluation from their institution as part of the in-kind contribution.n-kind contribution.

OVERALL RATING: Excellent

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NATIONAL SCIENCE FOUNDATION

Based on NSF Form 1 (2/92)

PROPOSAL EVALUATION FORM

PROPOSAL NO.	INSTITUTION	PLEASE RETURN BY
95-52374	Youngstown State University	

PRINCIPAL INVESTIGATOR	NSF PROGRAM
Sturrus, William	ILI-IP

TITLE
Restructuring the Physics Lab: a Remote Interactive Approach

Please evaluate this proposal using the criteria presented on the back of this review form. Continue on additional sheet(s) as necessary.

This proposal seeks about $25,000 for 17 calculator-based laboratory packages and 8 master Pentium-based lab stations. The proposal cannot be faulted for lack of originality: it proposes a potentially interesting way of doing laboratories that I have never seen discussed before. If such a program were successful, I think that it would be of great interest to a number of other institutions. The PIs seem to be aware of what has been done with MBLs and seem competent to carry out the project. The PIs should be commended for recognizing that training of other teachers is a necessary part of the project.

There are certain aspects of the proposal that are problematic. I read the important central section on pages 7-8 several times and was still unable to understand how these labs would operate. The reviewing panel also spent quite a bit of time discussing the narrative before we were able to come to any kind of consensus on even the basic structure of the labs. This part of the narrative needs to be more carefully rewritten.

I was also unsure how students would be guided through the lab. I don't think that students will be able to design a meaningful experiment on their first exposure without some thoughtfully-designed guidance (preferably Socratic) that may need to be extensively worked out ahead of time. Is it going to be practical to work with the students this closely? It is probably important that an instructors guide is prepared to help future instructors appropriately guide students through the process.

A minor issue: I worried a bit about CBL equipment vanishing mysteriously in between labs: this would certainly be a problem to consider at my institution. What do the PIs plan to do to prevent this (or build in continuing funds for replacement)?

I also thought that the evaluation and dissemination sections could be made stronger. Particularly weak was the evaluation section: I think that much more specific evaluation tools should be designed to determine changes in student attitudes and abilities as a result of the program. The PIs should also think about other ways to disseminate information, including articles and using the Internet.

All in all, though, this was a refreshingly original proposal. The PIs should also be commended for saving trees by submitting a two-sided document.

OVERALL RATING: ☐ EXCELLENT ☐ VERY GOOD ☒ GOOD ☐ FAIR ☐ POOR

PRINCIPAL INVESTIGATOR COPY

National Science Foundation

OMB No.3145-060(
NSF Form 1 (5/9(

P R O P O S A L E V A L U A T I O N F O R M

PROPOSAL NO: 9552374 INSTITUTION: Youngstown St University
PRINCIPAL INVESTIGATOR: W. Sturrus
NSF PROGRAM: INSTRUMENTATION AND LABORATORY IMPROVEMENT 22PHY
TITLE: Restructuring the Physics Lab: A Remote Interactive Approach

Please evaluate this proposal, continuing on additional sheet(s) as necessary.

This is an interesting and, to the best of my knowledge, an innovative proposal. The one lab per week schedule places a very unnatural restriction on the process of science. Many other models have the same motivation and intent to allow students to "experience" physics. However, as the PI's point out the approaches previously validated may not be suitable for all campuses.

The goals, plan and (presumed) advantages are clearly and simply stated. Faculty expertise is sufficient to carry out the plan, and the requested equipment is adequately justified. The dissemination plan is adequate, but the assessment plan is insufficient despite the sample in the appendix. Baseline data for the first term should be taken, and the assessment questions need to focus in on effects attributable to the change in lab format.

OVERALL RATING: Very Good

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