Chapter 6
External Funding Sources and Extracurricular Programs

Over the last 50 years, academic offerings in the department have been greatly influenced by external funding sources, most often in the form of grants delegated for specific uses. A significant amount of faculty time and effort was expended in seeking funding sources, writing and rewriting grant proposals, implementing successful grant funding objectives and integrating outcomes into the ongoing activities of the department.

Grant funds usually supported department programs in four general areas.

A. Course content and teaching methods
B. Ancillary extracurricular academic programs
C. Instrument acquisition
D. Student scholarships/assistantships

Funding came primarily from four sources; federal agencies, private foundations, chemical industries and alumni contributions

The primary and most prominent source of external funding for the sciences is the National Science Foundation. Over the years the Chemistry Department has been very successful in the competitive process of submitting grant proposals in a variety of programs sponsored by NSF. Listed here are the names and acronyms as references to later entries in the text.

COSIP – College Science Involvement Program
URP – Undergraduate Research Participation
SOS – Student Orientated Studies
LOCI – Local Course Improvement
CAUSE – Comprehensive Assistance to Undergraduate Science Education
CSIP – College Science Instrumentation Program
PSPISME – Private Sector Partnerships to Improve Science and Mathematics Education
RUIE – Research in Undergraduate Institutions Equipment
ISEP – Instructional Scientific Equipment Program
MRI – Major Research Instrumentation

There are other federal agencies that offer grant support for higher education projects. The Chemistry Department has been a beneficiary over the years from the following sources.
National Atlantic Treaty Organization (NATO)
Atomic Energy Commission

Federal Office of Education
- Title VI grants
- SDIP – Strengthening Developing Institutions Program (Title III)
- AIDP – Advanced Institution Development Program (Title III)

Non-government foundations, mostly affiliated with chemical industries, and chemical corporations have also provided support to the Department. These include the following:

Pfizer Foundation
Merck Foundation
Dreyfus Fund
Dow Foundation
Dupont Corporation
Allied Chemical
Honeywell, Inc
Occidental Chemical Corporation
Union Carbide-Linde
Howard Hughes Foundation
Shell Foundation

In addition to these grants earmarked for the department, faculty were also awarded grants in support of individual research proposals from the following agencies.
National Science Foundation
National Institutes of Health
Sloan Foundation Fellowship Award
Research Corporation Cottrell Award
ACS – Petroleum Research Fund
Research Corporation

It appears that grant funding solicitation began in the middle 1950's at a time when the college began to hire a research faculty (Szymanski, Stanton, Conley). The table below lists grant funds awarded to the department and individual faculty in the time period of the late 1950's and the decade of the 1960's.

LIST A - Undergraduate Research

Grant Name	**Grant Number**	**Year**	**Amount**
	NSF-G-8305	1959	
	NSF-G-11, 889	1960	
Undergraduate Research Participation Program	NSF-G-15, 757	1961	$5,980
Undergraduate Research Participation Program	NSF-G-21, 776	1962	
	NSF-G-17, 977	1963	$6,200
Undergraduate Science Education Program	NSF-GE-4130	1964	$8,400
Undergraduate Research Participation Program	NSF-GY-988	1966	$5,600
Undergraduate Education in Science	NSF-GY-2805	1967	$6,800
	NSF-GY-5915	1969	

LIST B - Other Grants

Grant Name	Year	Author	Amount
Research Corporation	1956	H. A. Szymanski	
Research Corporation	1958	R. T. Conley	
N.S.F. Research Grant G - 7286	1959	R. Annino	
Petroleum Research Fund - A.C.S. 556-B5	1960	H. A. Szymanski	$2030?
Atomic Energy Commission Research Grant	1955-1962	H. A. Szymanski	
Petroleum Research Fund - A.C.S.	1962	R. Annino	
Public Health Service Grant	1960-1962	R. T. Conley	
Office of Ordinance Research	1960-1963	R. T. Conley	$9,696
N.S.F. Research Grant GL-3510	1960	R. Annino	
N.S.F. Matching Grant	1963	Staff	$1,369.01
DuPont College Aid Program	1963 and 1966		
United Health Fund of Buffalo Grant	1964	H. A. Szymanski	$600
N.S.F. Research Grant - GP-197	1965	R. Annino	
N.S.F. Matching Grant - GV	1966	Staff	
Petroleum Research Fund - A.C.S.	1966 and 1968	F. Dinan	
N.S.F. Matching Grant - GY-2366	1967	Staff	$6,800
NSF- Instructional Scientific Equipment Program Grant	1967	Staff	
N.S.F. Institutional Grant - GY-3737	1967		$7,500
Petroleum Research Fund - A.C.S.	1967	J. Bieron	$5,400
Petroleum Research Fund - A.C.S.	1968	J. Van Verth	
Higher Education Act Grant	1968	Staff	
Alfred P. Sloan Foundation Fellowship	1968	R. Stanton	
NSF-COSIP Grant (for development of Biochemistry)	1968		$143,700
Higher Education Act Grant - Title VI Equipment Grant	1968		
AEC- Nuclear Science Education Grant	1968		

Another source of information about the chemistry beginning in 1969 was a publication compiled by the College's archives.

Listings from *Datelines* J. Clayton Murray, S.J.

Rev. J. Clayton Murray , when he served as director of the Canisius College Archives compiled an historical retrospective of the first 125 years of the College. Time lines list

every noteworthy activity in chronological order. Given below are entries from this document of external grants that supported activities of the Chemistry Department., in the time period 1968 to 1989.

July 1st 1969 – The National Science Foundation made award of $122,900 to the Department of Bio-Chemistry for "college science improvement."

Summer 1970 – The National Science Foundation awarded the college a grant of $29,000 toward the purchase of a mini-computer to be used in the training of science undergraduates.

December 1971 – $5,022 awarded by National Science Foundation to the college "to help support science programs."

September 1976 – Among eighteen projects envisioned by the Advanced Institutional Development Program (AIDP) was a Student Development Project, designed to reduce the number of student failures due to difficulties in certain areas, such as reading, writing, mathematics and habits of study. Complementing this was a Faculty Advisor Program significantly advanced over the previous one, being aimed in a special way at the personal needs of incoming freshman. (Note: The PSI Method described later was one of the eighteen projects mentioned above)

October 1 1979 – A $380,000 grant for funding seven new academic and administrative programs became effective. The grant, administrated by the Federal Office of Education, is from the Strengthening Developing Institutions Program – SDIP.

May 1980 – $535,000 grant received from federal government to continue six academic and administrative programs begun the previous October, under the first phase of a three-year Strengthening Developing Institutions Program (SDIP) from the Federal Office of Education. This grant brings the amount received by the college for SDIP to $915,000. (Note: The Chemistry and Industry Program described later was one of these seven projects)

May 8 1981 – The National Science Foundation awarded a major grant to Dr. William F. Zapisek of $22,777.00 to continue research in recombinant DNA.

March 1984 – The Chemistry Department received one of only 34 grants presented by the DuPont Corporation to undergraduate institutions with outstanding records of sending students on to graduate study. The $7,000 unrestricted grant can be used to support any educational and research activities.

September 1984 – A $23,200 grant has been awarded to the chemistry department to encourage teaching introductory chemistry using team learning and case-study methods.

December 1986 – Canisius received a $200,000 grant from the Charles A. Dana Foundation to help students find jobs relating to their academic majors. Interested students are placed via a selection program directed by the office of Academic Affairs. Canisius was one of 10 liberal arts colleges receiving the grant, which requires Canisius to provide $400,000 in matching funds over 4 years. (Note: Chemistry/biocbemistry students were recipients of these grants for summer research projects).

March 1987 – Laboratory Equipment Assistance Program (LEAP) funded by Occidental Chemical Corporation to loan lab equipment to area high schools. The equipment is maintained by the college, and high school teachers are trained on its proper use before receiving it.

June 1988 – The National Science Foundation has granted $268,000 over the next four years to aid a Canisius-based program designed to upgrade Chemistry education in area

secondary schools. The Laboratory Equipment Assistance Program (LEAP) began during 1987-88 school year with $21,000 from Occidental Chemical Corporation.
November 1988 – The chemistry department has been recognized nationally in *The Journal of Chemical Education*. A survey of four-year, private liberal arts colleges without graduate programs in chemistry by the journal ranked Canisius fourth nationally in the number of graduates who have gone on to pursue Ph.D.'s, ninth nationally in the percentage of department faculty who have published scholarly research articles, 16th nationally in the dollar amount of research grants received from the National Science Foundation, Research Corporation and Petroleum Research Fund, and 18th nationally in the total number of scholarly articles published by the faculty.
March 1989 – A gift of approximately $60,000 worth of equipment for the enhancement of course work and the promotion of student research was made by the Occidental Chemical Corporation.

Department Archives

A similar listing but providing more details can be compiled from the Chemistry Department's internal file of annual repots., presented below.

1976-1977

Renovation of the analytical laboratory.

Upon receipt of a $98,500 grant last spring from the National Science Foundation under its CAUSE (Comprehensive Assistance to Undergraduate Science Education) program the Department undertook the complete remodeling of its third floor analytical laboratory.

Included in the project was the installation of a new stockroom which will supply both the analytical and physical chemistries laboratories, all new laboratory furniture based on the island concept, new fume hoods, the installation of new compressed air and hot water lines, and the purchase of several new analytical instruments. Notable among the latter are a Perkin-Elmer 460 Atomic Absorption Spectrophotometer, and a complete Parr electrochemical system.

Receipt of an NSF-LOCI grant.

In order to facilitate and improve the teaching of the Department's non-science major courses, Dr. Bieron conceived the idea of developing a series of teaching modules which could be used in a variety of courses by students of different degrees of sophistication. His grant proposal requesting funds for this idea was funded to the extent of $16,400 by NSF under its LOCI (Local Course Improvement). Dr. Bieron and Dr. Leone are devoting the present summer to the development of modules in forecasting, risk-benefit analysis, modeling, population growth,

1987-1978

i. The department was successful in obtaining a $6,800 matching fund "Title VI" grant from the U.S. Office of Education. The money from this grant has been used in part to purchase a new Beckman IR 4250 Infrared Spectrophotometer. This instrument, which is of research quality, will see heavy use in CHM 334, CHM 303, CHM 227-228, and in various research projects. The Title VI grant was written by Dr. Dinan.

1978-1979

Local Cause Improvement (LOCI) Grant

The LOCI grant which was funded by the National Science Foundation in the amount of $19,000 for the purpose of developing courses in the Chemistry Department, was continued under the directorship of Dr. J. Bieron. The development of both the Environmental Chemistry Course and the Senior Honors in Science Course were sponsored under this grant.
Also, a faculty workshop (25 participants) on the interdisciplinary topic, The Technological Imperative, as well as a faculty seminar series on Science and Society were offered under this grant.

1979-1980

SDIP – Industrial Chemistry Program

This program has been discussed under ”D”. It was funded by Title III in the amount of $60,000 for one year starting October 1979. SDIP – Industrial Chemistry Program
This is a second project proposal written by Dr. Joseph Bieron for SDIP funding requesting continued funding of the Industrial Chemistry Program. It was granted with a revised budget of $75,000 for the next two years.

Cottrell College Science Grant from Research Corporation (1980)

To Dr. Stanton in the amount of $10,800 for two years; also supporting two students for research on “PARTAN Approach to Convergence Problems in SCF Calculations”.

Research Corporation (1980)To Dr. Dinan in the amount of $10,800 in support of “An Investigation of Simplified Nucleoside Synthesis”.

1980-1981
PRF Grant Alkoxide ions

Linde Corporation $18,00 to purchase a Nova 830 Minicomputer for Dr. James Leone

(Fall ’82) The Department received a $32,000 research instrumentation grant from the National Science Foundation for the purchase of a Varian 3200 UV-Visible-IR Spectrophotometer. Approval of the grant was based on research proposals submitted by Fr. McCarthy and Dr. Schaber, and upon general departmental results. The grant was coordinated primarily by Dr. Bieron.

(Spring ’84) We received a $20,000 grant from the Dreyfus Foundation for the purchase of a Nicolet FT-IR Spectrophotometer. The grant proposal was written by Dr. Dinan. The Nicolet will be used both for its high resolution, high sensitivity properties, and more generally as a means of introducing our students to Fouier transform laboratory techniques. The Dreyfus decision to fund the Nicolet Purchase seems to have been based not only on the proposed instrument, but also upon statistics we supplied documenting our success in sending students on to graduate school.

(Spring ’84) We received an unrestricted $7,000 award from the DuPont Corporation. We will be applying this to the purchase of a $32,000 Perkin-Elmer Differential Scanning Calorimeter. Perkin-Elmer will make an additional $8,000 contribution towards the cost of this instrument. The calorimeter will become the centerpiece of the first semester physical chemistry laboratory course.

As in the case of the Dreyfus Award, our past success in sending students on for PhD’s was a major factor in helping is obtain DuPont support.

(Spring ’82) The Dow Foundation funded a four year, $5,000 per year scholarship with the stipulation that the Department award it to an outstanding incoming chemistry major who declares his intention to pursue a career in chemical research. In conjunction with the scholarship, Dow granted the Department an additional $1,000 per year to use as it sees fit.

(Summer ’84) The Dreyfus Foundation funded a $1,000 scholarship to be granted to an upcoming junior or senior chemistry major planning to go on for graduate research. Kodak subsequently matched this with an additional $1,000, which we will apply to student summer research.

NSF – ILI Industry/Environmental Analysis June 1, 1996 to May 31, 1998 Analytical Chemistry across the Curriculum, A Case Study Approach $46,130 to Dr.---------

NSF- ILI June 1994- May 1997. Improved NMR Teaching and Laboratory Capabilities $84,800
1997 Merck Foundation (Paula Dehn – co- author)

NSF – CSI College Science Instrument;4/1/87 to 9/30/89 Course development to purchase GC/MS Separations and Microscale Synthesis (Bieron)

Oct 1, 1979 $380,000 grant from Federal Office of Education
SDIP – Strengthening Developing Institutions Program

NSF – CCLI Adaptation and Implementation; June 1, 2002 submitted $140,031 Schaber, Corso, Steve, Food, hair, beverages, and water; Analytical Biochemistry Across the Curriculum. A Case Study Approach.

Student Support ;Nov. 1999 in Various Programs. Merck/AAAS, HHMI, CEEP, Allied/Signal, Oishei

1993 NSF – ILI Instrumentation and Laboratory Improvement Program; Improved NMR Teaching and Laboratory Capabilities; $170,000 (85,000 NSF) (85,000 match) to purchase a Bruker AC 250 NMR ; Dr. Bieron, Dr. Dinan, Dr. Kozik.

1993-94
93-94 Grant awarded $23,000; from the Pfizer Foundation for research in teaching General and Organic Chemistry (J.F. Bieron, F. J. Dinan).

1982-84 Biennial Report Listings
(Fall '82) The Department received a $32,000 research instrumentation grant from the National Science Foundation for the purchase of a Varian 3200 UV-Visible-IR Spectrophotometer. Approval of the grant was based on research proposals submitted by Fr. McCarthy and Dr. Shaber, and upon general departmental results.

(Spring '84) We received a $20,000 grant from the Dreyfus Foundation for the purchase of a Nicolet FT-IR Spectrophotometer.

Grants listed in Department Quadrennial Report 1984-88

1. National Science Foundation;
   4 year, $269,320 NSF award to Dr. Bieron for support of LEAP project; (details in section 8 of this report.)

2. NSF-College Science Instrumentation Program (CSIP) award:
   $22,921 matching funds for purchase of a Hewlett-Packard Gas Chromatograph/Mass Spectrometer; grant prepared by Dr. Bieron, Dr. Dinan and Dr. Shaber.

3. Buffalo Board of Education: $10,000 to support Microscale Workshop for Chemistry Teachers; awarded to Dr. Dinan.
4. Northeast Regional Chromatography Discussion Group: $1000 award to Dr. Bieron for research in chromatography.
5. NSF-Research in Undergraduate Institutions Equipment Grant: $33,862 awarded to Dr. Stanton for purchase of a Hewlett-Packard computer system to be used in quantum chemistry research.
6. Research Corporation-Cottrell College Science Grant: $11,000 awarded to Dr. Stanton for quantum chemical research on carbon clusters.
7. Shell Foundation: $2000/yr during 1986, '87, '88. Unrestricted grant to the department.
8. Allied Corporation: $3000/yr during 1986, '87, '88. Unrestricted grant to the department.
9. DuPont Corporation: $7000, 1984; $3000, 1988. Unrestricted grant to the department.

10. Dow Foundation: $25,000 (1984-88), $60,000 (1988-92) for scholarship aid and department support.

Extracurricular Programs

This section describes a variety of programs and activities that are not a part of the course work required for a BS degree but supplement and enhance the academic quality of the Chemistry and Biochemistry Department. Included in this section are the following:

Major Grants to Support Programs
Biochemistry Program
Chemistry and Industry Program
Laboratory Equipment Assistance Program (LEAP)
Group Learning and Case Studies
Instrument Institutes
Personalized System of Instruction

Major Grants to Support Programs

The Chemistry Department over the last fifty years has initiated and implemented new academic programs that expanded and enhanced the educational activities. In most cases, the process was made possible by financial support from both government and private industry sources.

NSF-COSIP $143,700 National Science Foundation
This major grant enabled the department to start the Biochemistry Program that became an integral part of the academic offerings.

AIDP
A very large grant to the College included various program support. The Chemistry Department introduced new pedogogy for teaching General Chemistry, entitled Personalized System of Instruction (PSI) also known as the Keller Plan. The teaching style faded away after the grant support ended because it did not seem to offer any better results than the lecture method.

SDIP
This major grant to the College was a continuation of AIDP support. The Chemistry Department gained financial support for the Chemistry and Industry Program. The project was multi-faceted and the grant supported the department in a number of activities that became self-sustaining over a number of years.

NSF Occidental Chemical Corporation ($50,000)
The Laboratory Equipment Assistance Program was a nationally recognized program jointly funded by NSF and Chemical Industries in Western New York. It supported chemical education in high schools

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Pfizer Foundation Case Study and Group Learning
The foundation provided support to develop, write, implement and evaluate the pedogogy of small group learning and case study methods for teaching General and Organic Chemistry courses. This early work established the teaching styles for most chemistry courses in the Department.

Honeywell Chemistry Olympiad
On an annual basis over the last 15 years, the local Research Laboratory of Honeywell has provided support for this very successful WNY entry in this international competition conducted out of the Chemistry Department.

NSF Matching Equipment Support
The National Science Foundation sponsors funding competition on a matching fund basis that allows science departments to purchase major laboratory instruments. The Chemistry Department has received the following support in recent years. (list to be inserted)

Biochemistry Program

The year was 1967 and biochemistry was a sub-discipline of chemistry that was growing rapidly. It became evident that the chemistry curriculum at the College needed to be expanded to address this phenomenon. Four faculty, R. Stanton, F. Dinan, J. Bieron and Vincent Stouter from the Biology Department formed a committee and outlined a plan to initiate a Biochemistry Program.

A grant proposal was submitted to the National Science Foundation in their College Science Improvement Program (COSIP) and in 1968, Canisius College received a $143,700 grant from NSF. The Abstract from the grant proposal is reprinted here which outlines the plan.

"This grant requires has been prepared primarily to provide funds for the implementation of a new established, interdisciplinary program in biochemistry at Canisius College. The science departments at the College, particularly Biology and Chemistry, have traditionally been strong but unintegrated. This program was created to correct the deficiency which presently exists in undergraduate training in the area of overlap between biology and chemistry. The college's weakness in this area is evidenced by the fact that only one Canisius College graduate has undertaken graduate studies in biochemistry over the past ten years. This observation, coupled with student interest in training in biochemistry and the need for graduate students in this discipline led to the inauguration of this new program.

The choice of Biochemistry as the sole departmental beneficiary of this grant may be amply justified. The College plans to emphasize improvement of the health-oriented sciences and will pursue this goal in a multiplex manner.

The Psychology and Biology Departments will be relocated in a renovated Health-Sciences building, and the Chemistry Department will benefit best by the overlap generated by the interdisciplinary nature of the Biochemistry curriculum.

Current plans for the implementation of the Biochemistry curriculum call for the College to add a biochemist to the faculty for the 1968-69 academic year. Both the

Chemistry and Biology Departments will teach additional courses oriented toward biochemistry. A laboratory suitable for the biochemistry program will be constructed by the College.

The Chemistry Department is currently the strongest department on campus, having adequate space, personnel and equipment. The newly-established Biochemistry Curriculum will be located together with the Chemistry Department in the Horan-O'Donnell Science Building and therefore will be able to make optimum use of Chemistry Department facilities.

The equipment needs of the Biochemistry Curriculum are, however, extensive, readily defined and most immediate. For this reason, and because much of the equipment requested herein will also serve to strengthen the Chemistry and Biology Departments, Biochemistry has been chosen as the subject of this proposal."

The College supplemented the award with $138,000 of its own funds, Dr. William F. Zapisek was hired as the biochemistry program director, laboratories were constructed, students were accepted into the program and the rest is history.

Chemistry and Industry Program

Chemistry and Industry program objectives were; to expand the curriculum, improve liaison with industry, initiate industrially oriented research projects, place students in summer jobs, strengthen resources of the Chemistry Department, and make the program financially self-sustaining.

Additionally, the curriculum was expanded by offering four new courses; Survey of Industrial Chemistry, Polymer Chemistry, Chemical Microscopy and Environmental Chemistry.

The program was designed to be a liaison with local industry by forming a Chemistry and Industry Council, introducing short courses and offering chemistry courses to support a BS degree program in the evening.

The Chemistry and Industry program also allowed for industrially related research projects to be conducted. Some examples of such projects were photolytic ozonolysis of chlorinated hydrocarbons, decomposition of organic peroxides, stable intermediates in polyurethane coatings, COD analysis in high chloride concentration, recovery of dichromate in coolant waters, removal of fluoride ion in waste water, curing cycles for bonded abrasives, organic synthesis contracts, and Hg analysis in sodium methylate production.

The short courses consisted of fundamentals of industrial hygiene, chemical engineering for chemists, patent fundamentals for scientists and engineers, application of statistics to analytical data, principles of corrosion, saving time, money and effort using statistically designed experiments, modern strategies for searching the chemical literature, statistical approaches for quality and productivity improvement, writing strategies in the sciences, an introduction to personal computers for the scientists, chemical catalysis, biodegradation of chemical wastes and environmental toxicology.

After three years, the program had made a lasting impact; enrollment increased, course offerings expanded, its image in the chemical community became enhanced, more consulting and research opportunities became available, betterment of faculty development was apparent, and the enthusiasm amongst the students was evident.

Furthermore, after eight years of evaluation, relationships with industry were firmly established. As a result, the program received corporate contributions, donations of equipment, interest in student employment, consulting opportunities, support of NSF proposals and industrial sabbaticals.

The program was implemented in 1979 and was initially funded by a Title III grant under the Strengthening Developing Institution Program (SDIP), $120,000. The project was promoted as a successful model for any undergraduate Chemistry Department at a liberal arts college in an urban industrial location.

LEAP Program 1987

Background

The Laboratory Equipment Assistance Program (LEAP) originated with an idea generated by participation in a local science exploration day program. Professor Bieron had presented a talk on forensic chemistry. The technique of gas chromatography was introduced and the method was demonstrated with the separation of alcohol and water on a gas chromatograph which was carried along to the talk. The students showed high interest in the instrument after the presentation and a large group remained to inject samples and analyze the results. (whiskey samples were used.)

With the awareness that teaching instruments are only used for short, intensive periods during the year, the seminal idea of LEAP was conceived. We could lend instruments to high schools for short periods (two weeks), keep the instruments in constant use by distribution to a number of schools and in effect maximize utilization of fairly expensive, contemporary laboratory instrumentation that was not affordable to any individual school district.

In the spring semester of 1987, the idea was presented to Dr. Charles Rader, Director of Technology, at Occidental Chemical Corporation's main research center located at Grand Island, north of Buffalo. He agreed to fund the start-up costs of the project and elicited the participation of the Grand Island School District to field test the idea.

In September, 1987 the College submitted a grant proposal to the National Science Foundation and LEAP received a four-year grant for $268,000 for the 1988-92 time period. Financial and program support from Occidental Chemical Corporation has been continuous during this time period as well.

Therefore, funding for LEAP comes from three sources. Canisius College provided faculty released time, secretarial support, workshop supplies and duplication/printing services. The National Science Foundation provided support for all workshop activities, primarily college faculty salaries and participant stipends. Occidental Chemical provides funding for equipment purchases while other industries primarily supported summer intern salaries and released time for participating scientists.

The blend of funding was important to the early success of LEAP because school districts could participate with absolutely no cost to them. After five years of operation, it became much easier to obtain support from these same school districts as NSF support began to phase out.

Program Description

LEAP has grown to be an extended in-service science education program for high school science teachers of biology, chemistry and physics. The program supports the following activities:

1) The acquisition, distribution and maintenance of laboratory equipment for use in high school science courses. The equipment is new and appropriate for high schools. Financial support from Occidental Chemical to purchase this equipment over five years was $61,000. (Distribution is arranged by the LEAP Coordinator, a half-time staff person and delivered by college student employees.)
2) Summer workshops for high school teachers were offered on a regular basis. The workshops consist of 60 hours of lectures and laboratories on topics of current interest where instrument usage is fully integrated into the presentations. Three college credits and a stipend of $200 were offered to participants. Over the last five years, 10 workshops were offered on the following topics:
    - Chemistry Topics: Laboratory Experiments for Regents and AP Chemistry (1988)
    - Physics/Chemistry Topics; Polymers, Spectroscopy, Optics, Electronics, and Motion (1989)
    - Biology/Chemistry Topics; Environmental Chemistry, Physiology, Genetics, Ecology, Biofeedback (1989)
    - Microscale Lab Techniques and ChemCom (1990)
    - Environmental Science and AP Biology (1990_
    - AP and Regents Physics (1990)
    - ChemCom I and ChemCom II (1991)
    - Environmental Chemistry and Biochemical Methods (1991)
    - Digital Electronics and Modern Optics (1991)
    - Music, Noise, Sound and Physics (1992)
3) One-day workshops of 5 hours length on Saturdays during the academic year. The program is determined primarily by a Steering Committee of college, industry and high school personnel.
4) Industry work experience was made available for high school teachers. The Coordinator of LEAP developed paid industry positions for any teacher participating in LEAP. These positions provided opportunities for science teachers to learn about the chemical and environmental industries in the Buffalo area.
5) Industry tours were arranged for groups of eight teachers to spend an entire work day with scientists and technicians in the workplace. This experience provides insights into salary scales, career opportunities and the work environment in addition to exposing teachers to research problems of current interest.
6) Career days for high school students were also conducted. For example, two-day sessions was conducted where representatives of 12 industries made presentations. Tours of local industrial sites were also conducted for high school students.

7) A rural model for LEAP was also demonstrated. An arrangement with the Board of Cooperative Educational Services (BOCES) in Olean, N.Y. provided equipment distribution to 18 schools in rural Allegany and Cattaraugus counties. Off-site workshops at the Olean BOCES Center were conducted for the teachers.

It is one thing to itemize the various components of LEAP but the program functions well because of synergy. The constant week-to-week contact with high school teachers to arrange for instrument scheduling and delivery provides repetitive opportunities for communication and program feedback. The workshops are well attended because the topics are current and are relevant to the high school curriculum. Perhaps as important is that preference for instrument scheduling is given to workshop attendees.

Participation in LEAP is summarized in Table I presented at the end of this narrative. It lists the 81 schools in LEAP and the years in which they participated. Approximately 185 teachers from these high schools have taken advantage of one or more of the various activities of LEAP.

Group Learning and Case Studies

In the early 1990's, various alternative methods of teaching pedagogy in addition to class lectures were being introduced at the college. In 1993, Dr. Joseph Bieron and Dr. Frank Dinan submitted a grant proposal to the Pfizer Foundation to support course development using teaching methods of team learning and case studies. The successful proposal provided $35,000 for funding the development, implementation and evaluation of General and Organic Chemistry courses using these teaching styles. Based on this seminal work, team learning in small groups has become an integral part of the chemistry curriculum at the college. Reproduced below is part of the original grant proposal that outlines the method.

"Description of the Proposed Program

Our goal is to bring the power of team learning in small groups and discussion-based learning into the teaching of general chemistry. This goal will be accomplished by using two teaching methodologies, each well suited to the achievement of a specific educational goal. These techniques are: (1) team learning, and (2) the case study method. In our plan, the former will be used to deal with the problem of covering difficult subject matter. This is a concern in all such courses that have a high content of subject matter; general chemistry is one of these. The latter will be used to introduce a critical thinking component into this course. The manner in which we plan to accomplish these goals is described below, beginning with the team learning technique we are now developing.

Team Learning

Research indicates that working in small, heterogeneous, permanent groups affords student outcomes that are both educationally and socially desirable. Among these is a reduction in stereotypes based

on race and gender, and a decrease in drop-out rates for science students. Despite these advantages, however, team learning is not widely used in science teaching, and to our knowledge is not currently used in chemistry instruction. Among the reasons that this is the case are that faculty often feel that material that they have not personally covered in lecture has not been covered at all, and the widespread assumption that coverage of material must be sacrificed if small group learning is used, since it is inherently inefficient. As a result, when small groups are used in science classrooms, they are often used only briefly and in a superficial manner. The issue of the course material coverage is not a trivial one, and it must be dealt with in teaching general chemistry. External accrediting agencies and standardized examinations place heavy minimum standards on the content of any introductory chemistry course.

The Chemistry Department at Canisius College has just begun an experiment in the useof small group teaching in another high content subject area, introductory organic chemistry. In the summer of 1993 we designed materials to allow us to teach one section of our introductory organic chemistry course using our modified team learning approach. That experiment is currently underway, and is meeting with good success. We propose to continue to modify and further develop our method to make it suitable for use in our introductory chemistry course. Changes in the method will certainly be required, since we shall be dealing not only with different, more segmented subject matter, but also with a less experienced and less mature student group. The basics of the method that we are developing are described below. On the first day of class, after the team learning method has been described, student academic backgrounds, which have been obtained in advance, are used to form permanent groups, each consisting of five or six students. Each group is comprised of a mix of males and females, Blacks and Whites and academically gifted and less gifted students. Get acquainted exercises for the small groups are then carried out.

On the second day of class a grading system is described. It has been designed to insure individual accountability, to reward group performance and to include a component of peer evaluation. The group's first assignment is to decide, within limits set by the instructor, the relative weights they wish to give to group, individual, and peer grades. The students negotiate a class-wide consensus on these weightings. This is a very effective exercise in team building and shows students that they have a real voice in the fairness and equity of important aspects of the course.

The text which is chosen for a team learning course must be one which is very clearly written and suitable for students to read with as little assistance as possible. We anticipate using the new text by R. J. Gillespie in our

introductory chemistry course. The material in the text is sub-divided into units that can be covered during one class period. Normally it is necessary to divide a single chapter into several parts; referred to below as Section Outlines. Each of these Section Outlines consists of three parts: 1) a highly specific reading assignment which clearly specifies not only what the student must read, but also what sections should be omitted from the readings; 2) a problem assignment, designed to bring out the important concepts in that Section, and yet not be overwhelming to the student; 3) a list of learning objectives which specify what specific tasks the student should be able to do upon completion of the Section Outline. The first Section Outline is distributed at the end of the second class, and the students are told that they will take their first mini-test on its contents at the beginning of the next class. Upon arrival in a typical class, the students form in their groups and are given five minutes to help each other with any of the day's learning objectives or problems. Our experience shows that students are usually present and working in their groups five minutes before the period begins. Help is available from the instructor during this period, but the groups are generally able to resolve most student problems without the instructor's intervention. They are then given a ten-minute mini-test based on the learning objectives specified for that day. Students take this mini-test as individuals, and, as they finish, their answer sheets are collected. Then the group, working collectively, takes the same mini-test. While the group is completing its mini-test, the individual mini-tests are graded. Upon completion of the group mini-test, it is handed in and the graded individual mini-tests are returned.

At this point, the mini-test is open for discussion. Students are free to pursue the reasoning behind any of the mini-test answers. Any question or its answer can be challenged by a group (not an individual) if the group feels it can support a challenge with a specific reference from the text. Challenges must be clearly written, signed by all group members, and submitted the same day.

Student questions about the mini-test afford the opportunity to give a mini-lecture on those points in a Section Outline that students have difficulty picking up on their own. When all of the questions have been answered, the Section Outline is reviewed, and questions are encouraged on any points that need clarification. At this point, the available class time is nearly exhausted, and the Section Outline for the next class is distributed. Hour examinations are given periodically. Like the mini-tests they are also taken by both individuals and groups, as described above, and are subject to the discussion and appeals process.

Twice each semester all members of each group are required to evaluate anonymously the performance of the other members of their permanent group. A mid-semester evaluation is

used only to give each group member feedback on how the other group members assess his/her performance. The second peer evaluation, given near the semester's end and weighted as decided by the class, is used as a determinant of each student's final grade.

This is a very brief description of the team learning method we are now developing in one section of our introductory organic chemistry course. For comparison, another section of this course is being taught using the conventional lecture mode of presentation. We plan to evaluate the relative merits of these two approaches, and to follow a similar procedure when we introduce this method into our introductory chemistry course.

This team learning method emphasizes student responsibility. Team members tend to motivate attendance, handle discipline problems, and provide learning support for each other. Permanent groups provide support for students encountering academic as well as personal difficulties. Friendships form among people of very diverse backgrounds, and interpersonal skills are enhanced as group members realize that good communication skills are essential to the success of the group.

Our limited experience indicates that the team learning approach works very effectively for minority students. Group learning apparently produces better success rates for these students than does the conventional lecture approach. Five minority students in our team learning class are all doing very well. This is an area that we intend to study further.

This new method for teaching difficult science courses is very rewarding to the faculty member. Students come to class regularly, and even arrive early, because they want to. They behave as professionals, responsible for their own learning. Absences are rare, and student performances tend to improve as they come to know each other better. Gender and ethnic stereotypes are diminished in the groups, and mutual support seems to grow and strengthen as the semester progresses.

Case Study Approach

The case study approach is widely used in business and law schools and was dramatized well by Professor Kinglsey in the television series, "The Paper Chase". Science courses have also been taught by the case study method. James B.Conant of Harvard pioneered the use of case studies within the lecture format and structured a course around famous discoveries, such as Lavoisier's work with oxygen.

In recent years Canisius College has encouraged the development of critical thinking skills. A faculty development workshop led us to consider the case study method as a means of enhancing critical thinking in introductory chemistry. Preliminary efforts on our part have engendered both confidence and anticipation that the use of case

studies in the General Chemistry course will address some of the problems discussed above. The Case Study Method to us means the following:

- A topic that addresses one or more principles in the General Chemistry curriculum is chosen. A case or story is written about this topic. It is important that the case develop interest on the part of the student, preferably by introducing characters into the case with whom the student can identify.
- The case presents a problem to be solved. Information is presented in the form of tables of data, graphs, personal witness and externally written articles.
- Students study the case, formulate some observations and prepare to answer questions. This can be done individually, but in-class responses are much better, since they offer students the chance to work in groups.
- Class discussions can take many forms, but we favor the approach of a recognized expert in the field, William Welty. He recommends a proper introduction, directive but not dominating questioning, good blackboard work to highlight essential issues, and an appropriate summary. This approach works well for a class of 40-50 which is broken down into groups.
- After the case discussion, students can be evaluated by presenting them with a series of open-ended questions that can be answered individually and/or as a group.

The General Chemistry course at Canisius has one 75-minute recitation period every week. Our goal is to develop case studies that would be presented during this period on alternate weeks throughout the semester. We have already started to write two case studies and we intend to try them in this year's General Chemistry course. To complement the chapter on oxidationreduction we have developed a case study dealing with the Statue of Liberty's restoration. We tell the story of a student's father, an engineer who has been charged with choosing a means of restoring the Statue, which is severely corroded.

A second, more interdisciplinary, case study is being developed with participation from our Business School. The case for Gasohol is set up as a possible product in a start-up business being developed by a student enrolled in an entrepreneur program (Canisius has such a program). The case investigates the chemical properties of ethanol (bond energies), the cost of production (fermentation and ethylene source) and the environmental advantages. The business part will show a financial analysis to demonstrate feasibility in the marketplace.

Each case study will take two weeks to complete and the subject matter will be chosen to overlap classroom material being taken at the same time. The primary goal of each case study is to promote critical thinking by the students. They

will be asked to apply data, entertain disparate viewpoints, consider alternative solutions, and to place the chemistry they are learning in a larger context in the world they experience. The case studies approach should help the student to integrate subject matter which crosses disciplines.

Highlights and Innovative Aspects of the Program

-Students work in small permanent groups. These build interpersonal and communication skills, enhance learning for both weak and strong students, and are effective in overcoming racial and gender stereotypes.

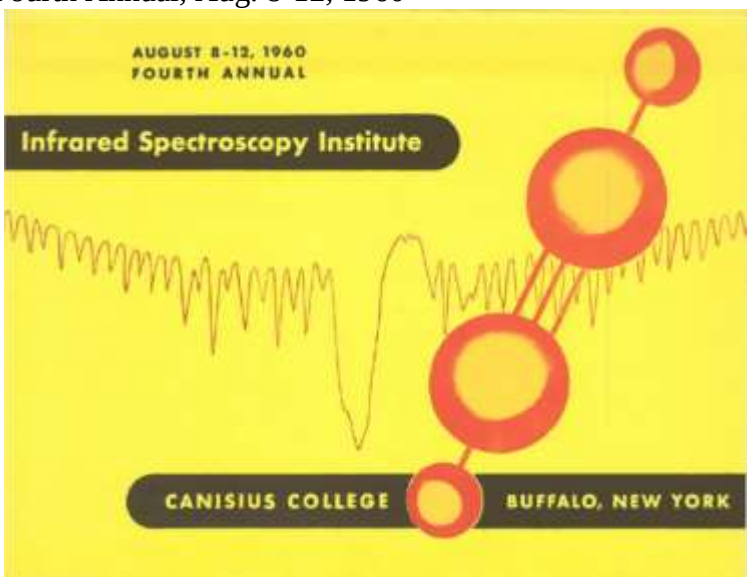
- The structured team learning system that we are now developing is very efficient and overcomes the content coverage problem."

Instrument Institutes in Chemistry – Week-long summer workshops

A program of workshops was initiated by Herman Szymanski at the College. The topics were infrared spectroscopy, gas chromatography and nuclear magnetic resonance. Instructors were teams of college faculty and industrial chemists. Undergraduate students were involved as laboratory assistants. Instruction were an integrated activity of lectures, problem solving and instrument practices. Representations of instrument companies also participated by exhibiting their products.

Old brochures from the institutes give outlines and are shown here:

Infrared Spectroscopy Institute
Fourth Annual, Aug. 8-12, 1960



Infrared Spectroscopy Institute (IR)

The analytical methods of infrared spectroscopy became significant in the late 1950's caused primarily by the availability of instruments manufactured by companies like Beckman and Perkin Elm. Dr. Herman Szymanski recognized the importance of this instrumental method of analysis and organized the first IR Institute in 1957. By 1960, the fourth institute featured many of the prominent people involved in the practice; academic faculty, instrument manufacturers, industrial chemists, and government laboratory workers. The Infrared Institutes became nationally recognized and Canisius faculty authored textbooks in the field that were well received. Representative textbooks that were well received were:

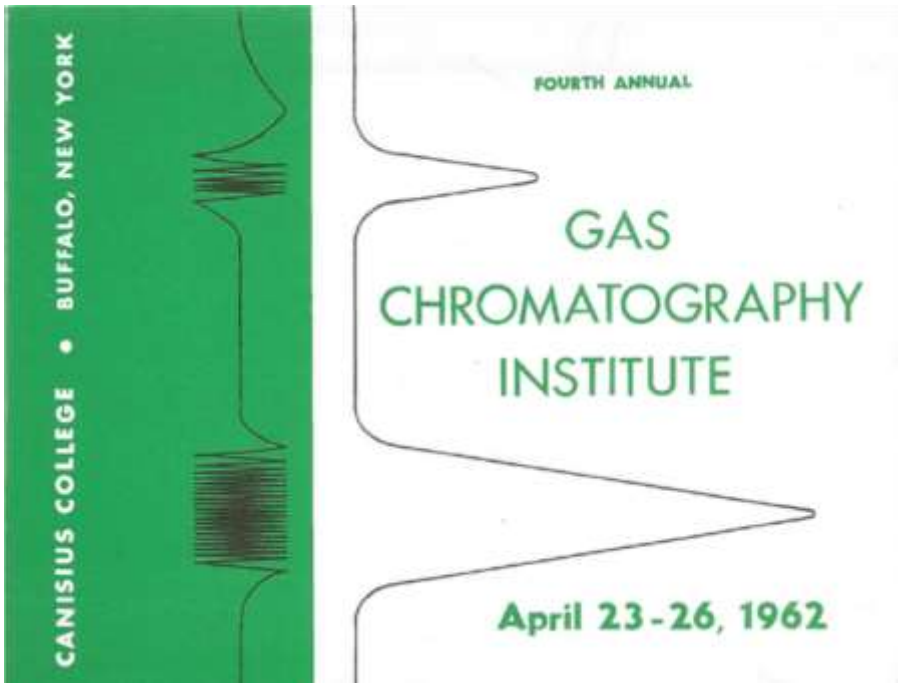
IR Theory and Practice of Infrared Spectroscopy, Herman A. Szymanski; Plenum Press, 1964

Infrared Spectroscopy, 2nd Edition, Robert T. Conley
Allyn & Bacon, Inc. Boston, 1972

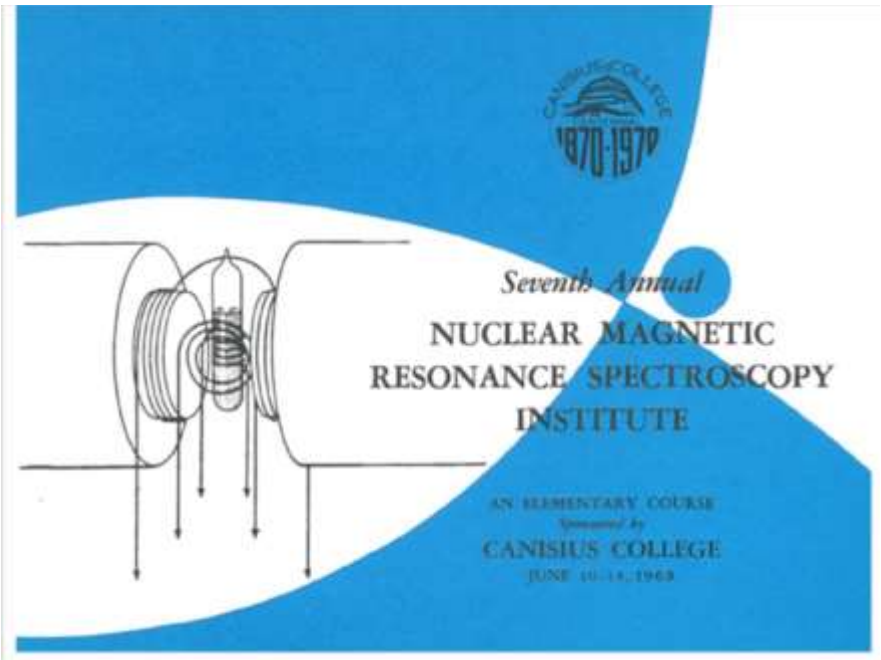
The institute was comprised of three and once-half days of lectures, laboratory exercises, spectral interpretation, instrument design and use, quantitative analytical methods, and spherical applications. The instructors were all experts in the various areas of presentation.

Gas Chromatography Institute

Fourth Annual, Apr. 23-26, 1962



Nuclear Magnetic Resonance Spectroscopy Institute
Seventh Annual, June 10-14, 1968



Personalized System of Instruction (PSI)

This alternative method of instruction to the lecture style was introduced at the college in 1972. The project was funded by a $1.5 million grant to Canisius College from the Department of Health, Education and Welfare under the Advanced Institutional Development Program (AIDP). Under the guidance of Dr. James Van Verth, chemistry students are permitted to study each at their own set pace. Instituted at Canisius by Dr. Phil Heffley and Dr. Frank Dinan, this PSI course revolves around certain units of study (20 per semester), along with a 15 minute test at the culmination of each individual unit. Student progress at their own rate, and are graded pass or non-pass immediately after each test. These tests are taken at the students' discretion, and only when one test is completed with a passing grade can the student proceed to the next unit. A final exam is given at the end of the semester, and is also graded accordingly.

At the time of the course offering, Van Verth gave an interview to *The Griffin* student newspaper where he describes the method in more detail.

"Dr. Van Verth gave his wholehearted support to this course, stating that although it is past the Experimental stage, he would like to see it expand to many other subjects at Canisius. Dr. Van Verth continued with the fact that his PSI course operates on the Mastery Concept; that being each student must show complete mastery of a unit before they are allowed to proceed. This causes a more intense and lasting knowledge of the subject matter than the lecture system of teaching. He also points to the large enrollment of students as further proof of the widespread acceptance of this system of learning. From a student's point of view, this course offers complete freedom to the student, which could be beneficial to the other subjects with regards to time. Attendance is not mandatory, so long as the student proceeds at some rate of learning. Many students

readily approve of this method of learning, which may indeed expand to other subjects in the future. Dr. Van Verth explains the widespread use of this system throughout the country, and with few resultant problems."

General and Organic Chemistry courses were offered in the PSI format for eight years before this alternative style of teaching was phased out.