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To our readers . . .

We were saddened to learn of the recent deaths of two distinguished members of our Association, Fr. John A. Frisch, S.J., of Canisius College, and Fr. Edward Berry, S.J., of Fordham University. A brief obituary of Fr. Frisch is included in this issue and we hope to have an obituary for Fr. Berry for the next issue. May they rest in peace.

To complement the survey in the June issue of the BULLETIN of science education in Jesuit colleges and universities, Mr. Lammert B. Otten, S.J. has surveyed pre-engineering and engineering opportunities in Jesuit schools. The BULLETIN staff is greatly indebted to Mr. Otten for providing this helpful service to our readers. As with the previous survey we welcome comments, suggestions, and supplementary information, especially concerning pre-engineering.

We have not had much success soliciting articles from our readers on the subject of new high school programs. Hence we are reprinting four articles which recently appeared in the *Science and Math Weekly*. Each of the authors has been closely connected with the program he is analyzing and has used it in the classroom. Their remarks and evaluations will hopefully stimulate response from our readers. The "Reports of Scientific Activity" in this issue indicate that these experimental high school programs are widely in use in Jesuit schools in the United States, in Jamaica, and in the Philippines. We invite discussion on their adaptation to the Jesuit high school situation.

We are most grateful to Mr. R. R. Haffner, editorial director of the *Science and Math Weekly* for permission to reprint these four articles. Many of our readers will be familiar with this excellent publication, appearing weekly for high school students and periodically in a special teacher's edition (from which the present articles were taken).

It is interesting to note the recent meeting held at McQuaid High School (see "Reports of Scientific Activity" under McQuaid High School). Held to discuss problems of articulation between the high school and college, this conference touched on many of the topics that have been and will be discussed at the annual meetings of the Association. The calibre of the discussion herein reported will hopefully be a catalyst for similar discussions at this year's annual meeting in Boston. It is also the type discussion we would like to see carried on in the pages of this BULLETIN. The mutual profit from shared ideas should amply compensate for the expenditure of valuable time.

JOHN A. FRISCH, S.J.

1899–1963

Fr. John A. Frisch, S.J. a nationally known biologist and educator, died on Sunday, May 12, 1963 at the age of 73, after a long illness at Kenmore Mercy Hospital, Kenmore, N.Y. Fr. Frisch was born in Buffalo, N.Y. on October 9, 1889. He graduated from Canisius High School and spent one year at Canisius College before entering the Society of Jesus on September 8, 1908. Upon the completion of his philosophical studies, Fr. Frisch was an instructor in biology at Holy Cross College from 1915 to 1920. He was ordained to the priesthood at Georgetown University on June 27, 1922, and after completion of his theological studies served as professor of biology at Canisius College for a period of two years. He was chairman of the biology department at Georgetown University from 1927 to 1930, and professor of biology at Loyola College, Baltimore from 1930 to 1935. In 1935 he was appointed chairman of the biology department of Canisius, a post he held until 1959.

Fr. Frisch received the master of science degree from Canisius College in 1928 and the doctor of philosophy degree in zoology from Johns Hopkins University in 1935. A specialist in the field of protozoan physiology, Fr. Frisch was elected to membership in both Sigma Xi and Phi Beta Kappa while studying at Johns Hopkins. He was also past president of the American Association of Jesuit Scientists, a fellow of the New York Academy of Sciences, a fellow of the American Association for the Advancement of Science, a member of the American Society of Zoologists, a charter member of the American Society of Protozoologists, a member of the Ecological Society of America and a member of the corporation of the Marine Biological Laboratory at Woods Hole, Massachusetts.

As an educator, Fr. Frisch was probably best known for his promotion of the pre-medical and pre-dental concentrations at Canisius College. Approximately five hundred of his students received their doctor of medicine after graduating from Canisius and about two hundred of his students graduated from dental school.

Fr. Frisch celebrated his golden anniversary as a member of the Society of Jesus on January 19, 1958.

Requiescat in pace.

A SURVEY OF PRE-ENGINEERING AND ENGINEERING EDUCATION IN JESUIT COLLEGES AND UNIVERSITIES

LAMMERT B. OTTEN, S.J.

Introduction. This survey of engineering disciplines in Jesuit colleges and universities continues the study of educational opportunities in Jesuit institutions in the areas of science and engineering. As with the previous survey in the June issue of the BULLETIN, the main purpose of this survey is to provide science teachers in high schools, colleges and universities with information helpful in counseling students.

Format. The format of the present survey follows that of the previous one. Information which can be summarized conveniently in schematic form is presented in tables. These are followed by textual material which gives further details of the resources of each department according to the information submitted. Because of the difficulty encountered in determining which schools have pre-engineering programs, this survey of pre-engineering is admittedly incomplete. It includes only six schools. Further information with respect to pre-engineering programs will be welcomed by the editor of the BULLETIN.

Acknowledgements. We would like to take this opportunity to thank most sincerely all the department chairmen for their generosity in responding to the questionnaire. The chairmen have been indicated in the list of faculty by the designation †. Anyone wishing to contact these chairmen will find a convenient list of addresses of all Jesuit colleges and universities in the country on page 148 of the June issue of the BULLETIN. We hope that the information submitted by each department is fairly represented, and we welcome suggestions and criticisms of this survey which may help in future revisions.

TABLES

In the tables which follow we have tried to give a schematic presentation of the information submitted by the various department chairmen. In the last three columns a code has been used in order to facilitate the presentation of information concerning special undergraduate programs and financial assistance. We have limited the number of symbols used in this code in order to facilitate the use of the tables. Only the more common programs have been coded. In many cases information does not fall clearly into one of the coded categories. In these cases reference is made in the table by the use of an asterisk to information included in the text material under the given school.

Since these tables are meant to present only a schematic view, they should be used in conjunction with the text material which follows them. Even the more common types of programs find widely different applications at different schools, and in cases where the peculiarities of the program have been made known to us this information has been included in the text material. Blank spaces in the table indicate that no information is available. Both the tabular and the textual material are given in the following order:

1. pre-engineering
2. aeronautical engineering
3. chemical engineering
4. civil engineering
5. electrical engineering
6. geology and geological engineering
7. geophysics, geophysical engineering and meteorology
8. industrial engineering
9. mechanical engineering
10. theoretical and applied mechanics.

TABLE 1

PRE-ENGINEERING

School	Number of Students in Program	Cooperating Engineering Schools	College Program		Engineering Program	
			Years Required	B.S. Degree	Level at Transfer	Engineering Degree
Canisius	90	Detroit	2		Junior	Yes
John Carroll						Yes
Regis	56	Marquette, St. Louis	3	Yes	Junior	Yes
Rockhurst	40	Detroit, Marquette, St. Louis, Santa Clara	3	Yes	Junior	Yes
St. Peter's	30–40	Detroit and other schools	2		Junior	Yes
Scranton	45	Detroit	2			Yes

School	Faculty: Number	Faculty: Ph.D.'s	Number of Senior Under-graduates	Number in M.S. Program: Full-time	Number in M.S. Program: Part-time
					Aeronautical
Detroit	5	1	23	0	4
Parks College (St. Louis)	4	0	50	×	×
					Chemical E
Detroit	6	4	30	11	9
Gonzaga	3	3	7	×	×
					Civil En
Detroit	4	1	28	×	×
Gonzaga	3	0	8	×	×
Loyola (Los Angeles)	4	1		×	×
Marquette	8	1	50	×	×
St. Louis	4	1	12	×	×
Santa Clara	3	1	15	*	*
Seattle	4	2	10	×	×
					Electrical
Detroit	11	2	81	0	13
Gonzaga	3	0	19	×	×
Loyola (Los Angeles)	4	0		×	×
Marquette	15	9	80	17	40
St. Louis	6	3	47	2	142
Santa Clara	5	4	25	*	*
Seattle	6	2	20	0	70

The numbers listed for both undergraduate and graduate students are estimated

*	See descriptive material given in the "Supplementary Information"
×	Program is not offered.
AP	Advanced placement.
AsRes	Research assistantship.
AsT	Teaching assistantship.
Co	Cooperative program with alternate periods of study and work in in
Fel	Graduate fellowship.
FelAEC	AEC nuclear science and engineering fellowship.
FelNIH	NIH fellowship.
FS	Full scholarship.
Gr	Graduate courses available to capable undergraduates.
HP	Honors program.
Res	Research available, in some instances required for degree program.
ResNSF	NSF undergraduate research participation program.
PS	Partial scholarship.
RGAs	Research and graduate assistantships.
SS	State scholarships.
Th	Senior thesis required for undergraduates.

LE 2

Special Undergraduate Programs	Financial Assistance	
	Undergraduate	Graduate
Engineering		
HP, Co	Co	Fel, As
AP	FS, PS	×
ngineering		
ResNSF	PS, FS	Fel
Res	AsRes	×
gineering		
HC, Co	FS, PS	×
	FS	×
Res	FS, PS, SS	×
Th, Res		×
Gr, ResNSF	PS, FS	×
Th, Res, Gr, AP	FS, PS, SS	RGAs
	PS, FS	×
Engineering		
Gr, Res, Th, Co	FS, PS	FS, PS, Fel
	FS, As	×
Res	FS, PS, SS	×
Res, Gr	FS, PS	RGAs*, FelNSF, FelNIH
Gr, ResNSF	FS, PS	PS, FS, AsT, RGAs, Fel
AP, Res, Gr, Th	FS, PS, SS	RGAs
ResNSF, Gr, HC	FS, PS	PS

averages over the past few years.
under listed school.

dustry.

TAB

School	Faculty		Number Senior Under-graduates	Number in M.S. Program	
	Number	Ph.D.'s		Full-time	Part-time
					Geology and Geo
St. Louis	6	6	1	1	0
					Geophysics, Geophysical
St. Louis	9	8	9	19	0
					Industrial
St. Louis			21	×	×
					Mechanical
Detroit	8	2	80	1	15
Gonzaga	3	1	14	×	×
Loyola (Los Angeles)	4	1		×	×
Marquette	13	6	70	12	20
Santa Clara	6	2	19	*	*
Seattle	5	1	22	3	60
					Theoretical and
Marquette	8	5	0	1	12

The numbers listed for both undergraduate and graduate students are estimated

*	See descriptive material given in the "Supplementary Information"
×	Program is not offered.
AP	Advanced placement.
AsRes	Research assistantship.
AsT	Teaching assistantship.
Co	Cooperative program with alternate periods of study and work in
Fel	Graduate fellowship.
FelAEC	AEC nuclear science and engineering fellowship.
FelNIH	NIH fellowship.
FS	Full scholarship.
Gr	Graduate courses available to capable undergraduates.
HP	Honors program.
Res	Research available, in some instances required for degree program.
ResNSF	NSF undergraduate research participation program.
PS	Partial scholarship.
RGAs	Research and graduate assistantships.
SS	State scholarships.
Th	Senior thesis required for undergraduates.

LE 3

Special Undergraduate Programs	Financial Assistance	
	Undergraduate	Graduate
logical Engineering		
ResNSF, Gr	FS, PS	PS, FS, AsT, RGAs, Fel
Engineering and Meteorology		
ResNSF, Gr	FS, PS	FS, PS, AsT, RGAs, Fel
Engineering		
ResNSF, Gr	FS, PS	×
Engineering		
Co, Res, Gr	FS, PS	Fel, As
	FS, AsRes	×
Res	FS, PS, SS	×
Gr, Res		AsT, AsRes, FelAEC, FelNSF
Th, Res, Gr, AP	FS, PS, SS	RGAs
Res		
Applied Mechanics		
	PS	FelNSF, AsT, RGAs

averages over the past few years.
under listed school.

industry.

PRE-ENGINEERING

Canisius College

Supplementary Information

From twelve to twenty-four students go yearly to a three year work-study cooperative program at the University of Detroit. Ninety-five percent of the honors graduates in chemical engineering at the University of Detroit in the last six years have been from Canisius. One of last year's NSF fellowship winners was from Canisius.

Regis College

Supplementary Information

Degrees in civil, electrical, geophysical, industrial and mechanical engineering are awarded if a 2.5 credit average is maintained.

Rockhurst College

Faculty

† Thomas E. Sullivan, Sc.D., Massachusetts Institute of Technology, chemical engineering.

Supplementary Information

Both the bachelor of science and the engineering degrees will be awarded if the student maintains a 2.5 credit average until graduation from the engineering college.

St. Peter's College

Faculty

† James B. Collins, C.E., Cooper Union, pre-engineering.
John E. Dimatteo, M.S.M.E., Stevens Tech, pre-engineering.
Matthew J. Dujets, M.A., Seton Hall.

Supplementary Information

The student transfers at the junior level to the University of Detroit where he alternates three months of academic work with three months of salaried employment.

Newark College, Manhattan College, Columbia University, Brooklyn Polytechnic and Pratt Institute have also received students from this program.

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† Chairman of the department.

Degrees in chemical, mechanical, aeronautical, electrical, architectural and civil engineering are offered.

A Guest Lecturer Program affords the students an opportunity to appreciate the scope and interrelation of the various fields of engineering.

Scranton University

Faculty

Joseph E. Beezup, B.S., Pennsylvania State.

Stanley L. Chickson, M.S., Bucknell.

† Andrew W. Plonsky, M.S.M.E., Massachusetts Institute of Technology.

AERONAUTICAL ENGINEERING

University of Detroit

Faculty

Edward L. Davenport, Jr., B.Ae. E., Detroit, aeronautical engineering.

Patrick J. Roache, B.Ae.E., M.S.Ae., Notre Dame, compressible aerodynamics.

Edward A. Szczepaniak, B.Ae.E., A.M., Detroit, aerodynamics and propulsion.

† Kenneth E. Smith, B.Ae.E., Detroit, pre-engineering and design engineering.

Syd Yusuff, M.Sc., M.Ae.E., Dr.Ae.E., Brooklyn Poly., structural engineering and research.

Current Research

Experimental investigation of three dimensional coanda effects.

Theoretical and experimental investigation of the mechanics of crack propogation.

Stability of pressurized cylinders under combined loading.

Research Equipment

Atmospheric wind tunnel with air speed up to 170 mph, wind tunnel with speed of mach 1.5 and 2.64, analog computer, polariscope for photoelastic studies.

Supplementary Information

The two-year old department is expanding research and graduate courses.

Parks College of St. Louis University

Faculty

Richard M. Andres, M.S., St. Louis, gas dynamics.

Royal J. Bondie, Jr., M.S., Wichita, vehicle design.

John A. George, M.S., California Institute of Technology, plasma physics.

† Richard B. Trefny, M.S., Washington, structures.

Supplementary Information

Within the next five years laboratory and research facilities will be expanded.

CHEMICAL ENGINEERING

University of Detroit

Faculty

Subrata Ghosh, Ph.D., Birmingham, England, solidification of aluminum-silicon alloys.

Henry C. Gudebski, M.Sc., Detroit, slip and shear in tension and compression.

† Leon S. Kowalczyk, D.Sc., Warsaw, reaction kinetics at elevated pressures, thermal conductivity at high temperatures.

Francis P. O'Connell, Ph.D., Lehigh, electrolysis at low temperatures, flow pattern of liquid agitation.

Paul P. Rumps, M.Sc., Detroit, air pollution, liquid diffusion.

Tsi-Shan Yu, Ph.D., Georgia Tech, effect of different types of molecules at the interphase on mass transfer.

Current Research

Reaction rates in the gas phase at elevated pressures.

Effect of metal fillers on plastics.

Electrolysis at lower temperatures.

Solidification of Al-Si alloys.

Air pollution program for the Detroit area.

Research Equipment

Computer center.

Gonzaga University

Faculty

E. James Davis, Ph.D., Washington, transport phenomena.

Arthur McNeil, S.J., Ph.D., Catholic University, analytical chemistry.

Manthripragada G. Rao, Ph.D., Washington, ion exchange in packed beds.

Current Research

Two phase fluid flow, heat transfer.

CIVIL ENGINEERING

University of Detroit

Faculty

Roy Bremer, M.S.P.H., Michigan, sanitary engineering.
† Elihu Geer, Ph.D., Michigan, structures.
George E. LaPalm, B.C.E., Detroit, structures and soil mechanics.

Current Research

Conoids.
Polyvinyl-chloride waterstops and related items.
Research and development on various plastic items.

Gonzaga University

Faculty

Richard A. Busch, M.S., Washington State, highways and soils.
Cheng-Tien Luke, M.S., Massachusetts Institute of Technology, fluid mechanics.
Maghard O. Serbousek, M.S., Minnesota, structures.

Loyola University (Los Angeles)

Faculty

Donald Anderson, M.S.C.E., Purdue, surveying and sanitary engineering.
James Foxworthy, M.S.C.E., Southern California, sanitary and hydraulics.
William Hirt, M.S.C.E., Southern California, structures.
† Richard C. Kolf, Ph.D., Marquette, fluid dynamics.

Research Equipment

Alwac III-E digital computer, two analog computers.

Marquette University

Faculty

Ralph E. Boeck, M.S., Massachusetts Institute of Technology, structural design.

Hyoungkey Hong, Ph.D., Wisconsin, highways and soils.
James E. Kerrigqn, M.S., Wisconsin, sanitary engineering.
Raymond J. Kipp, Ph.D., Wisconsin, sanitary engineering.
Robert W. Kueñch, Ph.D., Northwestern, structural design.
John B. McKevitt, B.S., Notre Dame, surveying and geology.
O. Neil Olson, C.E., Oregon State, structural concrete.
Robert L. Sullo, M.Ed., Marquette, concrete mixes.

Current Research

Traffic accident study of Milwaukee County expressways.

Soil stabilization with lignosulfonic acid polymers.

Glucose utilization by pure culture floc-forming bacteria in activated sludge.

Investigation of well-water pollution from unknown source.

Significance of so-called "aftergrowths" of coliform organisms in dilution waters receiving treated sewage effluents.

Rigid-plastic analysis of conical shells with axisymmetric loading and various support conditions.

Development of a universal computer program for the analysis and design of present prestressed concrete sections.

The use of selected media in water filtration.

Application of computer techniques to railway and highway curves.

St. Louis University

Faculty

Mr. Celis.
† J. L. Cronin, Ph.D.
Mr. McCarthy.
Mr. Silver.

Research Equipment

Computer center.

University of Santa Clara

Faculty

Eugene J. Fisher, B.S., Santa Clara, engineering materials.
Robert H. Keyser, Ph.D., Wisconsin, soil mechanics.
Robert I. Murray, M.S., Stanford, fluid mechanics.

Current Research

Research in fluid mechanics is supported by Lockheed's Missile and Space Division.

Research Equipment

Computer center with analog computer and IBM 1620 digital computer.

Supplementary Information

A program leading to a master's degree in engineering is offered. There are ten full-time and 450 part time students. Research and graduate assistantships provide $1800 plus tuition.

Seattle Unievrsity

Edward J. Baldinger, M.S., Michigan.
Robert Okey, Ph.D., Washington, sanitary engineering and water supply.
Walter J. Purcell, M.S., Cornell.
Richard T. Schwaegler, M.S., Massachusetts Institute of Technology.

ELECTRICAL ENGINEERING

University of Detroit

Faculty

R. W. Ahlquist, M.S.
Joseph Azarewicz, M.S.
George Chute, E.E.
Hassan El-Sabbagh, Ph.D., Illinois,
H. R. Mason, M.S.
T. Janisz, M.S., thin films.
B. Jakowenko, B.S.
D. Ma, M.S.
M. Juzych, M.S., medical electronics.
J. Merdler, M.S.
A. Toppeto, Ph.D., Michigan, magnetic cores.

Research Current

Field effect transistor.

Research Equipment

Furnaces, sink and semiconductor materials.

Gonzaga University

Faculty

Edwin Atwood, M.S., Idaho, electrical machinery.
† Howard Stingle, M.S., Idaho, power transmission.
Oscar VonRohr, M.S., Washington, servomechanisms.

Loyola University (Los Angeles)

Faculty

Eugene Kessler, B.S., Loyola, electronics.

John Page, M.S., UCLA, electronics and microwaves.

Thomas Smith, M.S., Marquette, microwaves.

Clyde Werts, S.J., M.S., California Institute of Technology, computers and electric machines.

Current Research

Microwave transmission in various media.

Research Equipment

Alwac III-E digital computer, two analog computers.

Marquette University

Faculty

Joseph H. Battocletti, Ph.D., UCLA, plasma effects on microwaves.

John C. Donovan, M.S.E.E., Southern California, servomechanisms.

Arthur Bernard Drought, Sc.D. Harvard, biomedical engineering.

Jay N. Frank, B.E.E. Marquette, motor control.

Evan H. Greener, Ph.D. Northwestern, electrical properties of materials.

J. D. Horgan, Ph.D. Wisconsin, biomedical engineering.

Thomas Koryu Ishii, Ph.D. Wisconsin, D. Eng., Nihon, microwaves and millimeter waves.

Donald J. Kopydowski, M.S., Pennsylvania, solid state electronics and switching.

Stanley Krupnik, Jr., B.E.E., Marquette, electrical circuits, power transmission, electrical machinery.

Saul D. Larks, Ph.D. California, biomedical engineering.

Robert L. Mertz, Ph.D., Wisconsin, adaptive control systems.

Arthur C. Moeller, Cand. Ph.D., Wisconsin, computer applications.

Edward P. Morris, M.S. Wisconsin, electrical circuits, symmetrical components.

Richard R. Sabroff, Ph.D. Wisconsin, automatic control systems.

Jan K. Sedivy, D.Tech. Sc., Vienna, energy conversion.

Current Research

Linear system identification using parameter-perturbed Laguerre-filter models and second-order parameter-perturbed learning models; accuracy and stability of non-linear loops in analog computers.

Digital computer simulation of the human respiratory system; investigation of indicator dilution techniques; digital computer simulation of the analog computer; simulation of the electrical and mechanical system involved in the breath-to-breath variations of lung volume; improved clinical testing of the human respiratory system utilizing simulation techniques; simulation of physiological experiments in carbon dioxide inhalation.

Automated medical history taking; perinatal study-relations between fetal and neonatal electrocardiograms; electrical activity of the uterus and fetal heart; statistical analysis of the fetal electrocardiogram; development of the Marquette fetal heart station; origins of congenital heart disease; fetal electrocardiogram in the large domestic animal; computer-aided medical diagnosis.

FM phone telemetry; numerical solution of elliptic boundary value and eigenvalue problems; non-linear systems solution; unified generalized machine.

Semiconducting phenomena in oxides; dielectric phenomena in oxide semiconductors; thermoluminescence; carrier injection at oxide/metal contacts; chemical polishing of oxides.

Behavior of electromagnetic waves at a waveguide junction; generation of millimeter-waves by avalanche devices; millimeter-wave harmonic generator; channel waveguide; millimeter-wave tunnel diode circuit; microwave detector circuit for power application; microwave logic circuit; millimeter wave reflex klystron amplifiers.

Natural modes of oscillation of cylindrical plasmas; main set of resonances accompanying the dipolar resonance of a cylindrical low-pressure are discharge.

Supplementary Information

Additional sources of aid to the graduate student are the Cutler-Hammer Foundation, NESEP, the Bacon Foundation, and the United States Public Health Service.

The research program has accounted for numerous publications, among which are eighty-seven by Dr. Ishii and fifty-seven by Dr. Larks.

St. Louis University

Faculty

Mr. Brown, physical electronics.
Dr. Connell.
† Dr. Dreifke, pulse testing.
Dr. Jones, heat transfer.

Mr. Kelemen.
Mr. McCabe, digital computers.

Current Research

Numerical time domain synthesis.
Time-varying and non-linear system analysis and synthesis.
Space electronics and automatic controls.

Research Equipment

Analog computer, automatic control devices, dual linear oscilloscopes, computer center with IBM 1620 computer.

University of Santa Clara

Faculty

Henry P. Nettesheim, M.S., Stanford, electronic circuits.
J. D. Bruce, Ph.D., Kansas, microwaves.
S. Park Chan, Ph.D., Illinois, linear graph theory, electrical engineering.
Richard C. Dorf, Ph.D., United States Naval Postgraduate School, multivariable and adoptive control systems.
Gerald E. Markle, Ph.D., Wayne State, numerical analysis.

Current Research

Microwaves, network theory.

Research Equipment

Computer center with analog computer and IBM 1620 computer.

Supplementary Information

A master's degree is offered. There are ten full time and 450 part time students. Research and graduate assistantships provide $1800 plus tuition.

Seattle University

Faculty

Timothy J. Healy, M.S., Stanford, linear systems analysis.
Byron P. Gage, Cand. Ph.D., Washington, microwaves.
Charles Sienkiewicz, M.S., Washington, solid state.
Richard L. Turner, Ph.D., Washington, electronics and microwaves.
Richard R. Weiss, M.S., Michigan, electronics.
† Francis P. Wood, S.J., M.S., Stanford, electromechanical energy conversion and control systems.

Research Equipment

IBM 1620–407 computer, subcriterial nuclear reactor, Gammacell.

Supplementary Information

Undergraduate advanced electronics and servomechanism laboratories are being developed with NSF aid.

GEOLOGY‡ AND GEOLOGICAL ENGINEERING

St. Louis University

Faculty

† Victor T. Allen, Ph.D., California, clay minerology.
Charles B. Belt, Ph.D., Columbia, geochemistry.
Kenneth G. Brill, Ph.D., Michigan, paleontology.

Current Research

Trace element studies using an atomic absorption spectrometer, crystallography model design, Bauxite ore deposit study, local geologic and structural mapping, stratigraphic studies of Mississippian limestone.

Research Equipment

X-ray diffraction unit, thermo-luminescence equipment, absorption spectrometer, computer center.

GEOPHYSICS‡, GEOPHYSICAL ENGINEERING, AND METEOROLOGY

St. Louis University

Faculty

Victor J. Blum, S.J., Ph.D., St. Louis, dean, Institute of Technology.
† Ross R. Heinrich, Ph.D., St. Louis, meteorology.
Carl Kisslinger, Ph.D., St. Louis.
Emil J. Mateker, Cand. Ph.D., St. Louis.
Clifford Murino, Ph.D., St. Louis, satellite meteorology.
Otto W. Nuttli, Ph.D., St. Louis, seismology.
Albert J. Pallman, Ph.D., Cologne, tropical meteorology.
William V. Stauder, S.J., Ph.D., California, seismology.
Stanislaw Vincenz, D.Sc., London, geomagnetism.

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‡ Please consult the June issue of this Bulletin for supplementary information concerning geology and geophysics.

Current Research

Focal mechanisms or earthquakes using P and S waves, structural studies of the crust and upper mantle of the earth, surface wave studies, local earthquake studies, effects of the free surface of the earth on body waves, explosion-generated seismic waves, field studies and model studies, seismic refraction and electrical resistivity studies for exploration, solar and terrestrial energy balance study using satellites, rock magnetism and paleomagnetism.

INDUSTRIAL ENGINEERING

St. Louis University

Current Research

Predicting direction of growth of automatic technology.

MECHANICAL ENGINEERING

University of Detroit

Faculty

Jack Campau, M.S., Wayne State, heat transfer, air moving, machine design.
Arthur Haman, M.B.A., Detroit, flame arrestors.
Thomas Manos, Ph.D., Michigan, transportation.
Richard McHugh, B.M.E., Detroit, glass bottle accidents.
George B. Uicker, M.S., Pennsylvania, air pollution.
Andries C. deWilde, M.S., Delft, internal combustion engines.
Mieczyslaw Wojciechowski, D.Sc., Warsaw, heat transfer.
Y. Wilson Yamauchi, M.S., Wayne State, heat transfer.

Current Research

Guarded hot plate design.
Investigation of flash-back phenomena in marine internal combustion engines.
Safety in truck front wheel bearings.

Gonzaga University

Faculty

James G. McGivern, D.Sc., Gonzaga, Ed.D., Washington State, applied mechanics.
Raymond Murphy, M.S., Notre Dame, computers.
Juan A. Shirk, B.S., Washington State, applied thermodynamics.

Loyola University (Los Angeles)

Faculty

Joseph Callinan, M.S., UCLA, thermodynamics, heat transfer.
Harland Moss, Ph.D., Southern California, materials, solid state physics.
Lawrence Wierzbicki, M.A., UCLA, graphics.
Paul Wirsching, M.S., Notre Dame, dynamics, vibrations.

Current Research

Vibration analysis and measurement-vibration table and shock methods.
Solar calorimetry-absorbing surfaces, green-house effects, etc.
Transient thermal flow in heated ducts at variable mass flow rates.

Research Equipment

Kelsh plotter, several analog field plotters, Alwac III-E digital computer, two analog computers.

Marquette University

Faculty

John P. Bradish, M.S., Wisconsin, nuclear engineering heat transfer.
Evan H. Greener, Ph.D., Northwestern, materials science.
Walter M. Hirthe, Ph.D., Northwestern, materials science.
John Linehan, M.S., Rensselaer, nuclear engineering.
John J. Lonergan, B.M.E., Marquette, production.
Richard J. Panlener, B.M.E., Marquette, refrigeration.
Wilfred J. Rebello, Ph.D., Purdue, combustion.
Bobbie L. Richardson, Ph.D., Purdue, nuclear engineering.
Alfred O. Schmidt, D.Sc., Michigan, metal processing.
John E. Schoen, M.S., metallurgy.
Erwin G. Spewachek, M.S., Wisconsin, industrial engineering.
Peter H. Wackman, Ph.D., Pittsburgh, materials science.
Elmer J. Weiter, B.M.E., Marquette, vibrations.

Current Research

Investigation of electrical and mechanical properties of transaction metal oxides.

Effect of combustion deposits on thermal characteristics of internal combustion engines.

Studies of friction under dynamic conditions.
Simulation studies of nuclear reactors.
Vibration studies in metal processing.
Boundary value problem solution on an iterative analog computer.

Analysis of natural circulation boiling.
Thermoluminescence in polar semiconductors.
Study of the three-body model of Lithium-6.
Industrial systems simulation.

Research Equipment

Inston testing machine, C.S.I. model 5800 analog computer, IBM 1620 computer, X-ray diffraction facilities, extensive instrumentation, vacuum systems and thermal systems for material research.

University of Santa Clara

Faculty

Henry V. Hahne, Ph.D., Stanford, engineering mechanics.
Henry A. McKenna, B.S., Santa Clara, production processes.
Richard K. Pefley, M.E., Stanford, combustion.
Jack A Peterson, M.S., Idaho, controls.
Michel A. Saad, Ph.D., Michigan, thermodynamics.
Harold M. Tapay, M.S., Kansas State, stress analysis.

Research Equipment

Computer center with IBM 1620 computer and analog computer.

Supplementary Information

A master of engineering program is offered. It has an enrollment of ten full-time and 450 part-time students. Research and graduate assistantships provide $1800 plus tuition.

Seattle University

Faculty

John Avery, B.Sc., low cycle fatigue, two step history.
Lewis Filler, Ph.D., fluid mechanics.
Harry Majors, Jr., M.S., thermal fatigue.
Stephen Robel, M.S., mechanics of heart valves.
Robert Viggers, M.S., control systems.

Current Research

Thermal fatigue under combined stress.
Mechanics of flow of blood.
Studies in heart valves.
Design of blood pump.

Research Equipment

Thermal fatigue machines, high speed strain gauge recording instruments.

THEORETICAL AND APPLIED MECHANICS

Marquette University

Faculty

Abdel F. Elkouh, Ph.D., Wisconsin, fluid mechanics.
Robert A. Greenkorn, Ph.D., Wisconsin, properties of fluids.
Robert E. Harloff, M.S., Wisconsin, behavior of materials.
Joseph E. Matar, Ph.D., Michigan, elasticity, plasticity, fluids.
William G. Murphy, M.S., Illinois, soil mechanisms, foundations.
Hui Pih, Ph.D., Illinois Institute of Technology, photoelasticity.
William L. Reitmeyer, M.S., Marquette, astronomy.
Ali A. H. Seireg, Ph.D., Wisconsin, vibrations.

Current Research

Effect of location of damping on transient response of vibratory systems, stability of vibratory systems with strong non-linearities, impedence effects on impact force and dissipation of energy, some studies in dynamic friction.

Stratified flow, fluid flow in a porous media.

Local subsurface stratigraphy, physical properties of soils, behavior of piles, composite structures.

Photoelastic studies of inclusions and cavities in three-dimensional bodies, studies in dynamic photoelasticity, photoelastic coating method in plastic stress waves, three-dimensional photoelastic investigation of threaded joints, exploration in the non-destructive method in three-dimensional photoelasticity.

Photoelectric investigation of the Orion Nebula, photoelectric determination of galactic redshifts.

Research Equipment

Computing center with IBM 1620 computer and analog computer, electron microscope, photoelastic laboratory, vibration laboratory.

BSCS: AN ANALYSIS OF THE NEW BIOLOGY CURRICULUM

RICHARD S. SMITH

BSCS, Blue, Yellow, Green, Salmon, Blocks, and various other supplementary terms and materials are becoming a focal point of interest and discussion in the field of biological education. What does it all mean? Is it new? Are teachers to become intermediaries for national curricula? These and many other questions are currently in the forefront of secondary school biology education. In the succeeding paragraphs, I shall hope to answer the previous questions and many like them to which I have been exposed.

My own experience with the Biological Sciences Curriculum Studies (BSCS) began in the summer of 1960 when I was a member of a writing team composed of thirty high school biology teachers and thirty college and university professors. This in itself I found to be unique, compared to the usual two to three authors of a textbook. It has provided the curriculum itself with a vast amount of experience and direction with regard to level, accuracy, and current and projected emphasis. The entire program owes much to many.

Its Purpose. From its inception the BSCS was charged with multiple responsibilities. As Dr. Bent Glass has stated:

> The BSCS was to study the defects of present biology teaching at all levels and to provide specific programs and materials to bring curricula up-to-date and to focus them more sharply on what a consensus would hold to be the major objectives of biology teaching. (1)

But to direct its activities at the onset "to all levels" was not feasible. Therefore, while admitting that the need for curricular study at the elementary and college levels was vital, it was decided to focus primary attention on the high school biology course.

Extensive discussions by the Steering Committee provided direction for the BSCS. This committee made several key observations:

a. Significant biological knowledge is accumulating at an almost logarithmic rate; it therefore becomes impossible to "cover" in one course all that a citizen might profitably know.

b. In the past half century, it has become increasingly evident that biol-

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ogy is being taught as a body of "true" information with unchanging laws; and that the provisional nature of knowledge and the concept of biology (and all of science) as a body of methods of inquiry were being sadly overlooked.

c. Vast differences exist between the biochemical, behavioral, and ecological approaches to biology; it is apparent that there is no one best way to organize a biology course.

d. Regardless of organization, subject matter content in a biology course should accent certain fundamental biological themes: themes of evolution, genetic continuity, behavior, regulation and homeostasis, complementarity of structure and function, complementarity of organisms and environment, and diversity of type and unity of pattern in living things.

e. Finally, a departure from strictly observational laboratory methods to real involvement in scientific inquiry is necessary in order that future citizens fully understand the nature of the scientific revolution that affects their daily lives.

These observations served to direct the BSCS in its effort to correct the inadequacies of an antiquated biology curriculum.

Content Emphasis. From the writing conference and two subsequent revisions there has arisen, under premise (c) above, a program for tenth grade biology with three different patterns of study, but with a core of 70% similar information.

Since it was desired to keep these "versions" at the same level, and in order not to convey any idea of preferred sequence, colors were picked as titles. Thus, it was hoped that there would be no tendency to pick one as more difficult or better than the others. Taking into account the core of similar material, the three versions may be identified by their differences.

The Blue Version has been tagged by its emphasis on the molecular level of life, and its origin and evolution. The Yellow Version uses the cellular level as the basis of organization. The Green Version, with a "dissection" of the biosphere, represents an ecological approach.

Unfortunately, in some respects, this has led to erroneous ideas about the scope and sequence of the entire course. It should be understood that one is not training a molecular biologist, cellular physiologist, or ecologist, nor does a teacher have to be a specialist in one of the three fields to use the suggested version. Although each course has its own flavor, the major emphasis is still 70% the same with organization of all materials around the themes stated in premise (d).

Laboratory Orientation. Closely correlated with each textbook is a laboratory guide. An attempt has been made to emphasize genuine laboratory investigations rather than exercises. It has been a new and sometimes startling experience for our students to find not all the answers easily available. Instead, an investigatory situation prevails. The pupils have an opportunity to reason, practice inquiry, and function much as a scientist operates in his research laboratory. This is not to say that academic structure is completely ignored. I believe more factual material is present than can possibly be covered in a tenth grade course. It does mean that the true student has the opportunity to think for himself rather than be led by the hand through a structured, memorizable, step-by-step, content oriented exercise.

To many teachers this is a disadvantage because activity becomes imperative. Materials must be obtained, washed, and returned. Apparatus and instrumentation set up, stored, or observed. The pupils do not sit quietly from the beginning to the end of the period drawing pictures of the internal organs of a preserved frog, or tracing the petals of a flower. In the Blue Version, for instance, the seed is planted, germinated, and grown using different temperature and lighting time to see the end product of flowering. All this takes time, space, and student ingenuity in observing day-to-day changes. It also requires 10–15 minutes per day of class time to check these changes.

At no time does a pupil actually sit down and memorize or draw the parts of a monocot or dicot seed, root, stem, or flower. However, it has been my experience, using the program, that understanding of growth and development leads to a close association with the previously mentioned anatomy. Again in the Blue Version the student studies the frog from fertilization through tadpole development. He is exposed to extensive terminology, but is at no time expected to sit down and memorize these as in a taxonomical exercise. Therefore, to those teachers whose keynote is quiet regimentation, the laboratory program has and will be an area requiring considerable adjustment.

Not only is the type of laboratory work changed but also the time element is increased. With the many opportunities presented for laboratory experiences, laboratory class time is almost doubled. Whereas I previously conducted about one hour of structured lab per week, I now find at least two and often three hours are necessary. This does not always have to be a full period, but frequently becomes 20–30 minutes per day for five or six consecutive days. If one is going to use BSCS it is highly recommended that there be at least one double laboratory a week out of a six- or seven-period schedule. I have not been this fortunate and feel my present schedule of five 45-minute classes is very inadequate to do justice to the course.

Change of Equipment and Supplies. In light of the increased emphasis on laboratory procedure and design, there is a greater equipment and supply requirement. Equipment such as refrigerators, gas ovens, incubators, sensitive balances, power supply units, and the like, are a necessity. (In many instances a refrigerator has become a status symbol of BSCS biology.) Furtherfore, binocular microscopes assume as much importance as the monocular in working with living specimens. In the area of supplies or expendable materials, biochemicals, culture tubes, pipettes, and miscellaneous glassware are commonplace. However, former budgetary allowances for preserved specimens are literally nonexistent. Running water in at least four work areas along with gas and electricity is a minimum prerequisite. I have found that my yearly operating budget has not increased appreciably, but rather the money is directed and allocated for different types of material. Two BSCS consultants, Norman Abraham and Alfred Novak have estimated at least $500.00 per year per biology teacher for perishable items such as living organisms, biochemicals and reagents, glassware, etc. "This fund should be flexible enough so that teachers may purchase supplies as they are needed throughout the year." (2)

Level of Content. As previously mentioned, the goal of the BSCS writing conference was a course for the average tenth grade student. Since more students are known to take biology than any of the other sciences in high school, this could not be, and is not a course for only the college-bound student.

I taught the Yellow Version one year, and the Blue another. In both instances the course was well received by most pupils. However, in the test year the course was found to be too difficult for the lower 20–25 per cent of the tenth grade. The main problem was the reading and comprehension level of the so-called slow learner. It might be noted here that both versions did equally well for our students. (I am currently at a loss about which version to use for the fall of 1963.)

Possible Disadvantages. In general, there is the time factor. There is a tremendous amount of teacher preparation for lab work which I cannot see being eased in the foreseeable future. Cultures, living organisms, and solutions are in constant demand. This means the teacher, and hopefully laboratory assistants, must start materials early so they are in the right stages, sometimes weeks ahead of use. The teacher must maintain working hours after school and often over weekends.

For those teachers who have been away from formal schooling for five years or longer, there is an almost inevitable reschooling needed. Many students in undergraduate training today are not ready to handle these modern concepts of cell physiology, photosynthesis, microbiology, and evolution.

If the instructor has not kept abreast of recent advances in modern biology, his traditional training in descriptive biology certainly needs a retreading. Although BSCS has trained many in briefing sessions, and others have attended in-service or NSF Summer Institutes, an extensive system of training will be necessary when wide-scale publication becomes available in the fall of 1963.

Hopefully, it is anticipated that administrators will encourage teachers to obtain special preparation before these materials are adopted. The BSCS Newsletter constantly list these teacher training opportunities.

A possible drawback in relationship to lab work is the space requirement. Students must have storage areas to maintain experiments over long periods of time. Adequate shelf and cabinet space is generally lacking in traditional biology classrooms. Some teachers will question the return value of the extended laboratories and the mathematical analysis required in most growth and development sequences. As rebuttal, I offer that many of our students realized for the first time the sophistication of not only biology, but science in general.

If one is concentrating solely on training students to pass college board achievement tests in biology, there is still a wide gap between the type of descriptive question in the exams and student training in BSCS. It was my experience this year that students who took BSCS biology in 1960 (the first test year) and are now seniors, had a much more difficult time and lower Board scores than those in our 1960 traditional biology courses. However, BSCS has been assured that if any inequalities do exist appropriate adjustments will be made.

Other BSCS Materials. Another approach to the teaching of sophomore biology is called the Laboratory Block program. Each Block is designed for six weeks of extensive study in one area of biology. This time is entirely laboratory and offers many open-ended extensions for student investigations. These are not designed for specific versions, but rather to augment the teaching of scientific inquiry. At present there are seven of these in experimental editions. They cover subjects from plant growth and development to interdependence of structure and function.

Using three Blocks as a core of material, there is at present in pilot study the 2nd Level Course, a second year of biology. By supplementing and extending the laboratory program with biometrics and using the optional experiments in the Blocks, this becomes a challenging program for the enrichment of students.

Many times during the year my senior students spent extensive time over weekends carrying through their second year course. They learned early that plants and animals don't recognize a five-day school week. The organisms grow, eat, and develop on a seven-day-a-week schedule. How many teachers are willing to activate their students in this manner?

Also, there are several other BSCS projects. These include a pamphlet series, two volumes of biological investigations, a bulletin series, a series of film programs (not to be confused with the AIBS Film Series) and the beginning stages of a slow-learner program. One may keep abreast of these by being placed on the mailing list for the BSCS Newsletter, University of Colorado, Boulder, Colorado.

In Conclusion. As we have seen, BSCS is a cooperative effort among research scientists, high school teachers, and others, to produce an acceptable modern biology course. Although the content has been completely updated in light of modern knowledge, the accumulation of factual material is secondary to understanding of the ways these facts are derived. In an ever increasing scientifically oriented society, it becomes imperative that the populace attain an insight into the scientific enterprise. In my experience to date BSCS has come closer to attaining this goal than any other curriculum to which I've been exposed. A complete evaluation and the course's impact must wait upon widespread use of the program.

There are many able biology teachers and programs in the United States. To these, perhaps, BSCS will offer no advantages. However, for the majority of us, BSCS has given a design and direction with worthwhile attributes.

The last three years have been the hardest and most time consuming of my fourteen years of teaching. Yet, I feel BSCS has led me from a repetitive, cookbook teacher of facts, to the verge of being a fairly able teacher of science. Finally, in terms of my classes, there has been an evolution from general disinterest to a lively appreciation for man's inherited ecological niche.

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1. Glass, H. B. 1961. "A New High School Biology Program," *American Scientist*, Vol. 49, No. 4, p. 525.
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Haverford Senior High School, Havertown, Pa.

CBA: THE CHEMICAL BOND APPROACH TO CHEMISTRY TEACHING

LOUIS W. BIXBY

If one were asked to condense, in a short phrase, the philosophy of Chemical Bond Approach (CBA) chemistry, "A Chemist's View of Chemistry" would do nicely. Students have, by the end of the course, a true basic understanding of the factors which constitute a chemical reaction, what makes a chemical reaction "go," and why some things react readily and others do not.

The answers to these problems are learned, not by rote, but by investigating a relatively small number of reactions in the laboratory and in the classroom. The observations and learnings regarding these reactions are then applied to a great number of chemical substances and reactions. New concepts build on old ones, and change as the need arises. Hence the student emerges with a useful core of basic chemical knowledge which he can apply to many situations. He is encouraged to seek his own answers *and* is able to do this in the majority of cases.

Basic Knowledge. What is considered "basic chemical knowledge"? The authors of the CBA text and laboratory manual took into account the fact that chemical knowledge is doubling every ten years. It was obvious to them, and to many teachers, that any beginning course which purports to present an overview of chemistry cannot economically present too many specific reactions or processes.

Therefore, the authors tried to write a course based on ideas which would be valid and useful for a reasonable period of time—at least one generation. A few of these principles and concepts are: chemical bonding, ionization potentials, electronegativity, covalent and ionic radii, and molecular geometry. Modern chemical theories involving energy relationships, orbital theory, acid-base ideas (all three), equilibrium, and dipole interactions are also presented.

The foregoing paragraph outlines briefly *what* is presented in CBA chemistry. It may be argued that any up-to-date teacher presents these concepts to his students anyhow. The beauty and uniqueness of the course lies, then, in *how* it is presented. How does CBA differ from a more traditional pedagogical approach to the teaching of chemistry? The scientific model plays a key role in this process.

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Model Building. The student is introduced to model building through a so-called "black box." This is a sealed container. He is not aware of the contents except by reason of his ability to construct a mental model from manipulatory procedures. This experiment gives the student a real "feeling" for the problems involved in constructing a mental model of atoms and molecules. Next, he builds a model of "What constitutes a chemical reaction?" by pouring a series of reagent pairs together. His conclusion, incidentally, involves a change-in-temperature observation in almost every case.

This is the foundation upon which he later builds his concept (model) of energy. Geometry the (packing of spheres) is involved in the student's first molecular model, which he constructs from consideration of electrostatic forces between particles. He finds this model useful in explaining some physical constants of substances studied. Later, this model, the charge-cloud model, is found inadequate to explain energy levels in the atom. The orbital model is then invoked.

This picture of chemical substances is a continually developing and expanding one in which ideas learned today are dependent upon and substantiated by former concepts. Other models which emerge as the course progresses are: energy, acid-base theory, equilibrium, and the periodic nature of matter. The student arrives at his zenith of accomplishment when he measures, through consideration of energy as a model, the heat of formation of solid ammonium chloride.

An oft-heard criticism of CBA chemistry involves the observation that there is little descriptive material presented. For instance, what about reactions of the carbonate ion with acid and heat; "active" metal carbonates versus "inactive" metal carbonates, etc.? True, these ideas are not taught per se. Rather, the students learn principles (i.e., ionic and molecular size, electron density, and the relation of these factors to reactions) and are able to apply these ideas to the carbonate ion and to many other chemical species as well. The Haber Process is never spelled out in the text; rather, the student acquires enough knowledge of the nature of nitrogen so that he can predict what would have to be done in order to make it react with hydrogen.

There is no chapter, as such, on stoichiometry in the CBA text. In chapter two, the student is confronted with some reaction data which he proceeds to graph; he then draws conclusions relative to reacting quantities. Later, he is introduced to the mole and figures out his own method for solving chemical problems. This comes as a matter of course—and is, incidentally, a continual source of wonder to the writer, who learned his stoichiometry the hard way—by rote!

Student Reactions. Do students like CBA chemistry? It seems obvious that students must be successful to some degree in this new course. In their initial contact with CBA (the first three months), students find the course much "tougher" than traditional chemistry. The main reason is that they are required to do a great deal of original thinking. One student puts it bluntly: "After ten years in school, this is the first course in which I have been asked to do some thinking!" The student who has been getting all A's, by virtue of the ability to memorize, finds himself receiving B's and C's. However, with fortitude and time, pupils learn that they *are* capable of some original thought.

An interesting observation is made on many students who have received poor marks because of disinterest in memory work. Their interest and marks improve and they become genuinely interested in the subject. Students are especially fond of the laboratory. They are required to do individual work in a blank notebook and become particularly proud of their own observations. The writer attributes this to the scientific attitude in CBA—that there are no "wrong" observations if the student makes them honestly.

Students are encouraged to pursue reasons for unusual results. Many of the better students see the need to inquire into a specific subject further and refer to a variety of college text books for answers. It is significant that they are able to use these texts meaningfully and to expand their fund of knowledge independently. They doubt, analyze, and generally develop ideas which would never even appear in a more traditional type of chemistry course.

The Laboratory. CBA chemistry recognizes that the laboratory is the place where students make specific observations. From these observations, the student is able to arrive at broad generalizations which enable him to understand and predict specific properties of a species. Laboratory experiments have often been described as being "vertically developed." The various conceptual themes (model building, reactivity, structure and properties, stoichiometry, and thermochemistry) are developed gradually in the laboratory through experiments which get progressively more difficult and complicated.

The student is made to feel that it is within his power to learn facts and to originate ideas. Typical laboratory directions of more advanced experiments are: (1) "Obtain experimental data relative to the stability of the substance or substances assigned to you." (2) "You will be given a set of numbered test tubes containing substances to be identified. The specific names of these substances will be given but the names will not be associated with the specific numbers in the test tubes. You are to determine which of the substances is in each test tube."

Teachers will recognize the second set of directions as an approach to qualitative analysis. Prior to the experiment, students study solubility principles and then are given a handbook to look up characteristics of the various substances assigned. The result is an original flow sheet for qualitative analysis. Patterns derived from laboratory observations lead to new observations and new patterns. Students are encouraged, through this process, to explore extensions of experiments. Many times, they arrive at ideas not anticipated by the instructor. Time to work on these extensions is a problem, and apparently will remain one.

Teacher Reactions. Do teachers like CBA chemistry? A friend of the writer attended an advanced placement chemistry institute last summer. Five CBA teachers were in attendance. His comment regarding them was: "They're really nuts; all they talk about is CBA!" Whatever else the reader may imply here, we must say that this is fairly typical of "old hands" in CBA. Institutes in CBA chemistry have been very successful. The writer, who has taught CBA at Reed College for two summers, has discovered that teachers react much the same as students.

At first, they are amazed at the difference between CBA and the traditional approach. They also start out feeling quite lost when they see the need for original thinking and application of principles seldom used. Enthusiasm grows, however, as knowledge of the CBA method increases. Many teachers who have had physical chemistry find themselves gaining a *real* understanding of the concepts of entropy, enthalpy, and free energy. The teacher usually emerges from an institute with apprehension about teaching such a new approach, but with enthusiasm for the prospect. After a year of teaching the course and increased familiarity with the materials, teachers are usually sold on the approach and would not return to former methods.

Some Drawbacks. It would be unfair and wrong to present a completely rosy picture of CBA. In the first place, it must be admitted that it takes more time than the usual course. Most teachers simply reckon with this and spend the extra time. It is hoped that eventually administrators will recognize this fact, but we are not optimistic on this score. Is the time worth the effort? *Yes!*

In the second place, students ask more embarrassing questions, questions to which the teacher has no ready answers. If the teacher really feels he should have "all the answers," CBA is not for him. This is quite a source of delight for many teachers and, with the proper approach, can be turned into a useful teaching tool.

In the third place, teachers have not been able to complete the text in the time allotted. This does not concern too many teachers, for the basic aim is not to finish the book—but to teach well as much as is covered.

CBA has been tried with at least one very slow group (IQ around 80). The teacher only got half the course completed, but felt that he accomplished more with CBA than he would have with any other text; the students *did* learn something.

The course has been taught to average classes, large classes, small classes; in short, to a complete spectrum of classroom situations. It has not been found to be particularly college-oriented or only for the "good" student. For the past two years, I have taught it to average students in Weedsport, N.Y.—an upstate centralized district. This was the only chemistry course offered.

A salient characteristic of the CBA student is that he is able to answer a number of interesting questions concerning chemistry. A teacher contemplating the course might well ask himself if this is a worthwhile goal. Does he feel that his students should be able to answer them? With this in mind, read the following:

Using your knowledge of chemical principles, explain each of the following:

1. Despite the strong forces that hold ions together in an ionic crystal, only a small amount of energy, at most, must be added in order to dissolve an ionic compound in water.

2. All metallic ions except those having a large size and a low charge would be expected to form definite hydrates.

3. It is reasonable to expect that the following chemical process will be endothermic: $S_{8(g)} \rightarrow 4S_{2(g)}$.

4. Water, a common chemical species, is considered one of the most unusual and interesting chemical substances. Explain how it is unusual and give reasons for these properties.

St. Louis Country Day School

THE CHEM STUDY COURSE: AN OBJECTIVE APPRAISAL

HERBERT BASSOW

Ever since I began teaching the CHEM Study approach, I have been asked repeatedly by fellow teachers, "What's this CHEM Study all about? What do you think of it?" I am pleased indeed to have this opportunity to respond to these questions. Before I do, however, let me make one point very clear: I am simply a teacher who was invited to scrutinize the CHEM Study materials, and subsequently decided to use them in my own classes.

I have no official connection with the CHEM Study staff, nor was I involved in the writing or planning of the course. The most I can claim is that, as I attempted to teach the material, I sent various suggestions and objections to the CHEM Study people. Having said this, I would like now to say a few words about the program itself.

Why a Totally New Approach. First, why in the world try a totally new approach? After years of refining and polishing one's own course, developing the demonstrations and supplementary materials which when used with some standard text make the whole affair palatable, why would anyone in his right mind give this all up? Why would anyone then attempt to struggle with something totally strange—something he had no part in developing?

This is indeed the question I faced, as would anyone contemplating such a change. To be sure, there is the novelty and excitement of something experimental, something different—the chance to climb out of that large rut. But more than this, in my own case at least, there was a deep sense of dissatisfaction with existing texts and syllabi, and with what these sources were asking us as teachers to emphasize. And because we, as high school teachers, have neither the time nor in many cases the background to develop new materials, we would certainly be receptive to almost anything new that professional chemists and educators could work out for us.

If we then agree that, being fed up with equating the preparation and properties of oxygen, hydrogen, and carbon dioxide with chemistry, one is psychologically ready for something new, why CHEM Study? I have seen other new approaches which I wouldn't touch with a ten-foot pole! Why this one? The only answer I can give is a personal one: that to me, the CHEM Study philosophy and approach makes sense; its emphasis is

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the proper one for a beginning course in the experimental science we call chemistry. What is this emphasis?

In a word, it is the laboratory. From the title, "Chemistry—An Experimental Science," through the final examination, there is no mistaking this. I have never seen a course in which textual material, examinations, indeed the entire undertaking, is so tied up with the laboratory experiments. It was this feature, more than anything else, that enticed me into adopting the course. Perhaps a few illustrative examples would now be appropriate.

Observing a Burning Candle. The very first suggested activity is not the assigning of lab desks, not the filling out of forms, not teacher-demonstrated lab techniques, not any of the dull routines we usually start with. Rather it is the observing of a burning candle by each individual student, and the recording of these observations.

Right away the stage is set: careful observation is put at a premium. When the text is distributed the next day, the student can then compare his own observations of the candle with those of a professional. Right away, too, the asking of questions is encouraged. What, for example, is the pool of clear liquid seen to form in the bowl of the burning candle, immediately below the wick? Is it simply molten candle material?

This possibility sets the stage for several experiments concerned with melting behavior. It culminates in a take-home experiment with simple household equipment that is reminiscent of Michael Faraday's Christmas Lectures on "The Chemical History of a Candle" (now available as a paperback: Viking Press Explorer Book #X4).

Energy Changes in the Lab. Next, energy considerations—oh so neglected by us all—are tied to the candle investigations by simple calorimetric determinations of the heats of combustion and fusion of said candle material.

Thus the heats of reaction, so much a part of the subsequent development, have some meaning for the student because he has determined one, however crudely. I say crudely in a praiseworthy sense because, using such everyday equipment as a candle, balance, thermometer, and tin-can calorimeter, the student finds he can make some fairly impressive measurements.

Later on, by substituting a beaker for the tin can, the student performs another experiment in which he records temperature increases for (1) the dissolving of solid NaOH in water, (2) the dissolving of solid NaOH in aqueous HCl, and (3) the mixing of aqueous solutions of NaOH and HCl. He can thus determine these three heats of reaction, see that within the precision of the experiment $\Delta H_{(1)} + \Delta H_{(3)}$ does equal $\Delta H_{(2)}$, and hence is experimental proof of Hess's Law. When the text subsequently discusses thermochemistry, this experiment is the springboard.

Experiments With Chemical Equilibrium. One further example of how the experimental approach is emphasized: the study of chemical equilibrium. Here the classic reaction of Fe^{3+} and SCN^{-} to form the colored $FeSCN^{2+}$ ion is studied colorimetrically.

By introducing a large excess of Fe^{3+} into trial one, and making the assumption that all of the known concentration of SCN^{-} initially present has therefore reacted, the student can fix the concentration of the $FeSCN^{2+}$ formed.

In later trials he cuts the Fe^{3+} concentration repeatedly, and compares the color densities of the $FeSCN^{2+}$ products with that of trial one. Then, using the stoichiometry he has already learned he is able to calculate equilibrium concentrations for all species.

A little fiddling with the numerical values of these concentrations reveals that there is one mathematical expression for them which gives a constant result throughout the trials: the so-called equilibrium constant expression.

Using this example, and a similar treatment of hydrogen iodide equilibrium data, the text is then able to develop the law of chemical equilibrium on a purely experimental basis. But this is exactly what the student has been exposed to.

The obvious advantage of such a straightforward approach over some of the more exotic thermodynamic developments proposed in other "beginning" courses is another example of the seriousness with which the laboratory work is treated. It is hardly surprising, therefore, to find the students completely absorbed in their laboratory work, and quite excited about the things which evolve from it.

Organization and Content. Now a few remarks about the organization and content of the material, which is divided into three main sections. The first six chapters attempt an overview, in which the scope of the course is previewed, and necessary background material developed. Designed roughly as one-fourth of the total course, this overview section is concerned with such things as atomic-molecular theory; weight relations, the mole concept, and stoichiometry; the behavior of gases; an introduction to solutions and to the solid state; and a brief look at descriptive chemistry via the periodic table. There is a deliberate lack of development here, for the sake of brevity. This lack was the target of most of my objections.

The text does promise the student a return in depth to such concepts as the nuclear atom, but this promise is only partially kept. I shall return to this point later on in my remarks.

The 'Meat' of the Course. Roughly one-half of the course—the "meat" of it—is then devoted to what, for high school work, must be called a thorough study of such subjects as thermochemistry, reaction mechanisms and kinetics, chemical equilibrium, the Brönsted-Lowry acid-base theory, oxidation-reduction via the study of voltaic cells, and chemical bonding.

For the most part, these areas are introduced in the laboratory, and are skillfully woven together so that there is a logical flow from one to the other. Thus the acid-base chapter is essentially the study of chemical equilibrium in aqueous solution.

If one mixes solutions of NH_4Cl and NaOH, for example, the odor of ammonia indicates that the reaction

$$NH_4^+ + OH = HOH + NH_3(g)$$

has proceeded virtually to completion. From the Brönsted definitions, we may then rank NH_4^+ above HOH as an acid (it donated the proton), or picture OH^- as a stronger base than NH_3 (it accepted the proton).

In like manner, an entire table of relative strengths of acids and bases is experimentally constructed by focusing on equilibrium concentrations of reactants and products. The subsequent redox chapter treats half-cell reactions in the same way, substituting the transfer of electrons for the proton transfer mechanism mentioned above.

The bonding chapters, comprising the latter part of the principles section, are understandably not quite so neat. An attempt is made to picture all bond formation as due to the more favorable energy condition that must result from the simultaneous attraction of electrons by more than one nucleus. Orbital shapes and occupancy rules are presented dogmatically (would there were some other way in an introductory treatment).

It is here that the laboratory approach is, in my opinion, unfortunately abandoned. After suggesting that the atomic hydrogen spectrum does shed some light on electronic energy levels, the text then proceeds to ignore the discrete spectral lines, and develops instead an analogy which substitutes for the lines the discrete notches for the sliding weights of a triple-beam balance. The student is thus deprived of working with actual experimental data (the wavelengths of the spectral lines), and therefore misses the chance to trace the way in which purely mathematical treatment of data can give insight into—and even suggest—physical models.

A Basic Weakness? Indeed, if there is a weak point in the course at all, I feel it is the lack of development of theoretical models from experimental data. After the neat way in which such things as Hess's Law, equilibrium, and acid-base theory are built up from the students' own laboratory experiments, it is disappointing to find this kind of thing lacking in the presentation of atomic weights and chemical bonding. Fortunately, this lack of development of some of the important models of chemistry can be filled in by those teachers who feel the need for it, so that this need not be a serious problem.

The third and final portion of the course is devoted to a systematic study of the descriptive chemistry of the elements, and is built around the organization of the periodic table. The beautiful thing about this section is the way in which it uses descriptive chemistry to emphasize the principles introduced earlier in the course.

Thus, the chapters on organic chemistry review and apply the principles of reaction mechanisms and chemical bonding, while halogen chemistry does the same thing for half-cell type redox reactions and electrochemistry. It is here that the student really learns to appreciate the usefulness and power of what he has already learned, and it is here that he finds himself looking at reacting systems much as a chemist would.

By considering a given set of reactants potentially capable of either acid-base, redox, or precipitation type reactions (complex ion information is also considered), he now finds himself able to predict both the extent and probable products of a reaction. Note again the use of the laboratory. Instead of the later experiments becoming boring, cut-and-dried cookbook exercises, they are instead a challenging chance for the student to apply and strengthen what he has previously learned.

Adding it All Up. In summary, then, I see the CHEM Study approach a sound and exciting program for the teacher who is ready for a change. It can be used as is, or modified slightly to suit one's own preferences. The CHEM Study staff has also prepared a detailed Teachers Guide of background material for both recitation and labwork, and has produced a fine set of educational films that are specifically designed for use with the course —but would be an asset to any other chemistry course as well.

I am critical of portions of the material, to be sure (what two chemistry teachers could ever agree on how to teach chemistry anyway?). But the positive advantages so far outweigh those few things I personally see as drawbacks, that I am delighted indeed with the course, and shall continue to teach it.

The Fieldston School, New York, N.Y.

Why Teach PSSC Physics?

DON WESTIN

Is the PSSC Course Worth Switching To? What are the advantages? Is it more difficult to teach, to learn? Is it expensive? Can the "average" student "take it"?

These are the typical questions asked by teachers of physics who have read about, but have not tried teaching, the Physical Science Study Committee course for secondary schools in physics.

First, and foremost, I would suggest that the PSSC approach is more *valid science*. This course goes a long way toward meeting the aims, expressed by such able physicists as Dr. Kusch (Teacher's Edition, *Science and Math Weekly*, Oct. 10, 1962), for which any good, fundamental course in science should strive:

(a) an appreciation of the nature of the statements that science makes.

(b) an understanding that science has limitations.

(c) above all, a grasp of the broad outlines of man's present-day picture of his world.

(d) good instruction must involve thorough understanding of a common core of substantive knowledge—competence in carefully selected ideas rather than encyclopedic superficiality.

How often have you said: "Boyle's Law can be boiled down to $PV = P_1V_1$. This is it. Learn it! You'll be given 5 problems with three out of four quantities known; solve for the 4th, or unknown"? Egad! how dull! and so it goes, rush, rush, get the stuff across; teach facts, facts, everything that physicists have learned since Galileo. A shotgun approach which wounds the students, dulls the teacher, and is simply poor science! The regular course too often consists of a long list of *what* the physicist has learned—never mind *how* he learned it, or what *confidence* we can place in his findings.

> In the present-day era of science and technology it would seem that an essential part of a liberal arts education involves an understanding and appreciation of the nature of scientific inquiry. It is as important to know how the scientist works as it is to know what he has learned. In order to gain these insights the student must experience the scientific process for himself. It is only through such experience, however limited, that the non-science major can hope to gain a genuine and long-lasting understanding of science—one devoid of mystery and image of the strange man clad in a white jacket.

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The above is the aim of the PSSC course—ably expressed by F. L. Ferris, Jr. in the *American Journal of Physics,* March 1960.

The PSSC course is divided into four parts. *Part I* deals with: Time, Space, Motion, Mass, Matter, and Measurement; *Part II:* Behavior of Light, Geometric Optics, Wave Motion, Interference and Diffraction of Light and Waves in general; *Part III:* Force, Momentum, Conservation of Momentum, Kinetic and Potential Energy, Heat Energy and Molecular Motion, Conservation of Energy; *Part IV:* Coulomb's Law and Elementary Electric Charge, Charges in Electric Fields, Magnetic Fields, Electromagnetic Induction and Electromagnetic Waves, Photons and Matter Waves, Quantum Systems.

The above listing is as dull as the usual course, and by itself tells little. *The vitality and life of the course comes in with the "approach" and the the use of the laboratory as a true source of learning experience.*

What does this mean? From the very beginning, the PSSC course seeks to develop in the student certain basic skills which are the fundamental tools of any scientist, such as facility in using graphic methods, of judgment in showing relationships between variables, in interpretation of data from an algebraic expression *to* a graph and *back* again. Here is a two-way street—is it in your math course in your high school? (Incidentally you'll find your students understanding much of their math for the first time.)

The ability to apply knowledge to an unfamiliar situation develops. Ability to make relevant observations comes; the ability to formulate a simple scientific model and make predictions based on the model grows. Ability to suggest new lines of investigations, ability to make "valid" conclusions and approximations based on observations and data—all appear.

Let me illustrate: many of the phenomena of light, such as reflection, shadows, light intensity, geometric optics, etc., lead to an acceptable model of light as "little bullets" or particles, and the model seems at first eminently satisfactory. When investigating the refraction of particles—a beautifully simple experiment involving rolling balls from one level down a ramp onto another level surface, leaving tracks on a paper covered with carbon paper, the student sees that particles bend "toward the normal" if they are speeded up.

He is one with Newton. But alas he soon learns that measurements of the speed of light in glass or water is *less* than in air—so the particle model has to be modified. What is it that makes light bend? What model is needed? We're at a temporary dead-end in our study of light.

Let's look at waves and see how they behave. So, for a few weeks, the student investigates wave phenomena in a way that is much more thorough than you and I ever were subjected to in college. Inexpensive ripple tanks, slinkeys, microscope slides, carbon emulsion, razor blades, cellophane, graph paper, pencils, generate a delightfully new awakening of constructive and destructive interference—in several types of "waves."

Refraction of waves toward the normal necessitates a slowing down of the waves—this fact is measured in the laboratory. The student "sees" interference of water waves and has a background to understand "Young's Experiment"—which you and I went through in sophomore college physics with at best a minimum of success. The interpretation of the interference patterns in the water-ripple tanks is one that all students can understand.

The "model" can be measured, the components analyzed with clarity, the hyperbolic family of constructive and destructive loci are not mathematical "formulas" but readily understood results of interference. The theory of diffraction gratings is explained via the ripple tank—not equations which are all too often "black boxes" in a text.

> Thus the PSSC student is faced with a course which makes physics alive to him. He travels along with the authors, discovering things for himself, convincing himself that certain conclusions are inescapable rather than simply being told they are. It is the physicists' method of inquiry, pervading a logical and sequential pattern of ideas, inevitably leading the student to a true understanding of some of the fundamentals of mid-twentieth century physics that justifies the name given to the PSSC course: Physics. (F. L. Ferris, Jr.)

One of the basic themes throughout the PSSC text is "the story of light." Yet, nowhere is there a *definition of light.* The same is true for energy, force, momentum, and the like. No "pat" collection of a few words has much significance. *"By their fruits, shall ye know them" is the approach throughout the course.* Isn't it about time students of science are made aware that "the ability to do work" is a far cry from understanding the concept of energy?

The Laboratory. It is in the laboratory, that PSSC perhaps has its greatest strength—for it is here that the student has his richest experiences. Most of the experiments are so presented, and timed, so as to pave the way for reading the text. The students investigate physical phenomena rather than just verifying known conclusions. (Did you ever find the experiment on finding the specific heat of a chunk of metal worthwhile?) *When a student starts an experiment he doesn't know where it will lead, and by self-discovery there is that rewarding joy of learning by one's self—the role of the scientist becomes meaningful.*

The instructions are purposely limited, being devoted for the most part to purely technical aspects—but the leading questions ars most pertinent. You find that the terminal point in most of the experiments is extremely indefinite—for the "average" student there is usually a basic part which all students should finish; but only the better students will get to the more advanced questions, or suggested lines of inquiry.

Furthermore, this process often stimulates the "original-minded" and truly serious pupils to go into extensions of their own, to make up related experiments using the same, or similar equipment. To the never-ending joy of the teacher is the oft-repeated experience of having students devise improvements of their own that are superior to any he has thought of himself—or make more subtle and piercing observations than "teacher" had realized were there.

The equipment needed is simple and inexpensive—both, of course, most advantageous attributes to any school which changes over to PSSC. The expendable materials are exceedingly negligible as to cost—mostly carbon paper, ticker tape, a few batteries, string, and the like.

There are fifty-two experiments in the lab guide, a number which could not possibly be done thoroughly by all. At my school we usually have the students perform approximately 30 by themselves, and about 15 of the others are demonstrated during the course of the year. The remaining half-dozen or so are omitted. How lengthy reports should be required? The answer is as varied as the faces of many politicians. I personally favor as simple a report as possible—with all original data recorded as observed; graphing all relationships which are meaningful; a paragraph of conclusions about lessons learned; statements about errors in all data; etc. The "write-up" should not be tedious—*but the report must show an awareness of the import of observations made, a feeling for interrelationships of variables, what conclusions are valid, and so on.*

Any school program which doesn't allow for double-period labs is in need of overhaul anyway—which is another way of voicing the necessity of plenty of lab time for PSSC. If the course is to be done well I would suggest a minumum of 7, 45-minute periods a week; or 5 full hours periods. *Plenty of time is needed for discussion of the ideas; a good many of them are not easy to come by.*

However, I must say, that to end the story before the last chapter is to take much of the spice out of the dressing—for it is in the last four chapters that the student is given the opportunity to get acquainted with some 20th century ideas.

It is only here that the student is made truly aware of the "limitations" of science; it is only here, in the course, where he has to accept mystery, where he has to accept the dichotomy of *particle* and *wave theory* of electromagnetic waves; the beautiful, but bewildering ideas of de Broglie that modify the Bohr theory of the hydrogen atom. It is unquestionably worthwhile to "finish" if at all possible—for in the act of ending the story the student is able to begin to tie together many of the ideas which have been previously covered.

Additional Training To Teach PSSC Physics? This is a tough one. If you have been out of college only a few years, probably not. But—as is so often the case—if the last time you studied physics formally was 20 years ago—the answer should no doubt be yes. Go to one of the NSF Institutes (Summer) which specialize in the PSSC program—they are scattered all over the country.

If this is impossible, get to be a member of a group of teachers in your area who are teaching PSSC. If you feel weak in field theory, have never had any "modern" physics, I would not hesitate to say that you're heading for trouble with this program without a minimum of a 6-week institute or similar help. The Teacher's Guide, which accompanies the text, however, is a marvelous help—being most complete in working out "solutions" to the questions and problems.

What Year Should it Be Taught? This is another "toughie." Some schools spend a year and a half, or longer, of the 10th-12th year classes, feeling this much time is required in order to do an adequate job. Most, however, spend one year, usually the 11th or 12th grade. At our school we have both 11th and 12th graders taking PSSC Physics, with both age groups doing about equal work. As long as the students have had plane geometry and a good solid year of algebra as prerequisites they'll be in good shape. *Certainly the teacher must demand two years of math background from his students or he will find himself being slowed up too much.* (Incidentally, spending a couple of days with sliderule instruction early in the course is suggested as a must.)

Is PSSC Physics Tougher Than the Usual Course? For the student who thinks science is a bunch of formulas—yes. There is no question about PSSC being a more searching and demanding course for both the teacher and student, for it requires much more logical thinking and *careful* thinking.

You will find that many of the honor students, who have been memory machines, will be introduced to an awakening, to an awareness of the fallacy of this method of obtaining knowledge.

Some Headaches To Be Aware Of. *First*—have you a room which is suitable for laboratory work? By this I mean some fair sized tables, running water, A.C. outlets. But perhaps most important—the room must be available as primarily a physics lab; not used simultaneously by the chemistry, biology, and general science students. To have to "house clean" at the end of every lab period is next to impossible, for you will want to leave a good many "setups," as is, for continued work the following days.

Second—as previously mentioned, you must insist on at least one double lab period per week. Some teachers have had trouble in getting this into the school schedule; but this should be there as an integral part of any decent physics course. Any science department worth its salt can put the needed pressure on local administrators to see that this necessary time is allotted to their department.

Third. Storage of equipment. Several cardboard boxes will handle this problem quite adequately, provided there is room to store the boxes. If each experiment is put away in its own box at the completion of the job the work of the teacher is made so much easier when the times comes to "get ready" next year.

Fourth. Some parts of the text are tough to get across—the teacher has to think of additional and original ways of investigating new concepts. I have found that I have had better luck with certain parts of some chapters by omitting them as far as the students' reading is concerned—and covering the ideas by lecture and discussion.

Fifth. There is probably too much material to cover well in one year. How to pick and choose, without sacrificing continuity, is not easy. Each teacher has to decide this one on his own—which adds to the challenge of doing one's job.

Some Side Benefits. 1. Let the course sell itself. At Mt. Hermon we used the PSSC approach in two sections out of our six, as a trial four years ago. *The trial group was all the sales force needed.* The following year PSSC became the only introductory physics course.

2. Some *superior films* accompany the course. These are largely lab-type movies which demonstrate experiments which most secondary schools find impossible to undertake. (There is need for careful selection here, for far too many are available to be included in a one-year course. We use only about a dozen during the year.)

3. The course will help *stir up the other sciences* taught in your school. At mine, for example, I feel that PSSC Physics has been a great influence in creating beneficial changes in our offerings in chemistry and biology. Our chemistry teachers have, since our adoption of PSSC, thrown out their former "cook-book" lab manual and written their own. They have mimeographed untold pages of supplementary material. We are experimenting with Chem Study sections, and trying to find, in essence, an approach to chemistry that is closely allied to the PSSC approach in physics.

Two of our biology teachers were stimulated to write their own text in this field—now in the hands of a publisher. Both of these able young men give credit to the impetus of the PSSC philosophy in "pushing" them into the long, hard job of making up their own text and devising their own experiments. (One of the them, Jeffrey Baker, is now biology editor of *Science and Math Weekly*.)

4. *Materials for second year,* or Advanced Placement Physics. The headquarters unit, in Watertown, Mass., continues to produce supplementary

and more advanced ideas—both as to written text material and experiment kits. For example, an experimental interferometer costing about $10.00 is ideal for Advanced Placement Physics—or for additional lab work for your truly able students. The new, supplementary ideas to accompany the basic text are stimulating and challenging.

In brief summary, PSSC physics can be a rewarding and exciting experience for both student and teacher. It involves hard work on both sides of the desk—but the returns on the investment are great indeed. If you haven't joined the fold why not give it a chance? You can always go back to the "old ways" but I doubt if you will. (Latest records show almost *no* schools give up PSSC once they have tried it out. Ed.)

Mount Hermon School, Massachusetts.

REPORTS OF SCIENTIFIC ACTIVITY

HIGH SCHOOLS

Boston College High School. At the Boston Archdiocesan Science Fair the high school had two second place winners; Leonard Fenocketti, a senior, with a project on the production of O_3 by the electrolysis of H_2SO_4 and Robert DiMitto, a junior, with a project on cybernetics. During the year 1963–1964 the juniors will take the chemistry achievement tests in the College Boards for the first time, since they will have then finished the CHEM Study program. Fr. Francis Buck, S.J. offered a private course in CHEM Study during the summer to high school teachers. Fr. Edward Hanrahan, S.J. will be teaching PSSC physics during the academic year 1963–1964.

Mr. John A. Hanrahan, S.J.

Fordham Preparatory School. Three students were awarded a place in the 1963 summer program in experimental biology at the Rockefeller Institute. The award includes a $200 scholarship as well as the remission of tuition and fees. Approximately fifteen to twenty students in the metropolitan area are selected for this institute which is conducted for a period of six weeks each summer.

Mr. Raymond S. McCormick, S.J.

Gonzaga High School. Ten scholarships for scientific work during the summer were won by Gonzaga students, one to Georgetown University Medical School, four to American University, three to the Washington Cancer Association, and two to the Washington Heart Association. Fr. Robert F. Mullan S.J. was responsible for the inaugaration of an advanced biology course to be offered during the summer to archdiocesan high schools students at Notre Dame Academy. Fourteen Gonzaga students attended this course during the past summer. The total enrollment for the course was twenty-six students.

Fr. Robert F. Mullan, S.J.

McQuaid High School. The Buffalo Province held a college-high school curriculum conference on February 10 at McQuaid. Father Joseph C. Glose, S.J. presided at the conference and the deans of the province's colleges, the principals of the high schools and representatives from the various science departments in each of the high schools and colleges were in attendance. Also in attendance were Fr. Donald L. Kirsch, S.J., rector of Canisius High School, Fr. Robert F. Grewen, S. J., rector of McQuaid

Jesuit High School, and Fr. Cornelius J. Carr, S. J., province prefect for high schools.

For students capable of advanced placement work in high school, three alternative mathematics curricula were proposed, each of them terminating in a course in calculus. Two of these curricula provided for two semesters of calculus in senior year. It was proposed that, contrary to what has been done in the past, all capable students, even those in the Greek course, be given mathematics in senior year. It has been found by past experience that the omission of this mathematics has hampered students who intend to continue in college in a field requiring mathematics.

The physics committee recommended that the advanced placement program in mathematics is particularly valuable for physics majors in college. Advanced placement in physics was recommended for non-physics majors in order to give them more time for their specialty in college. It was also recommended that selected senior honors students be given training in additional problems with respect to the material covered in class in order to prepare them for taking the advanced placement exam in physics.

The chemistry committee suggested that the American Chemical Society examinations be given in high schools as a final examination from time to time. In order to foster relations between the high schools and colleges it was recommended that a newsletter be started, that awards be given by the colleges to outstanding high school science students once a year and that some high school course work be taken on the college campuses. The committee did not recommend advanced placement in chemistry, principally because of the high minimum standards already set by the American Chemical Society.

Readers of this BULLETIN will be interested to learn that additional advanced PSSC physics course material is being prepared at the Educational Services Incorporated, Physical Science Study Committee, 164 Main Street, Watertown 72, Massachusetts. The advanced topics in preparation are angular momentum, relativity, statistical mechanics and quantum physics. Further information may be obtained by writing to the address given above.

Fr. William T. Suchan, S.J.

St. George's College (Jamaica). The Science Society sponsored an astronomy night for the secondary schools of the area, at which Mr. Desmond Stanley, president of the Jamaican Astronomical Association spoke. The Society also prepared exhibits and demonstrations for an island-wide science exhibition held in Kingston.

For the fifth consecutive year a St. George's student has won the Jamaican scholarship. This year Mr. Lipton Wong won the scholarship by obtaining the highest score in the Cambridge external examinations.

Fr. Raymond McCluskey S.J. has used many of the PSSC laboratory experiments in his courses. The chemistry department has experimented with the CHEM Study program but has not yet employed this program in a formal way. The faculty of St. George's College has been instrumental in bringing these new courses to the attention of the Ministry of Education and to the staff of the University of the West Indies.

Mr. John E. Surette, S.J.

St. Joseph's Preparatory School. Fr. Stephen A. Garber, S.J. attended the conference for teachers of advanced placement chemistry which was held at Macalester College, St. Paul, Minnesota. During this past summer Fr. Garber studied at the University of Pennsylvania under an NSF grant.

Under the direction of Fr. Garber chemistry students are doing research on blood cholesterol under a grant received from the Heart Association of Southeastern Pennsylvania. One of the students delivered a paper before the Junior Academy of Science in the state finals at Hershey, Pennsylvania.

Fr. Stephen A. Garber, S.J.

Xavier High School (Concord). During the first year of its existence, Xavier required a first year physical science course for all students. The principal aims of this program were to provide students with a norm by which they could judge their own ability and interest in the fields of science, and also to provide a criterion by which selection could be made of those students who would enter the science honors program. The early chapters of the PSSC and CHEM Study textbooks were used in this course and they proved very helpful in bringing the students to a knowledge of the hypothetical-deductive method of science. Better students were also trained in the use of a slide rule. Those who have been selected for the science honors program will, during the next three years, take three semesters of chemistry in the CHEM Study program and three semesters of physics in the PSSC program.

Fr. John B. Kerdiejus, S.J.

Xavier High School (New York). Six juniors have been accepted to participate in summer institutes for talented high school students under NSF grants. One will study geology at Hunter College, two physics and mathematics and two pre-engineering at Manhattanville College, and one mathematics at Columbia University.

Mr. Joseph S. Rooney, S.J.

Colleges and Universities

Ateneo de Davao College. The college has once more been the recipient of two grants, one from the National Science Development Board and one from the Asian Foundation. These grants have enabled the college to conduct the second regional summer institute for science teachers of Mindanao and Sulu. The one hundred and twenty teachers from public and private high schools who attended the institute received training in one of the following: the BSCS biology program, the CBA chemistry program, the PSSC physics program, the Boston-Yale program in mathematics. A book exhibit helped to familiarize the teachers with the latest publications in science and science education.

The Division of Natural Sciences has just inaugurated a new program for training in the teaching of biology, chemistry, physics and mathematics. It consists of a B.S. program with a heavy concentration on teaching methodology.

Fr. Miguel Ma. Varela, S.J.

Boston College. The following chairmen of science departments at Boston College participated in an hour long panel discussion entitled "Science curriculum in a liberal arts program" over station WVBC: Dr. Robert F. O'Malley, chemistry; Fr. James W. Skehan, S.J., geology; Dr. Joseph A. Sullivan, mathematics; Fr. William D. Sullivan, S.J., biology.

Geology. As part of the centennial celebrations Boston College was host to the annual meeting of the National Association of Geology Teachers, New England Section on April 5th and 6th.

A number of lectures have been given during the past months by visiting geoscientists. Dr. Vincent J. Schaefer, the discoverer of cloud seeding methods, presented three lectures on campus which were attended by students and professional meteorologists from various parts of New England. Dr. Peterson, chief of the New England Groundwater Geology Branch of the United States Geological Survey, spoke to the geology club on research in hydrology. The American Geological Institute sponsored a three day visit of Professor Wallace D. Lowry of Virginia Polytechnic Institute to the Boston College campus. Professor Lowry gave a series of lectures on regional tectonics, structural geology and vulcanology.

Walter Arabasz is the first geology major to become a Scholar of Boston College. He will do special study and research on regional tectonics under the direction of Fr. James W. Skehan, S.J. Dr. George D. Brown, Jr., a member of the geology department faculty, received his doctorate from Indiana University in June, 1963. Dr. Emanuel G. Bombolakis has recently been appointed as assistant professor in the department. He has completed his doctorate at the Massachusetts Institute of Technology and is now in the process of designing and setting up experimental equipment for rock mechanics studies.

Active research is being continued in the following fields: regional tectonics, petrography, gravity and magnetometer studies. A 1620 computer will be used in the analysis of regional tectonic data.

Fr. James W. Skehan, S.J.

Canisius College. A study of the graduating science majors has shown the inadequacy of the usual first semester college mathematics course which has been offered during past years. During the past year freshman science majors began a new program which will include three semesters of a unified calculus course. One particular advantage of the new arrangement is that all science majors will have completed differential equations by the end of second year.

Physics. On May 20, 1963 the AEC granted $12,430 to the physics department for additional equipment for radiation studies. Most of the money was for a multi-channel radiation analyzer which is to be used in the advanced laboratory program of the physics department and for the physical chemistry laboratory of the chemistry department. Part of the grant is being used for the fabrication of a two-curie Pu-Be neutron source, which will bring the neutron howitzer source strength up to three curies. During the past semester physics seniors have conducted a series of neutron experiments including the activation of silver, the determination of the albedo of paraffin and the determination of the cadmium ratio for a radial traverse of the howitzer.

Two alumni of the physics department have recently received their doctorates, one from Notre Dame and one from Case Institute of Technology; two others expect to finish shortly at Purdue and the University of Pittsburgh respectively. Two graduating seniors are entering full-time graduate studies, one at Pennsylvania State University, the other at the University of Pittsburgh.

Fr. James J. Ruddick, S.J.

Fairfield University. The NSF has approved a three year extension of the in-service institute for secondary school teachers of mathematics, chemistry, physics and biology, which is under the direction of Dr. John A. Barone. The first year of the extension has received a $14,840 allocation of funds. Under the direction of the biology, chemistry and physics clubs, Fairfield University was host to an intercollegiate science forum on April 6, at which outstanding representatives from each field spoke on the topic "Recent Advances in Science."

Chemistry. The department has recently been added to the list of approved schools of the Committee on Professional Training of the American

Chemical Society. Dr. John A. Barone has received a three year extension of his grant from the National Cancer Institute providing him with a budget of $16,440 for research during these three years.

Fr. Robert E. Varnerin, S.J.

Fordham University. The physics department sponsored a dinner for seventy-four members of the Albertus Magnus Guild who attended the 1963 New York meeting of the American Physical Society and the American Association of Physics Teachers.

Chemistry. The department has received a grant of $10,000 from the NSF which will enable seven summer students and seven full-time undergraduates to participate in research in the chemistry department.

Dr. Michael Cefola, who was a member of the small group of scientists who first isolated plutonium, attended a Plutonium Symposium sponsored by the University of Chicago on February 18. The symposium commemorated the twentieth anniversary of the isolation of this element.

Fr. Robert D. Cloney, S.J. delivered a lecture entitled "Criteria for spontaneous chemical reactions" to the advanced placement chemistry classes at Xaverian High School, Brooklyn.

Fr. Frederick J. Dillemuth, S.J. and Dr. Leo K. Yanowski served as judges at the Manhattan Divisional Annual Science Fair, sponsored by the Catholic Science Council and held at Mother Cabrini High School. Fr. Dillemuth was also a judge for the finals of the Catholic Science Council Project Scholarship Contest held at Cardinal Hayes High School.

The New York City Health Research Council has awarded a grant of $31,642 to Dr. Douglas J. Hennessy for a two-year study of insecticide resistance. Dr. Hennessy has delivered the following lectures during the past months: "The chemistry of chalcone oxides" to the American Chemical Society; "Evidence of past life on the parent body of certain meteorites" to the Student Affiliate of the American Chemical Society, New Jersey Section; "What of extra-terrestrial life?" to the Albertus Magnus Guild; and "The chemical behavior of DDT as a basis of toxicity and resistance" to the American Mosquito Control Association. In addition, Dr. Hennessy was principal speaker at the dedication of the science hall at Notre Dame College, Staten Island and also lectured at St. Dunstan's University, Prince Edward Island, Canada on biogenic materials in meteorites.

Dr. Emil J. Moriconi, chairman of the department, presented a paper written with F. J. Creegan, C. K. Donovan, and F. A. Spano entitled "Ring expansion of the 2-alkyl-l-indanones to isocarbostyril derivatives" at the American Chemical Society meeting in Los Angeles.

Dr. Bartholomew Nagy worked for one month at the Institute for Cell Research, Medical Nobel Institute, Carolin Institute, Stockholm, with Dr.

T. Caspersson on the composition of the organized elements of the Orgueil meteorite using ultraviolet microprobe techniques.

Dr. Walter J. Schubert and Dr. F. F. Nord are co-authors of an article entitled "On the enzymic degradation of isolated soft-wood lignin" which appears in *Life Sciences,* Volume 8, 1962.

Dr. Leo K. Yanowski took part in a symposium of the American Chemical Society which was held in honor of Dr. Donald D. Van Slyke, internationally known chemist, on the occasion of his eightieth birthday. Dr. Yanowski authored the history of the American Microchemical Society which was printed in the program.

Fr. Robert D. Cloney, S.J.

Physics. The department has received an NSF grant of $12,400 for an undergraduate science education program. The funds will be used to support twelve Fordham undergraduates for ten weeks of research and private study during the summer of 1963. A matching grant of $21,870 has been received from NSF for the purchase of equipment for the advanced undergraduate laboratories in optics, electronics, atomic and nuclear physics, and electricity and magnetism. This equipment will be used in upgrading the advanced laboratory courses in order to keep pace with the new freshman-sophomore physics program in Fordham College, which is also being supported by NSF. Dr. Joseph I. Budnick has received a grant of $24,000 from NSF to support for one year his research on nuclear magnetic resonance in ferromagnetic alloys. Dr. Budnick contributed the chapter on "Nuclear Magnetism" to the *Magnetic Materials Digest* for the year 1961.

At the New York meetings of the American Physical Society Dr. Budnick delivered a paper on "Iron-57 nuclear magnetic resonance in dilute solid solutions of iron in nickel" and Dr. Alfons Weber delivered a paper on "Pure rotational Raman spectrum of cycloheptatriene."

A paper entitled "Quadrupole interaction in 0.48 Mev level of Ta-181 in hafnium single crystals" was published by Fr. Frederick L. Canavan, S.J. and P.J. Ouseph in the *Physics Letters* for December 15, 1962.

Two physics students, William Drumin and Thomas Murphy, have been awarded NSF pre-doctoral Fellowships.

Fr. Joseph F. Mulligan, S. J.

Georgetown University. Fr. Matthew P. Thekaekara, S.J. of the physics department was elected president of the National Capital Section of the Optical Society of America at a meeting held on May 22, 1963 at Georgetown. At this meeting Dr. Richard Tousey, head of Rocket Spectroscopy Branch, Atmosphere and Astrophysics Division, United States Naval Research Laboratory, delivered a paper on "The role of spectroscopy in space research."

Astronomy. At the April, 1963 meeting of the American Astronomical Society held at Kitt Peak National Observatory the following papers were delivered by members of the department: Fr. Martin F. McCarthy, S.J. delivered a paper on the "Classification of late type stars in the near ultraviolet from objective prism spectra"; Dr. Vera C. Rubin delivered a paper on "The velocity field of O-B5 Stars in the vicinity of the sun"; Mrs. Jayley M. Burly, a graduate student, delivered a paper on "Neutral hydrogen in NGC 6822." The December 1963 meeting of the American Astronomical Society will be held at Georgetown.

Fr. Francis J. Heyden, S.J. will conduct an eclipse expedition to a site in Ellsworth, Maine which is in the path of totality of the July 20th solar eclipse. He will be assisted in this work by members of the observatory staff, graduate students and several professional astronomers from the Washington area.

Fr. Francis J. Heyden, S.J.

Holy Cross College. A Sigma Xi Club was founded at Holy Cross on Februrary 14, 1963. Dr. William E. Hartnett of the mathematics department was elected president and Dr. Edward F. Kennedy of the physics department was elected secretary-treasurer. The first of the Sigma Xi lectures was given on March 11 by Dr. Andrew Van Hook of the chemistry department who spoke on "Crystallization."

A total of $112,500 was given by NSF for two summer institutes for teachers, conducted at Holy Cross during the summer of 1963. An institute in mathematics was conducted by Dr. Vincent O. McBrien and one in biology, chemistry and physics was conducted by Fr. Robert B. MacDonnell, S.J.

Chemistry. A matching grant of $7,000 has been awarded to the chemistry department by NSF for the purchase of apparatus.

Dr. R.W. Ricci attended a photochemistry symposium at the University of Rochester in March where a paper which he had co-authored entitled "Flash photolysis of o-nitrotoluene derivatives" was presented.

Fr. Joseph A. Martus, S.J. was elected vice-president of the New England Association of Chemistry Teachers at the May meeting held at Clark University, Worcester. Fr. Martus was also one of the Holy Cross representatives at the May meeting of the New England conference on graduate studies held at Northeastern University.

Dr. Andrew Van Hook presented a paper of the "Effect of sound and ultrasound on crystallization" in the symposium of crystallization at the fiftieth anniversary meeting of the American Institute of Chemical Engineers held in Buffalo, New York. Dr. Van Hook has a paper entitled "Summa forma dei cristalli di saccarosio" in the September-October 1962 issue of *La Industria Saccarifera Italiana*.

Michael G. McGrath, a senior chemistry major, has been awarded an NSF Fellowship and will study organic chemistry at the Massachusetts Institute of Technology.

Fr. Bernard A. Fiekers, S.J.

Mathematics. Dr. William E. Hartnett has accepted a position in the division of mathematical biology at the Peter Bent Brigham Hospital in Boston. Dr. John R. McCarthy has a year's leave-of-absence to study at the Catholic University of America under an NSF Science-Faculty Fellowship. Dr. Daniel G. Dewey, who studied at Brown during the past year as a Science-Faculty Fellow, has returned to the department.

Fr. John J. MacDonnell, S.J.

Loyola College. For the first time in the twenty year history of the Loyola Evening College a physics major program is being offered. This program will provide the necessary college-level technical training plus a background in the tradition of the liberal arts. Emphasis is directed toward both the theoretical and experimental aspects of fundamental physics. Special scheduling of laboratory work hours will allow students to complete all eight upper-division physics courses in only two years of evening school.

Physics. The department has been awarded a $6,300 grant by NSF for the support of an undergraduate science education program under the direction of Dr. James L. Gumnick, chairman of the department. The program will be supervised by Dr. Bernard J. Weigman of the mathematics department. The objective of this experimental program is to offer experience in research and independent study to superior undergraduate students under the direction of the faculty members. In addition the department has received a grant of $10,000 from the AEC for the purchase of equipment to be used in the educational program at Loyola. This award was made in the latter part of 1962 and will run through December, 1963.

Fr. Edward S. Hauber, S.J.

St. Joseph's College. Twenty-one of the thirty-seven physics majors who graduated in 1963 have entered graduate school. Of this group seventeen fellowships and assistantships have been offered.

Physics. The Cooperative course in electronic physics is being extended through the academic year 1963–1964 but it will now be called engineering physics. The program includes options in nuclear physics, solid state and electronics. At present about one-half of the physics enrollment is in the engineering group; the other half is taking a regular physics program stressing preparation for graduate work.

Fr. John S. O'Conor, S.J.

St. Peter's College. Dr. John McGill, chairman of the biology department was recently elected vice-president of the New York Chapter of the Albertus Magnus Guild.

Biology. During the year 1962–1963 Fr. Rocco Belmonte, S.J. gave a course in histotechnique to a special group of students. From the graduating class of 1963 fourteen students were accepted by a total of twelve medical schools and two students were accepted by a total of five dental schools. Three medical scholarships were awarded to graduating seniors by Buffalo, Cornell and Yale. One senior with a fellowship and another with an assistantship have begun graduate work in zoology at the University of Illinois.

Fr. Jerome H. Gruszcyk, S.J.

Wheeling College. Three chemistry majors of the class of 1963 have accepted assistantships at Cornell, Kansas State and the University of Michigan. A fourth student will attend West Virginia University.

Chemistry. Dr. Charles Lonar of Northwestern university has joined the chemistry department staff as of September, 1963.

During the summer months, Fr. Joseph A. Duke, S.J. conducted research in the Cardiovascular Research Institute at the University of California Medical School.

The following lectures were given during the spring Chemistry for Industry Lecture Series: "Basic theory of electrochemistry" by Fr. Duke, S.J.; "Electrochemistry of alkali-chlorine Production" by W. C. Gardiner of Olin Mathieson; "Electrochemistry of anodic coatings" by C. E. Michelson of Olin Mathieson; "Electrochemistry of cathodic protection" by W.A. Koehler of West Virginia University.

Fr. Joseph A. Duke, S.J.

Scholasticates

Shrub Oak. The following lectures were given before the Loyola Science Academy during the months of March and April, 1963: "The Measurement of mesothorium in human bone by breath technique" by Fr. Thomas L. Cullen, S.J.; "Nuclear models" by Fr. Francis R. Haig, S.J.; "Spontaneous reactions" by Fr. Robert D. Cloney, S.J.; "The geological and geophysical aspects of the southeastern coastal regions of Brazil" by Fr. F.X. Roser, S.J.; "The problem of units and dimensions" by Mr. Leslie J. Pierre, S.J. (*Md.*).

Biology. Mr. William J. Rogan, S.J. (*Md.*), who received an honorable mention in the NSF awards, has been given a fellowship amounting to $3400 by the biology department of Johns Hopkins University. Mr. Joseph A. Tomasulo, S.J. (*Buf.*) has received a $2000 trainee fellowship from the National Health Sciences Training Program and has begun doctoral work in anatomy at the State University of New York in Buffalo. Mr. Tomasulo has a B.S. degree in biology from Le Moyne and studied for a year at the University of Buffalo Medical School before entering the Society. He also took courses at St. John's University while pursuing his philosophy studies at Shrub Oak.

Physics. Fr. Thomas L. Cullen, S.J. (*N.Y.*) attended the April international symposium on the "Natural radiation environment" at Rice University, Houston, Texas at which the following studies in which he collaborated were presented: "Studies in the Brazilian regions of high natural radioactivity", "External radiation levels in high background regions of Brazil", "Naturally occuring radionuclides in food and waters from Brazilian areas of high radioactivity". Fr. Cullen continued his research in Brazil during the summer of 1963.

Fr. James Fischer, S.J.

Spring Hill. Dr. K. A. Strand of the United States Naval Observatory spoke to the scholastics at the house of studies during his two day lecture series at Spring Hill College in December. On March 19 Dr. Alfred Kidder II, professor of anthropology at the University of Pennsylvania, discussed problems encountered in his archaeological investigations.

Biology. During the past year under the inspiration of Mr. Kowalski (*Wisc.*) a biology room has been opened in the scholasticate. The room provides convenient laboratory space and it contains an eighteen-hundred power oil immersion lens binocular microscope, which Fr. Patrick Yancey, S.J. of the biology department of Spring Hill College has loaned to the scholastics. The room is being used by Mr. Fuhs (*N.E.*) to study the tropisms of ants and by Mr. Pfab (*Wisc.*) to perform experiments in the genetics of flies.

A paper by Mr. Wehman (*Chi.*) entitled "Innervation of the tongue: 10mm. cat embryo" was read at the April meeting of the Western District of Beta Beta Beta at the University of Florida.

Chemistry. Mr. James L. Lambert, S.J. (*N.O.*), who completed his doctoral work in organic chemistry at Johns Hopkins University this past summer, taught the summer course in physical organic chemistry to the scholastics who are chemistry majors. Mr. Noel Brawn, S.J. (*N.E.*) has begun doctoral studies in organic chemistry under a full tuition scholarship and assistantship at Brandeis University. Mr. Amado Sandoval, S.J. (*Ant.*)

has begun studies in organic chemistry at Columbia University under a similar scholarship and assistantship.

Physics. Mr. James Baker, S.J. (*Mo.*) has begun studies in physics at Boston College under a teaching assistantship. Mr. Patrick McDermott, S.J. (*N.O.*) has accepted an NSF Fellowship to Boston College where his area of concentration will be biophysics. Mr. J. Dennis Willigan, S.J. (*N.E.*) has begun studies in space physics under a NASA fellowship at Columbia University.

Mr. Robert J. Paradowski, S.J.

Weston. The January meeting of the Weston Colloquium was devoted to a discussion of the natural sciences and the Jesuit liberal arts college, led by Fr. William G. Guindon, S.J., chairman of the physics department at Boston College. Fr. Guindon summarized the content of his article, which was published in the October issue of the *Jesuit Educational Quarterly*, as a starting point for the discussion. "New attitudes in mathematics" was the subject of the March colloquium, presented by Fr. Stanley J. Bezuszka, S.J., chairman of the mathematics department of Boston College. Fr. Bezuszka outlined the new approaches to mathematics for the primary and secondary school development by several committees, including his own mathematics institute at Boston College. The final lecturer of the year was Professor I. Bernard Cohen, chairman of the Committee on the History of Science at Harvard University, who delivered the 1963 Ahern-Quigley lecture entitled "Newton, Galileo, and Kepler." Professor Cohen presented a very lucid and informed account of these three scientists which included insights into their respective characters and the significance of their contributions to scientific thought.

Mr. Donald J. Plocke, S.J.

Graduate Studies and Research

Fordham. The following received their doctorates in June: Mr. Robert Bagnato, S.J. (*N.Y.*) in mathematics from Yeshiva University; Mr. Thomas Dundon, S.J. (*Wisc.*) in biology from St. Louis University; Mr. William T. Hall, S.J. (*Phil.*) in biology from Fordham University; Mr. Ramon Salamone, S.J. (*N.Y.*) in chemistry from Fordham University.

The following received Master of Science degrees in June from Fordham University: Fr. Valerian Alonso, S.J. (*Ant.*) in biology; Mr. Edward Cavey, S.J. (*Md.*) in mathematics; Fr. Thomas Gibbons, S.J. (*N.E.*) in physics; Fr. Yvon Pageau, S.J. (*Lower Can.*) in biology; Mr. Charles Zimpfer, S.J. (*Buf.*) in mathematics. Fr. Pageau began studies this past summer in paleontology at the University of Chicago.

Mr. James F. O'Brien, S.J.

Johns Hopkins. Mr. James L. Lambert, S.J. (*N.O.*) completed his doctoral studies in organic chemistry and graduated in June. The title of his thesis was "Homoenolate anions" and a preliminary report on this research has been published in the *Journal of the American Chemical Society,* 84 (1962), 4606. Mr. Lambert was elected to membership in Phi Beta Kappa by the Hopkins chapter in May, 1963. Mr. John G. Marzolf, S.J. (*Buf.*) completed his doctoral studies in physics and graduated in June. The title of his thesis was "Single crystal diffraction profiles for monochromatic radiation." The study made use of the monochromatic radiation obtainable from a Mossbauer source to test theoretically predicted X-ray diffraction profiles. The main features of the theory including assymetry were confirmed and some minor discrepancies stemming from crystal imperfections were noted.

Mr. William H. Millerd, S.J.

Manila Observatory. The new Manila Observatory at Loyola Heights, Quezon City in Manila is undertaking research in solar physics, ionospheric studies and seismology. Since the observatory is located at approximately eight hours east longitude, the solar section will be prepared to monitor solar events heretofore unavailable to the scientific community. The advantage of location applies also to the ionospheric section which is preparing improved ionospheric sounding equipment near to the new solar installation. A new seismic vault at the same location will supplement records of the older seismic station at Baguio. The observatory plans to participate in the International Quiet Sun Year of 1964.

St. Louis. Mr. Victor L. Badillo, S.J. (*Phil.*) received the doctorate in physics in June. His thesis research, which was supported by NSF and the American Cancer Institute, was reported on in a paper given at the March meeting of the American Physical Society in St. Louis. An abstract of this paper entitled "X-ray scattering by noncrystalline viruses" was published in the *Bulletin of the American Physical Society,* 8 (1963), 199 with Dr. A.H. Weber as co-author.

Mr. Agerico L. Esquivel, S.J. (*Phil.*) received the doctorate in physics in June. His thesis research, which was supported by NSF and the American Cancer Society, was reported on in a paper given at the April meeting of the American Physical Society in Washington, D.C. An abstract of this paper entitled "Electron scattering by noncrystalline viruses" was published in the *Bulletin of the American Physical Society,* 8 (1963), 338 with Dr. A.H. Weber as co-author.

Mr. John E. Mansfield, S.J. (*N.E.*) read two papers, one at the St. Louis meetings and one at the Washington meeting of the American Physical Society. The first paper entitled "Spin-precession effects in double Mott scattering" was published in the *Bulletin of the American Physical Society,* 8 (1963), 262 and the second entitled "Plural and multiple scattering corrections to double Mott scattering" was published in the *Bulletin of the American Physical Society,* 8 (1963), 301. Both papers were co-authored by Mr. Mansfield, Mr. Andrew J. Dufner, S.J. (*Ore.*), Dr. A.J. Buscovitch and Dr. A. H. Weber. Mr. Mansfield completed his master's degree at St. Louis in June and is now continuing his studies at Harvard University where he has a full scholarship.

Mr. Robert F. O'Brien, S.J.

Weston Observatory. As a result of a tour of duty which took Fr. Daniel Linehan, S.J. to East Africa with the United Nations Educational and Scientific Cultural Organization, Weston Observatory has had the opportunity to exchange ideas on telemetry techniques for seismic and geomagnetic measurements with several geophysicists in Africa.

Mr. William Messmer, S.J. (Mo.) and Mr. William O'Neill of the IBM Corporation have instructed observatory staff members, Boston College graduate students and Weston College theologians in the use of IBM 1620 computer. Mr. J. Kenneth Siberz, S.J., who is currently taking advanced training at the IBM center in Boston, has built up a library of small utility programs which give added flexibility in the data processing routines.

Before leaving the observatory in May, Fr. Joseph B. Pomeroy, S.J. (N.E.) completed the analysis of the last rocket borne magnetometer flight instrumented in these laboratories. The results of this flight will be published in the *Journal of Geophysical Research.* Adrien Desillier is carrying on the work of monitoring the magnetic field of the earth and is performing Fourier analyses and power spectrum studies under the direction of Fr. Linehan.

In May representatives of the Arthur D. Little Company of Cambridge, Massachusetts installed an atmospheric potential probe and recorder at Weston Observatory so that correlations between the atmospheric potential, telluric currents and magnetic field might be carried out. This system, which has been operating continuously since early May, has shown that during times of frontal passage, if the magnetic field activity is reasonably quiet, the earth and atmospheric potentials are quite closely correlated. Work has begun on the data analysis to measure the actual relationship between these two phenomena.

A new unmanned remote seismic detection station about fifteen miles north of Berlin, Massachusetts has been added to the New England seismic network. Mr. David Clarke, S.J. (Ore.) has begun processing the network data which in an average month includes one hundred and fifty quarry blasts received by two or more stations, five local quakes, and twenty distant quakes. Since the seismic data from the network is available on telephone lines, the Bell Telephone Laboratories of Whippany and Murray Hill, New Jersey connected signal lines to the net and conducted real time on line correlations of the earth signals received at the different seismic sites. Preliminary analyses confirm observatory hopes that there would be no steady artificial noise in the system. More complete analyses are in progress at Whippany. A filtering process, whereby slow vibrations of microseismal character are removed, has been added to the New England net. After the filtering, magnification is increased ten to thirty times, making new features of the record stand out clearly. By this method quarry blasts have been recorded as far as three hundred and fifty miles away, with reflection features clearly evident on the record.

Plans are currently underway for a new two story structure which will contain space for both theoretical and laboratory research.

Mr. David M. Clarke, S.J.

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CONTENTS