

Chemical Engineering at McMaster University

The Formative Years: A Brief History 1958-1982



**Cameron M. Crowe
Malcolm H. I. Baird
Archie E. Hamielec
Terrence W. Hoffman
Leslie W. Shemilt
Donald R. Woods**

Copyright 2011 © Department of Chemical Engineering, McMaster University, Hamilton, Ontario, L8S 4L7

All rights reserved. The use of any part of this publication, reproduced, transmitted in any means electronic, mechanical, photocopying, recording or otherwise, or stored in a retrieval system without the prior written consent of the copyright holder is an infringement of the copyright law.

Photographs are reproduced by courtesy of the Faculty of Engineering and the Department of Chemical Engineering, McMaster University

Printed in Canada by Global Heritage Press, Milton, Ontario

ISBN 978-0-9866617-0-9

Preface

Stimulated by the planned celebrations in 2008 of the 50th Anniversary of the foundation of the Faculty of Engineering at McMaster University, the authors decided to prepare a history of the Department of Chemical Engineering from its beginnings to about 1982. We knew that memories fade and that as the five surviving original members of the Department, we felt that we are best able to record this story. Les Shemilt, as succeeding Dean of Engineering to the late Jack Hodgins, joined our effort. The original intention was to be able to produce such a document to coincide with the 50th anniversary celebrations. Unfortunately the time required not only to write the text, but also to assemble the requisite information, led to our being unable to complete our story until now. We note that the publication of our book in 2011 also marks the 50th Anniversary of the graduation of McMaster's first Bachelors of Engineering.

We hope that this document will be of interest to all who studied, worked, taught or visited the Department of Chemical Engineering and to all those who have had some connection with our Department in the past. We apologize to those who might feel that they were not specifically mentioned. There have been so many wonderful students, both undergraduate and graduate, visiting colleagues, postdoctoral fellows and collaborators in research efforts that it would be impossible to give due credit to them all.

We acknowledge that there may be some errors of fact or omissions of achievements and honours. We tried to record everything that we could find, but inevitably errors and omissions may have occurred, for which we humbly apologize.

We hope that you will find that our history evokes memories for those who spent time with us, and for those who have known us at a distance and that it gives you an insight into the development of our department.

We wish to specifically acknowledge the provision by the late June Johnson of the diaries of her late husband, Ab Johnson, covering the period from his first meetings with Jack Hodgins in 1960 up to the year of his departure to become Dean of Engineering at the University of Western Ontario in 1971.

We would also like to express our gratitude for the strong support of the Department of Chemical Engineering, through former Chair Andrew Hrymak and current Chair Shiping Zhu. We are grateful to Christopher Tomicic for his work collecting copies of historical records from various offices in McMaster University and for the cooperation of those offices, namely those of the Dean of Engineering, the Registrar, Human Resources, the Senate Secretariat and the Secretary of the Board of Governors, in providing us with relevant information from their files.

CMC, MHIB, AEH, TWH, LWS and DRW
McMaster University
Hamilton, Ontario, L8S 4L7
December 9, 2010

Table of Contents

Chapter	Page
1. The Beginnings	1
The Engineering Building	2
2. The Nineteen Sixties	5
Curriculum Development	5
Establishment of Graduate Programs	7
Heat Transfer Research	8
Computer Simulation of a Chemical Plant	8
Technical Communication Course	9
Catalysis Research	10
Water and Waste Water Treatment	10
Mass Transfer Research	11
Polymer Research	12
Contributions to Public and Technical Activities	13
Departmental Social Activities	13
Changeover in the Dean's Office	15
A Retrospective View of the Sixties	15
3. The Nineteen Seventies	17
Female Students in Chemical Engineering	17
Engineering and Management	17
Biotechnology	17
McMaster Problem Solving Program	18
Real-Time Process Control	19
International Recognition	20
4. Computing in Chemical Engineering	21
The Computer Revolution	21
First Initiatives for Computing	22
Computer Simulation of Chemical Processes	23
5. Research in Polymers	27
Polymer Reaction Engineering	27
Gel Permeation Chromatography	27
Contributors to Polymer Research	28
Professional Development Courses	28
The MIPPT Years	29

Physical Processing of Polymers	29
6. Research in Catalytic Chemistry	33
Professor Robert B. Anderson	33
7. Water and Waste Water Treatment	37
8. McMaster Radium Project (McRaP)	41
9. Conclusion	43
Appendix	
A Collected Reminiscences	45
Former Staff	45
Former Undergraduate Students	57
Former Graduate Students	69
Former Post-Doctoral Fellows, Research Associates & Faculty	78
B Honours to Chemical Engineering Faculty	87
C Chairs of Chemical Engineering	95
Index of Names	97

Chapter 1 The Beginnings

McMaster University was founded in 1887 by Senator William McMaster and granted its first degrees in 1894. It was originally located in Toronto at McMaster Hall on Bloor Street West, now the home of the Royal Conservatory of Music. In 1930, McMaster University was moved to its present site in Hamilton, Ontario.

Historically, prior to 1950, nine universities in Canada offered chemical engineering programs¹. Each department had a very small faculty complement and large class sizes, especially with returning war veterans included. This meant that little chemical engineering research was carried out and that postgraduate degrees at Canadian universities were pursued mainly through chemistry departments, or in chemical engineering departments in American or British universities. The launch by the Soviet Union of the unmanned orbiting satellite, Sputnik 1, in October 1957, made the engineering and science communities suddenly aware that Western technology might be lagging behind that of the Soviet Union. This created a strong impetus to establish new faculties of engineering in Canada and to upgrade the quality of undergraduate and graduate engineering education. Partly in response to the shock of Sputnik, as well as to the postwar boom in industrial production, new faculties of engineering, in addition to McMaster, were established in Ontario from 1954 to 1958 at the Universities of Ottawa, Western Ontario, Windsor and Waterloo.

Prior to 1957, McMaster offered a pre-engineering year from which students could proceed to study engineering mainly at Queen's University in Kingston. At that time, there was some resistance in the Ontario Department of Education to establishing new complete engineering programs in Ontario. Concerns were expressed by faculty members in the humanities and social sciences, including McMaster President George Gilmour, that their disciplines would be overshadowed in importance in the face of the growing financial support of research in the sciences. Furthermore, professional programs in engineering were regarded by some as training, not education, and were seen as incompatible with the traditional concept of a university. Chancellor E. Carey Fox provided strong backing for the establishment of engineering programs at

¹ L.W. Shemilt (Editor), (1991), *Chemical Engineering in Canada – An Historical Perspective*, Canadian Society for Chemical Engineering, p. 15

McMaster, while supporting the legitimate concerns that the humanities should continue to exert a vital influence on the university.²

The establishment of the Faculty of Engineering was mainly the initiative of Dr. H.G. Thode, then Principal of Hamilton College, which administered the science departments of the University. Since Dr. Thode was President of the Chemical Institute of Canada in 1951-52 and a member of the National Research Council of Canada, he had gained a national perspective on the growth of industry and on Canada's need for advanced technology and increased numbers of engineers. Because during and following the Second World War, McMaster University had developed strong programs of research in chemistry and physics, Dr. Thode insisted that the new Faculty of Engineering would also emphasize research in parallel with quality undergraduate and graduate education. He was convinced that a strong research involvement by Faculty members was a necessary component of high quality undergraduate and graduate programs in science and engineering.

The founding Dean of Engineering was Dr. John W. Hodgins, formerly Professor of Chemical Engineering at the Royal Military College in Kingston, Ontario. Dr. Hodgins was appointed in 1955 as Professor of Chemical Engineering and Director of Engineering Studies and became Dean of Engineering by act of the McMaster Senate on January 28, 1958. At that same meeting, Senate also formally established the Faculty of Engineering. The first students to receive their Bachelor of Engineering degrees started in 1957 and would graduate in 1961.

The Engineering Building

Before Jack Hodgins officially became Dean of Engineering in 1958, one of his first priorities was to have a new Engineering Building designed and constructed. The architects, William R. Souter and Associates, were on a very tight design schedule to allow construction to start in late 1957 or early 1958. Jack Hodgins was McMaster's representative on that design team and was responsible, with technical consultants, for the detailed design of lecture rooms and undergraduate and graduate laboratories in the five wings of the building, each housing one of the Departments of Chemical, Civil, Electrical, Mechanical and Metallurgical Engineering.

² Charles M. Johnston, (1981), *McMaster University 2/The Early Years in Hamilton, 1930-1957*, University of Toronto Press, pp. 23-26

Jack Hodgins left his mark on this building in many ways. For example, he was responsible for the mosaic mural in the entranceway to the building. That mosaic, designed by Michael Torsney, incorporated a local engineering aspect to represent each of the engineering departments. For example, there was Stelco's blast furnace for Metallurgy, the Skyway Bridge for Civil, the cooling towers and electrical transmission lines for Electrical, the distillation towers for Chemical and an International Harvester tractor for Mechanical. A few errors occurred, such as the ship that was shown did not display the Red Ensign that was then current, but rather an incorrect version of the Union Jack. Jack Hodgins was also responsible for having all the piping and electrical conduits exposed in the hallways³, since he felt it was necessary for engineering students to see the internal service lines. The building was officially opened on Friday, October 23, 1959, and was renamed the 'John W. Hodgins Engineering Building' when the Engineering Faculty celebrated its 20th Anniversary in 1978.

The Chemical Engineering wing housed the undergraduate pilot-plant laboratory on the first floor along with a large laboratory for catalyst research and a very well equipped departmental machine shop. Terry Hoffman designed and erected the experimental equipment for the undergraduate program in third and fourth years, following its construction in the Department's and the Faculty's machine shops. Most of this equipment was built with industrial glass pipe so that the phenomena under study could be seen. Over the years, new or modified equipment was continually introduced. Laboratory experiments were carried out over a three-week period with two or three students in each group. Students were usually given an objective and a demonstration on how the equipment could be operated and then left to complete their study. Extensive reports were required after each three-week period. Most of the experiments were industrially oriented.

Research laboratories on the second and third floors were designed to house two graduate students and contain their research equipment. Because, traditionally, chemical engineering pilot-scale laboratory equipment required considerable head room, a large open well was provided that extended from the first floor through to the third floor. Many experimental research studies utilized this headroom. Later, space in the basement was made available for additional research laboratories. During the 1960's and 1970's many graduate students became involved with

³ Since the original construction, these ceilings have been closed in.

computational and theoretical studies. The fourth-floor penthouse was renovated to accommodate a number of carrels for these students and a small chemical engineering reference library.

There was a large room in the basement that was equipped with desks so that the final year students had a place to work together on their design or simulation projects.

In the 1980's, additions to the Engineering Building were constructed and in 2009, a new engineering Building was opened on the 50th anniversary of the opening of the original building. It is noteworthy that a design of major additions to the original Engineering Building was almost completed in 1969, but the project was suspended for lack of sufficient funding.

Chapter 2 The Nineteen Sixties

After the opening of the Engineering Building in October, 1959, Dean Jack Hodgins' next priority was to hire the best available new members of the Faculty. Jack also acted as Chair of Chemical Engineering and hired Terry Hoffman in 1958 following his Ph.D. from McGill University. The following year, Cameron Crowe was appointed after having completed two years with DuPont Canada in Maitland, Ontario, after his Ph.D. from Cambridge University in 1957.

The position of Department Chair, with a fixed term of three years, contrasted with that of permanent Department Head as was the practice at several sister universities. With a rotating chairmanship, incumbents knew that they would return to their regular academic roles, to be replaced by a colleague. This offered the dual advantages that no one faculty member remained in a long-term dominant position and that each incoming chair could bring new ideas and a fresh approach.

Curriculum Development

There were several requirements imposed by Dean Hodgins for the establishment of the curricula in the original five departments (Chemical, Civil, Electrical, Mechanical and Metallurgical Engineering). Their first year was common for all engineering students, which gave incoming students one year to adapt themselves to university life and to the demands of the engineering program, as well as to provide a better basis for choosing their branch of engineering. Students were assigned to particular department programs prior to their second year, based on their stated preferences and on their overall performances in the first year. They also received a common grounding in basic chemistry, physics and mathematics. Initially, all students took a full course in Engineering Drawing, which included drafting, graphics and descriptive geometry. With the later ready availability of computer graphics, this course was modified to become Engineering Design.

The second requirement was that all engineering students take one full course in the humanities or social sciences in each of their first, second and fourth years. One of these was a required course in English in second year, given by the English Department to engineering students only. The other two were chosen from an approved list of courses.

The chemical engineering curriculum offered the standard core courses, including thermodynamics, chemical reactor design, unit operations and transport phenomena, based on newly published textbooks^{4,5}. In particular, the publication of *Transport Phenomena* profoundly influenced the content of chemical engineering curricula throughout North America. The key concept was to unify the three separate subjects of mass transfer, heat transfer and fluid mechanics into one common framework. The three distinct subjects were first taught in separate courses, followed by a course in which these transport phenomena were shown to consolidate the ideas of their unity and their differences.

Courses in analytical, organic and physical chemistry in the Honours Chemistry program were provided by the Chemistry Department. These Honours courses were too extensive in content and consumed too many units for the needs of chemical engineering students. In addition, this limited the scope of our ability to introduce chemical engineering content to take account of new developments. As a result, over these years, the classical analytical chemistry course was replaced by a course in instrumental chemical analysis. Also the honours organic chemistry course was replaced by a new course designed to fit the Department's needs. Further, the physical chemistry course mainly covered the first and second laws of thermodynamics, but without direct application to chemical engineering. Since the introductory chemical engineering course also covered much of the same material, an agreement was made with the Chemistry Department that the physical chemistry course would be dropped and that the introductory chemical engineering courses in second year would be taught jointly by a member of each department.

Faculty from the Physics and Mathematics Departments taught the basic courses, including mechanics, electricity and magnetism, calculus, differential equations, numerical methods and statistics. From 1964 to 1967, the Chemical Engineering Department offered their own course in applied statistics, given by Cameron Crowe, with the objective of using practical examples from the chemical industry. This course was later replaced by one from the Applied Mathematics Department, because of pressure on chemical engineering teaching resources.

⁴ R.B. Bird, W.E. Stewart. and E.N. Lightfoot (1960), *Transport Phenomena*, John Wiley

⁵ O. Levenspiel., (1962), *Chemical Reaction Engineering*, John Wiley

In their fourth year, students were required to take a plant design course intended to integrate the material from all of the core courses. With the small classes in the early years, the whole class worked together on one design problem. The projects were chosen to be based, as much as possible, on real industrial processes from interested chemical companies and the reports were assessed by industrial colleagues. With the advent of faster computers, the design course included computer simulation of operating processes.

Establishment of Graduate Programs

The graduate program in chemical engineering began with the approval by McMaster Senate of the establishment of the Master of Engineering degree in May, 1959. This “Research” M.Eng. program required students to pass four graduate courses and to produce a research thesis normally within a period of seventeen months. The first M.Eng. degrees in chemical engineering were granted to Vuyyuru Mallareddy, Peter Seto and George Werezak in 1963.

In 1960, Jack Hodgins persuaded Ab Johnson to leave his position at the University of Toronto and join the Department in July 1961. Ab brought his extensive academic experience in teaching and, most significantly, in supervising Ph.D. students. This was a key factor in making the case for establishing the doctoral program. The Ph.D. degree in chemical engineering was approved by Senate in May, 1961, with the first such degrees being awarded in 1966 to Larry Ross and George Werezak.

In the mid-sixties, it became obvious that a second Master of Engineering program was needed with a higher course load of seven courses and a project report instead of a thesis. The aim of this program was that it should be completed within one year. This “Course” Master’s degree was approved by the McMaster Senate in 1966.

At about the same time, a provision was introduced to allow graduate students to carry out their research or project work at a chemical industry site, after having completed their courses at McMaster. This so-called Apprenticeship program was undertaken by a few graduate students, often by those who had already worked for a particular company.

Heat Transfer Research

Terry Hoffman came to McMaster from McGill where he was a part-time lecturer while he did his Ph.D. research on heat transfer to sprays at high temperature ($\sim 800^{\circ}\text{C}$), as part of the development of a new spray drying process at the Pulp and Paper Research Institute of Canada (PPRIC). He then continued this research on heat transfer to sprays, single drops and clouds of particles at McMaster, supported in part by the PPRIC. He also began a program on boiling heat transfer to thin films, in scraped-surface heat exchangers and cylinders of the size used in the CANDU nuclear reactor. This led to an experimental study of the problems associated with a possible loss-of-coolant accident and the interactive boiling in an array of these tubes reflecting the geometry in the reactor. All these studies relied on a heat flux meter, the construction of which was perfected using a laser device in our shop to precisely locate and drill small holes for thermocouple wires. Most of these research projects arose out of consulting activities with chemical industries.

Terry became the Canadian representative on an *ad hoc* committee which comprised representatives from those countries making significant contributions in heat transfer research. It was formed to establish the ground rules for International Heat Transfer Conferences which were to take place in different countries every four years. This committee then established the International Centre for Heat and Mass Transfer in Yugoslavia which met to review recent developments in these fields. He served on the Scientific and Organizing Committees of this Centre and on the International Heat Transfer committee and made contributions to the conferences there. He was also an Honorary Editor of the International Journal of Heat and Mass Transfer.

Computer Simulation of a Chemical Plant

Ab Johnson also brought his strong interest in applying computers to chemical engineering. In particular, Ab saw that digital computers would be able to simulate entire chemical plants, although at first suitable programs and adequate computing power were not available. Through the presence of Elmer Tory on a contractual appointment, Ab established contact with Elmer's former Ph.D. supervisor, Paul Shannon, then at Purdue University. Paul, with graduate student Henry Moser, had developed a FORTRAN program, called PACER, which allowed one to write subprograms for various processing units in a plant and to use PACER to coordinate the computations. After extensive tests of PACER

and contact with Dr. Norman Cooke of Canadian Industries Limited (CIL), agreement was reached to simulate the CIL sulfuric acid plant in Hamilton, Ontario. This project would form the fourth year design project in 1964-65 and would also involve all of the faculty members except Jack Hodgins, the eight members of the graduating class and several graduate students. By that time, Archie Hamielec had come in the fall of 1963 and Don Woods had joined us in early 1964.

The final report of this simulation was presented at McMaster in March 1965 to an invited audience of interested chemical engineers from industry, as well as being reported to the 15th Canadian Chemical Engineering Conference in Quebec City in October 1965. This was the first publicly reported simulation of a chemical process by digital computer. This work resulted in publication of a textbook⁶, and a citation by *Chemical Engineering* as one of the hundred most significant chemical engineering achievements of the last century⁷. The cooperative efforts of faculty in working on this simulation project were a significant factor that facilitated future collaborative research.

In the following years, computer simulations of many other processes were done, notably the Shell Canada alkylation process, BP waste water treatment plant, both in Oakville, Ontario, and the Alcan Bayer process in Arvida, Quebec.

Technical Communication Course

Don Woods brought considerable experience in conducting courses in technical communication during his two years in various British industries, as an Athlone Fellow. At the request of Ab Johnson, Don set up a second-year course in which the students would select a technical topic, prepare a written report and then present an oral summary of the material. This oral presentation was taped on television and was then shown privately to the student, in the company of the instructor. Two such technical reports were required of each student during the course. The result was a marked increase in the assurance and skill with which students could give talks in later years. In his research, Don had completed his Ph.D. in mass transfer with Warren Stewart of the University

⁶ C.M. Crowe, A.E. Hamielec., T.W. Hoffman., A.I. Johnson., P.T. Shannon. & D.R. Woods., (1971), *Chemical Plant Simulation*, Prentice-Hall

⁷ *Chemical Engineering*, Aug. 2002, p. 116

of Wisconsin, Madison. In the years following his appointment to McMaster, he branched out into studies of surface and colloidal phenomena, but also into capital cost estimation, and educational methods including problem solving.

Catalysis Research

In 1965, Bob Anderson, a distinguished catalytic chemist, joined the Department. Based on his extensive research in catalytic kinetics at the U.S. Bureau of Mines, he launched an active research program in catalysis. A significant consequence of his research was the use of his bench-scale results by other faculty members who studied the same reactions in large scale reactors. Terry Hoffman applied multivariate statistics, together with the kinetics, to model fluidized and transported bed reactors. Joe Wright, who joined the Department in 1969, developed methods for the real-time computer control of those reactions in tubular reactors. This is only one example of the cross fertilization of different research efforts.

Water and Waste Water Treatment

Dr. Keith Murphy joined the Department of Civil Engineering and Engineering Mechanics in 1961. Based on his expertise in waste water treatment technology, Keith developed an excellent program in environmental engineering. From Keith's contacts with colleagues in Chemical Engineering, he saw the significant potential for applying chemical engineering principles to waste water treatment, particularly those of chemical reactor design. This led to Keith being appointed additionally as Associate Professor of Chemical Engineering in 1965. In 1966, Dr. Jack Norman joined the Department of Civil Engineering and the next year was given a joint appointment in Chemical Engineering.

During the winter of 1967-68, with the encouragement of Jack Hodgins, Jack Norman applied for and obtained a five-year training grant from the Federal Department of the Environment to develop advanced waste water technology and to produce M.Eng. and Ph.D. graduates capable of implementing that technology in industrial and municipal treatment facilities. This grant enabled the building of a vigorous graduate program, and the attraction of many post-doctoral fellows and visiting faculty members. In 1967-68, the BP refinery waste water treatment process was the subject of the chemical engineering fourth-year design

project, using the combined knowledge of waste treatment and of simulation among the participating faculty.

The graduates of this program have proven its great value through their distinguished contributions during their subsequent careers in industry, consulting and academia not only in Canada, but also in the United States, Australia and Southeast Asia. The success of the program led to many further grants to faculty members to conduct research in such areas as denitrification, phosphorus reduction and residence time distributions.

Mass Transfer Research

Ab Johnson and Archie Hamielec developed an active research program in gas-liquid mass transfer. In parallel with his mass transfer research, Ab also established research in numerical methods, computer applications and simulation of processes. Hamielec later applied his expertise to high temperature metallurgical systems, in cooperation with Alex McLean and Wei Kao Lu of the Department of Metallurgy and Materials Science. For ten years Archie Hamielec also collaborated with Professor Hans Pruppacher of the Department of Atmospheric Sciences, UCLA. During this time Hamielec and Pruppacher co-supervised 5 PhD students in the area of cloud physics. Each of these UCLA PhD students spent up to one year at McMaster working with Hamielec.

Jack Hodgins maintained his research in mass transfer, particularly the use of sonic irradiation to enhance the rate of transfer. He also introduced innovative uses of nuclear radiation (such as the development of plastic wood by injecting styrene monomer into wood and inducing the polymerization by gamma radiation in McMaster's Nuclear reactor). Terry Hoffman and he received patents for their work on radiation and on mass transfer enhanced by sonic energy. Jack was a leader in engineering education and promoted innovation, entrepreneurship and university-industry interaction.⁸ He established Centre for Applied Research and Engineering Design, CAREED. Jack also introduced the Humanity Lecture series for all engineering students.

⁸J.W. Hodgins (1972), *Entrepreneurship in High Technology*, Cromlech Press, Hamilton

Malcolm Baird was appointed as Associate Professor in 1967, following three years of research at Canadian Industries Limited, McMasterville, Quebec, and subsequently four years of research and teaching in the Chemical Engineering Department of the University of Edinburgh. The major focuses of Malcolm's research were mixing and liquid-liquid solvent extraction, principally using two Karr reciprocating-plate extraction columns generously donated by ChemPro Inc. In addition to many talented graduate students, Malcolm was fortunate over the years to have enjoyed the collaboration of Professor Zu Jun Shen from the East China University of Chemical Engineering in Shanghai, Dr. Soo Hong Noh, now with KAIST, Seoul, Korea, and Dr. Inderjit Nirdosh, subsequently with Lakehead University, Thunder Bay, ON. Malcolm later was a co-author of the Handbook of Solvent Extraction.⁹

Polymer Research

The rumour that Archie Hamielec saw the 1967 movie, *The Graduate*, and was inspired by the advice given to Dustin Hoffman's character to pursue a career in plastics, is a myth. In fact, Hamielec already had developed an interest in polymers during his period with Canadian Industries Limited and soon switched his main research focus from mass transfer to polymer reaction kinetics. This move was the beginning of a long series of outstanding studies of the rates of polymer reactions and of the effects of various operating conditions on the resulting chain length distributions. The direct measurement of polymer chain length distributions was greatly facilitated by the acquisition of the Gel Permeation Chromatograph (GPC) from Waters Associates.

In 1968, John Vlachopoulos came to the Department after his Ph.D. from Washington University, St. Louis, to establish a dynamic research program in the physical processing of polymers, such as extrusion and blow moulding.

In 1982, Hamielec would establish the McMaster Institute for Polymer Production Technology (MIPPT) and act as its Director until his retirement in 1993. MIPPT has attracted the participation of many companies from Canada, USA and Europe in collaborative research and technical interaction.

⁹ T.C. Lo, M.H.I. Baird and C. Hanson, (1983), *Handbook of Solvent Extraction*, John Wiley

Contributions to Public and Technical Activities

It was clear from the establishment of the Department that each member of faculty needed to contribute to the promotion and reputation of the Department. On one hand, it was important to inform and attract the best possible first year students from the high schools, both local and province wide. Terry Hoffman instituted the Saturday morning lecture series that was aimed at stimulating high school students to pursue studies in engineering. The Engineering Faculty held annual open houses to which potential students and their family members were invited to learn about our teaching and research efforts. The Chair would hold monthly coffee meetings with chemical engineering students to hear about problems and concerns in the program. An Industrial Advisory Committee was established with membership from the Canadian chemical industry and a representative of an American department of chemical engineering. While this committee was valuable in obtaining input from industry that could help shape our courses to treat real problems, the major benefit to the Department resulted from the extensive preparation of material for discussion in the Committee.

On the technical side, an annual Research Booklet was published that provided information on current faculty and graduate students, research programs available and graduate courses offered. This booklet was important in promoting our department to prospective graduate students. There was a strong consensus that all members of faculty should attend annual technical conferences, in particular those of the Canadian Society for Chemical Engineering and the American Institute of Chemical Engineers. By presenting technical papers and interacting with colleagues from other universities and from industry, we gained recognition for the Department and valuable contacts for future research efforts. Over the years, Department members organized many technical sessions at the Canadian Chemical Engineering Conferences, particularly those held in Hamilton in 1959 and 1964, and also at international meetings such as those of the AIChE. Les Shemilt was President of the Chemical Institute of Canada in 1970-71.

Departmental Social Activities

With the aim of enhancing the *esprit de corps* among faculty, staff and undergraduate and graduate students, several social events were organized and became annual events. The welcoming party for incoming graduate students was held early in September, initially at the home of

the Department Chair. Terry Hoffman even removed a patch of lawn in his backyard, in order to build an open bonfire to roast corn.

Other popular events included hockey with the faculty and graduate students versus the undergraduate students. Who can forget Terry Hoffman in goal with Cam Crowe, Archie Hamielec and Joe Wright joining the graduate students? The summer brought softball. Then there was the annual fall golf challenge, when everyone wanted to be on John MacGregor's team.

In early January, the Department was closed for the day so that undergraduate and graduate students, staff and faculty could participate in the annual ski trip, with enthusiastic participation of students from countries where snow is unknown. Buses would take the skiers usually to Mont St. Louis but occasionally to Blue Mountain, where novice skiers were fitted for boots and short skis and provided with an hour's lesson. Some students, when asked how long they had skied, replied three years – neglecting to add that they had had only one day of skiing in each of those years. More than one novice skier had to be admonished not to sit on the T-bar. After the return to McMaster, a hot dinner, prepared by staff and several wives of faculty members, was awaiting the famished skiers.

Near the end of each academic year, the Chemical Engineering Club organized their annual dinner. At these occasions from 1968 on, at the initiative of Terry Hoffman following his sabbatical leave at the University of Delaware, final year students presented their perceptive impressions of faculty members in the "Roast the Profs" performance. It was unwise for a faculty member to be absent and so not to know how he had been caricatured.

The Chemical Engineering Club also held monthly "Smokers", social evenings to facilitate interaction between students and faculty. Once a year, the Graduate Students Club held an International Pot Luck dinner, to which students would bring a dish typical of their national cuisines.

We recognized early on the benefits to the undergraduate students of encouraging and partly subsidizing their attendance at annual Canadian Chemical Engineering Conferences. The benefits to the students came not only from their exposure to technical papers from other

institutions, but more importantly from their contacts with fellow students of other universities.

Changeover in the Dean's Office

In 1969, Jack Hodgins stepped down as Dean of Engineering after ten years of exceptional service as the founder of the Faculty of Engineering, but continued as Professor of Chemical Engineering. His successor as Dean was Les Shemilt, who was the founding Chair of the Department of Chemical Engineering at the University of New Brunswick and had previously taught for many years at the University of British Columbia. Les Shemilt had become Editor of the Canadian Journal of Chemical Engineering on July 1st, 1967, and brought the editorial administration of the Journal from UNB to McMaster on taking up his duties as Dean.

A Retrospective View of the Sixties

The initial plan for building the Department had been to appoint faculty members with specialties in the main core areas of chemical engineering: Mass Transfer, Heat Transfer, Fluid Flow, Chemical Reaction Engineering and Thermodynamics. This proved difficult to achieve because the bulk of doctoral research in chemical engineering in the 1960s was concentrated on heat and mass transfer. Thus, despite the initial plan, mass transfer was the specialty of most of the new faculty members: Malcolm Baird, Archie Hamielec, Jack Hodgins, Ab Johnson, Les Shemilt, and Don Woods

New technology and evolving interests resulted in many changes over the years in the research emphases of faculty members. By the end of the decade, the interaction of specialties among members of the Department led to strong collaborative research in waste water treatment, process control, computer applications to chemical process simulation and optimization, modelling of chemical reactors, applied chemistry including catalytic and polymer kinetics, and transport phenomena in iron and steel manufacturing¹⁰. It became clearly more important to select the best qualified applicants for open faculty positions than to try to cover every aspect of chemical engineering. This also facilitated collaborative

¹⁰ M.H.I. Baird (1970), *Things are Humming at McMaster*, Chemical Engineering Education, Summer, 112-116.

research programs, combining the complementary expertise of faculty members.

Chapter 3 The Nineteen Seventies

Female Students in Chemical Engineering

During the 1960's, only two female students had been enrolled in chemical engineering. The first woman to graduate was Anna Majorins in 1972. The number of female students increased gradually during the 1970's to reach an enrolment of about a quarter of the graduating classes in the latter half of the decade.

Because few women had graduated as chemical engineers, their enrolments in graduate programs were rare until later in the decade. The first women to receive graduate degrees in chemical engineering were Mary-Christine Bertrand, M.Eng. 1974 and Valerie Meng, Ph.D. 1985.

Engineering and Management

Ab Johnson spearheaded the initiative to establish a five-year degree program in Engineering and Management. This program was intended to combine each of the four-year engineering programs with the equivalent of one year of commerce and business courses from the Faculty of Business. Depending on the students' choices of courses, they could obtain partial advanced credit for a Master of Business Administration or a Chartered Accountancy Certification, as well as their engineering degree. This program was approved by Senate in 1970 and the first B.Eng.Mgt. degrees were awarded in 1975.

Biotechnology

With the founding of the McMaster School of Medicine in 1965, and the construction of the McMaster University Medical Centre (MUMC) near the Engineering Building, it became clear to Jack Hodgins that this could lead to fruitful collaboration in research between the Medical School and the Faculties of Engineering and of Science. Possible examples in chemical engineering might include kidney dialysis, analysis of blood flow, biocompatible polymers for implants and the application of chemical reactor principles to the response times of administered drugs.

In order to initiate this interaction, Irwin Feuerstein joined the Chemical Engineering Department in 1970 after his Ph.D. in chemical engineering from the University of Massachusetts and a post-doctoral

study of blood flow at McGill University. Such studies combined the principles of fluid dynamics and the biological characteristics of blood.

As a further step in this interaction, John Brash came to McMaster in 1972 from the Stanford Research Institute in Palo Alto, California, where he had been heavily involved in the study of polymers that could be used in contact with the human body, but which would not cause physiological problems such as clotting or rejection. John Brash was jointly appointed as Associate Professor of Chemical Engineering and of Pathology.

McMaster Problem Solving Program

In 1974, Don Woods, Cam Crowe, Terry Hoffman and Joe Wright received funding from the Ontario University Program for Instructional Development and obtained approval from McMaster University to initiate a program to study the ways in which students solved problems and mastered the required technical knowledge. We had all seen that students learned the material in different ways and that their skills at solving technical problems were, to say the least, haphazard.

Don embarked on a program beginning in September 1974 to enlist volunteer first-year students in an experimental program to teach problem solving. This program involved four weekly one-hour meetings that focused on actual assigned problems in their courses, such as physics or mathematics. Don established a sequence of steps, the McMaster Problem Solving strategy (MPS), based on previous strategies such as that of George Polya and on cognitive research¹¹ to solve any given problem, so that any student would be able to follow the steps and build confidence that these steps were easy to carry out and could more readily lead to a solution.

The problem solving program provided Don Woods with relief from teaching so that he could attend all the lectures that the students had and would be able to follow the volunteer students through their entire four-year program. One of his first observations was the variability in the thoroughness and accuracy (or lack thereof) of students' note taking.

¹¹ D.R. Woods, (2000) "An Evidence-based Strategy for Problem Solving," *Journal of Engineering Education*, **89**, 4, 443460. Winner of the Wickenden Award (2000).

Don would take his notes on a lecture and then show what he had written in comparison with the students' notes. In the three subsequent years, Don continued to lead this group of students through their entire undergraduate program. Among other aspects of problem solving were Small Group Skills, Self Assessment and Brainstorming.¹²

One consequence of the problem solving initiative was the development of three required workshop-style courses and a new course in formulating and numerically solving various chemical engineering problems. Cameron Crowe created this last course, Problem Formulation and Solution, which was designed to overcome deficiencies in previous courses. In engineering, the particular physical phenomena were modeled by equations. On the other hand, courses in numerical methods for solving various equations often started with equations that had no clear physical basis. This new course attempted to bridge that gap by using the MPS strategy to formulate a problem and then to examine the appropriate numerical methods for solving it. In fact, most real problems cannot be solved in an exact form and must be computed numerically.

Another consequence was the adoption of the problem based learning (PBL) program, as conducted by the McMaster Medical School. This program involves innovative small group learning, self-direction and self-assessment, with the guidance of a tutor. This PBL approach had to be modified to work effectively in Chemical Engineering, with groups lacking tutors.¹³

Real-Time Process Control

Joe Wright joined the Department in 1969 after his Ph.D. under Professor Rosenbrock in Cambridge University in 1967 and two years of industrial experience with Gulf Oil Canada at Varennes, Quebec. Joe instituted an innovative program in real-time control of chemical processes. He took the chemical kinetic information from Bob Ander-

¹² D.R. Woods, A.N. Hrymak, R.R. Marshall, P.E. Wood, C.M. Crowe, T.W. Hoffman, J.D. Wright, P.A. Taylor, K.A. Woodhouse and C.G.K. Bouchard (1997) "Developing Problem-solving skills: the McMaster Problem Solving Program," J. of Engineering Education, 86., 2, 7591. (Winner of the ASEE Wickenden Award for best paper)

¹³ D.R. Woods (1994) "Problem based Learning: How to gain the most from PBL," D.R. Woods Publishing, Waterdown, ON, 170 pp.

son's catalytic studies on the hydrogenolysis of butane as the basis of his research on the control of continuous fixed-bed catalytic reactors in real time.

Terry Hoffman and his graduate students also used the data on butane hydrogenolysis, together with statistics, to model a pilot-scale fluidized bed reactor. Park Reilly from the Department of Chemical Engineering of the University of Waterloo collaborated on this research, bringing his extensive experience in applied statistics. He also gave two graduate courses on aspects of applied statistics.

When John MacGregor arrived in 1972, he brought his extensive experience in the application of statistical process control to industrial problems at Monsanto, following his dual Masters degrees in Chemical Engineering and in Statistics and his Ph.D. in Statistics from the University of Wisconsin, Madison. The collaboration between Joe Wright and John MacGregor was a milestone in the application of advanced computer process control and statistical time-series analysis to the safe and efficient operation of chemical processes.

After his graduation in 1975 with a Ph.D. from the University of Wales, Paul Taylor worked for GEAC Corporation and Data General Canada in Toronto. He was appointed to the Department in 1978 and joined the control group. Paul later became chair of the Department of Computing and Software.

International Recognition

The journal, *Chemical Engineering Education*, features one Department of Chemical Engineering in each issue. In 1970, our Department was the first one in Canada to be selected.¹⁴

¹⁴ M.H.I. Baird, *op. cit.*

Chapter 4 – Computing in Chemical Engineering

The Computer Revolution

For those who grew up in the last two decades of the twentieth century, and for general background, it should be interesting to outline the tools, or lack thereof, that were available to faculty and students in the early 1960's. Computing, either by slide rule or mechanical calculator, could do far less than the cheapest hand calculator of today.

Unfortunately, the accuracy of slide rule calculations yielded answers to three significant digits at best. Not only were the calculations insufficiently accurate, but the tedium of repeating iterative calculations consumed inordinate amounts of students' time. Even worse, numerical methods, that are in standard use today to accelerate the progress of iterative calculations toward a solution, were rarely if ever taught. Most importantly, the slide rule allowed students to solve only one equation at a time!

Digital computers were available, but with a very low capacity and difficulty in programming and accessibility. One had to reserve time in blocks of hours in order to carry out significant computations and there was limited access, if any, for undergraduates. Photocopiers did not exist so that duplication of notes for students was typically done by Ditto®, with messy purple ink often smudged on hands and on papers and text that faded with time.

Students took a first-year engineering drawing course with the classic tools: T-square, set-square, drafting instruments and protractor. Graphs were of course done by hand.

Most faculty members were unable or very slow to type their own notes and papers, so that the department secretaries were kept quite busy typing all sorts of documents.

Analogue computers are devices that allow one to set up an electrical circuit in which the voltages mimic the behaviour of the model equations of a real process. Physically, one connected wires in various ways into the Analog Computer, in which the voltages then could show the time-dependent behaviour of the model being considered. This was very effective in showing students the effects of changing conditions on the dynamic behaviour of a process, including “blowing it up”, without

any danger! Unfortunately, for realistic modelling of complex processes, the analogue computer was incapable of providing the accuracy needed.

A major impact of the availability of high speed and large storage capacity in computers is that many algebraic or differential equations can be solved simultaneously. This involves processing lists of numbers (vectors) and rectangular arrays of numbers (matrices). Consequently, faculty and students soon realized that linear algebra and matrix calculus provided important tools to apply to the vectors and matrices in practical computations.

By contrast with the 1960s, everyone now has access to computers, students and faculty write, edit and print their own documents, using word processors, spread sheets and presentation software. Graphs are produced with ease and elegance using standard programs. Email makes the instant communication of messages to the whole class easy, including lecture notes, the latest assignments, solutions and urgent notices. Laptops allow a lecturer to bring the computer to class and to display the lecture slides as desired.

First Initiatives for Computing

Computing in the Faculty of Engineering began with the purchase by Dean Hodgins of a Bendix G15 computer, which would be far outstripped by today's hand-held calculators. It had 2,000 words of memory on a rotating magnetic drum and a paper tape input and output. The programming was done with numerical machine language that required explicitly retrieving a value from storage into the register, adding or multiplying by another value in storage and storing the result in a new location. Not only was the capacity of the Bendix limited and the programming tedious and lengthy, but any error in the paper tape input required repunching the whole program after correcting the error. Despite such limitations, Terry Hoffman and Cameron Crowe conducted significant computations, some of which consumed many hours of machine time.

Computing made a giant step forward when McMaster established a Computer Centre and purchased an IBM 7040 in 1964. Not only did the IBM machine have an enormously greater computing capacity, in terms of storage on magnetic disks and of computing speed, but faculty and students could write programs in FORTRAN. This programming

language, which was developed by IBM in the 1950's, allowed such simplifications as adding two numbers by writing

$$C=A+B$$

or multiplying two numbers by

$$C=A*B$$

where A, B and C represent storage locations that the computer knew how to find. In addition, input was achieved by using punched cards so that any error could be corrected by repunching the offending card and output was received as a printout on paper. The IBM machine made it feasible for chemical engineering faculty, undergraduate and graduate students to perform computations of considerable complexity. Indeed chemical engineering personnel were among the major users of the IBM.

Computer Simulation of Chemical Processes

In 1961, when Ab Johnson joined the Chemical Engineering Department, he brought with him not only considerable computing experience, but also a conviction that the application of computation to chemical engineering problems would become a major component of teaching, research and design of chemical processes and problems. Through his contact with Professor Paul Shannon, then at Purdue University and Ph.D. supervisor of Elmer Tory, Johnson acquired the PACER program for the simulation of chemical plants in steady state. This program was developed by Prof. Shannon and one of his graduate students, Henry Moser, at Purdue and was written in FORTRAN. PACER provided a basic set of programs (subroutines) that organized input data and descriptions of individual process units and carried out the iterative calculations sequentially until a final solution was achieved. While, by today's standards, PACER was primitive in that it lacked built-in physical property data and did not provide models for any process units, it was at that time a major step forward in our ability even to conceive of modelling an entire chemical process.

As described in Chapter 2, the first simulation of the CIL sulfuric acid process was a major advance in the computing capability of the Department. In subsequent years, successive final year classes conducted simulations and designs of a variety of chemical processes, in cooperation with personnel from each of the companies. The actual simulated processes are shown in Table 4.1.

In addition to the writing of models for the various process units in the plant, there were many questions that arose about the best way to

conduct the overall simulation. One decision that had to be made was the sequence in which the individual process units were calculated. Because no chemical process makes a pure product without having to separate the unconsumed feed materials, these feed materials are recycled to be introduced again into the process. There could be several such recycle loops, each of which also fed numerical information back to a point upstream. This numerical feedback introduced a numerical disturbance to the calculations so that repetitive (iterative) calculations were necessary until a converged solution was reached. The choice of the sequence of calculation was found to greatly affect the rate at which convergence could be achieved.

Early on, it became clear that there were other factors that could lead to numerical instability in the calculations. The most important was the choice of the number of digits of accuracy that were used. Single precision (6 or 7 digits of accuracy) was soon found to be unreliable in guaranteeing a stable converged solution. Indeed it became clear that double precision (13 or 14 digits of accuracy) was essential to achieve reliable convergence.

With several students and faculty each writing subprograms for different parts of the process, not all such programs were equally reliable or efficient. It was found that individual subprograms contained internal iterations that had their own tests for internal convergence. Unfortunately these internal tests would terminate with a different number of iterations from one entry to the next. This caused the result from a given subprogram to change randomly and thus to disturb the smooth path to convergence. The remedy was to insist that there be no tests for convergence within any subprogram and that any such iterative calculations have a fixed number of repetitions.

The most difficult simulation to converge was the Bayer Process for the extraction of aluminum oxide from Bauxite ore. It was not unusual to require as many as 600 iterations to reach convergence. This motivated Cameron Crowe to seek methods of extrapolating the succession of calculated values over several iterations and so of restarting a sequence of iterations from a new starting point that should be closer to the solution. This work was the subject of Oded Orbach's Ph.D. thesis and of Masatoshi Nishio's M.Eng. thesis, which led to the development of the Dominant Eigenvalue Method.

A further question that arose from the simulations was that of the accuracy of the measured flow rates, concentrations and temperatures that were used as input data, or as tests of the accuracy of the simulated results. Since all measurements have some errors, it is usual that the measurements do not obey the laws of conservation of mass, atomic species or energy. This led to an extended program of research by Cameron Crowe into methods of adjusting the measured data to achieve the best estimate of the true values that would obey the laws of conservation.

Ab Johnson worked tirelessly to train others in numerical methods and process simulation. He gave and organized numerous industrial short courses on these topics. Ab's research included the development of simulation programs other than PACER including MACSIM (McMaster sizer and simulator), GEMCS (General Engineering and Management Computation System) and DYNSYS (to simulate unsteady-state operation). Many visitors, post docs and professionals came to McMaster to learn from Ab. He was a member of the inaugural Board of Directors of the Canadian Journal of Chemical Engineering. He was one of the founding members of the group Computer Aids in Chemical Engineering (CACHE), a committee of the United States National Academy of Engineering. Ab emphasized the importance of industry-university interaction and organized numerous projects with AECL, Stelco and Procter & Gamble as well as the projects used in the Departmental simulations projects.

Table 4.1 Chemical Processes Simulated

Year	Process	Company, Location
1965	Sulfuric Acid	CIL, Hamilton, ON
1966	Sulfuric Acid	CIL, Hamilton, ON
1967	Alkylation	Shell Canada, Bronte, ON
1968	Alkylation	Shell Canada, Bronte, ON
1969	Bayer Process	Alcan, Arvida, QC
1970	Waste Water Treatment	British Petroleum, Oakville, ON
1971	Nitric Acid	North American Cyanamid, Welland, ON
1971	Fat Hydrolysis	Procter & Gamble, Hamilton, ON

Chapter 5 Research on Polymers

Polymer Reaction Engineering

Polymer research and teaching was first initiated at McMaster University in the early 1950's by Professor Laurie Cragg in the Department of Chemistry. After Cragg left McMaster University in 1959, this program stopped and it was not until late in 1963 that it was reinitiated in the Department of Chemical Engineering.

Archie Hamielec obtained a PhD in transport phenomena involving fluid mechanics of Newtonian fluids in Chemical Engineering at the University of Toronto in early 1961. He was then employed as a research engineer in the Central Research Laboratories (CRL) of Canadian Industries Limited (CIL) in McMasterville, Quebec until September 1963 when he accepted a position as Assistant Professor of Chemical Engineering at McMaster University. While working at CIL, he met Malcolm Baird who later became Associate Professor of Chemical Engineering at McMaster University in 1967.

CIL had a high-pressure polyethylene plant in Edmonton that Hamielec visited, in the capacity of trouble shooter. He had almost no prior experience with polymers but it was felt that his background in chemical engineering might be of some benefit..

Although Hamielec was hired at McMaster to teach transport phenomena he decided to change the thrust of his research toward polymer reactions. In 1963, Hamielec had discussions with Dean Hodgins about the possibility of initiating a research program on polymer synthesis kinetics and polymer reactor systems engineering. Hodgins agreed to co-supervise graduate students and to assist in obtaining equipment grants from the Natural Sciences and Engineering Research Council (NSERC).

Gel Permeation Chromatography

Hamielec heard that Dow Chemical Co. was developing a new and relatively inexpensive analytical device to measure the molecular weight distribution (MWD) of polymer chains. The analytical technique was called gel permeation chromatography (GPC).

Dow Chemical Co. had recently licensed Waters Associates in Framingham, Mass. to build and sell GPC instruments. Dean Hodgins and Hamielec immediately applied for and successfully obtained an NSERC equipment grant for the purchase of a GPC.

Two new graduate students, John Duerksen, a Ph.D. candidate, and Klaas Tebbens, an M.Eng candidate, started research on polymers under the co-supervision of Hamielec and Hodgins. Their first goal was to quantify GPC and then use GPC to investigate the free-radical polymerization of styrene in batch and continuous reactors. The work was successful and two papers were published in the American Institute of Chemical Engineering Journal in 1967

The American polymer industry was quite impressed with these publications and encouraged the development of a course to teach their analytical chemists and engineers how to use GPC. Seventy-five analytical chemists and chemical engineers attended the first course on the GPC at McMaster University in 1968. From that point on, polymer research and teaching in the Department of Chemical Engineering grew at a very rapid pace due to significant contributions from many of the professors in the Department.

Contributors to Polymer Research at McMaster

John MacGregor received a PhD in statistics from the University of Wisconsin in 1972 and became an assistant professor of chemical engineering at McMaster in September, 1972. MacGregor had a major impact on polymer reaction engineering in expanding its scope to include control of polymer reactor systems.

After receiving a PhD in chemistry at the University of Glasgow in 1961 John Brash became an associate professor of chemical engineering at McMaster in July, 1972. Brash had a significant impact in expanding polymer research to include polymer synthesis for biomedical applications.

Professional Development Courses

In 1975, Hamielec and Nils Friis, a postdoctoral fellow, wrote an extensive set of course notes on Polymer Reaction Engineering (PRE) and these formed the basis of a professional development course first given at McMaster University in 1976. The four day PRE course was

given annually at McMaster and elsewhere (for example, Porto Caras, Greece) for many years. Many professors in the Department contributed to this course by preparing notes and lecturing. These contributions were by: Brash (anionic polymerization), Crowe (applied math techniques), Hoffman (process modelling), MacGregor (polymer reactor control), Vlachopoulos (polymer rheology), Phil Wood (agitation in reactor vessels), and Woods (surface phenomena). The notes from the short courses were much sought after by those who were unable to attend the courses themselves.

The MIPPT Years

In 1981, Hamielec, Hoffman and MacGregor received an NSERC strategic Grant of \$400,000 to start up a new polymer institute called the McMaster Institute for Polymer Production Technology (MIPPT). Its function was to provide polymer analytical facilities and small-scale steel pressure reactors (1 and 2 gallon) for professors doing polymer research in the Department. MIPPT's other function was to attract polymer companies in Canada and the USA to join MIPPT and pay a membership fee of US\$15,000/year to provide additional funding for polymer research being done in the Department of Chemical Engineering.

MIPPT was established in 1982 with Hamielec as founding Director, MacGregor as founding Associate Director and Douglas Keller as Chief Chemist with responsibilities for the daily operation of MIPPT. MIPPT was very successful, having up to 18 member companies per year and significant levels of contract research. Other significant funding over many years came from OCMR (Ontario Centre for Materials Research), URIF (University Research Incentive Fund) and NSERC.

MIPPT used some of its income to sponsor the hiring of Dr. Harald Stover as a professor of chemistry, thus reinitiating polymer research and teaching in the Department of Chemistry. MIPPT also sponsored the hiring of Dr. Gu Xu as a faculty member in the Department of Materials Science and Engineering.

Physical Processing of Polymers

In 1968, John Vlachopoulos obtained a D.Sc. in chemical engineering at the University of Washington, St. Louis, Missouri, specializing in Newtonian fluid mechanics. His doctoral research was on the fluid

flow and heat transfer of turbulent high temperature air jets for testing of the heat shields of space vehicles which were manufactured at McDonnell Corporation in St. Louis.

Following completion of his doctorate, Vlachopoulos came to McMaster in August, 1968, as Assistant Professor of Chemical Engineering. Since the space program was being reduced after the moon landing in 1969 and there was tremendous growth in polymeric materials, Vlachopoulos decided to concentrate on research in polymer rheology and processing. This involves the conversion of polymer pellets or powders into useful products such as film, sheet, pipe, profiles, bottles, containers, automotive parts and numerous other products. Such processing also involves fluid flow and heat transfer, but with very low rates of flow due to the high viscosities involved, and with the added difficulty of non-Newtonian behavior that leads to various unusual flow phenomena and to significant production difficulties at the factory floor.

At the urging of Archie Hamielec, Vlachopoulos purchased a capillary viscometer which had just been designed and marketed by Monsanto. The efforts were focused on a study of extrudate swell and melt fracture phenomena that accompany the extrusion of polymers through dies. It was the first time that very well characterized materials were used in such studies and three papers published in 1971 and 1972 received a significant number of citations in the literature. These early studies provided him several years later with the necessary background in his subsequent efforts to model melt processes such as calendering, extrusion, injection molding, thermoforming, blow moulding, film blowing and rotational moulding.

Vlachopoulos started using finite differences (FD) for describing the fluid flow of molten polymers and early in 1970's he became aware the new numerical method of finite elements (FE) for solving of differential equations, which had been developed by civil and structural engineers. The advantage was the ability of the FE method to handle complex geometries and material nonlinearities so that Vlachopoulos decided to assign this problem to Costas Kiparissides for his Master's degree. Their joint paper on finite element modeling of calendering which appeared in print in 1975 was the first paper ever published on using the finite element method to simulate an industrial polymer process. This attracted international attention to Vlachopoulos' work and led to many requests from industry to license the finite difference and finite element software. However, it took several years' research by doctoral students

including Enno Agur, Evan Mitsoulis and later on by post-doctoral fellows in the 1980s to produce user-friendly software packages that could be used in industry. Subsequent efforts lead to several hundreds of licenses to industry worldwide.

Chapter 6 Research on Catalytic Chemistry

Professor Robert B. Anderson

Professor Robert B. Anderson's credentials before coming to McMaster are most impressive:

He came to McMaster from the United States Bureau of Mines in 1965. He had achieved significant advances in Fischer-Tropsch synthesis (FTS) for the catalytic conversion of carbon monoxide and hydrogen into liquid hydrocarbons at the Bureau of Mines, which he joined in 1944. Prior to this, Professor Anderson had completed doctoral studies at Iowa State University in physical chemistry followed by two years of postdoctoral work with Professor P.H. Emmett at Johns Hopkins University.

While at the U.S. Bureau of Mines he developed new catalysts for FTS and was the first to show that iron nitrides are unique and durable catalysts for FTS that have high selectivities to alcohols. Professor Anderson also worked on the kinetics and mechanism of FTS. Perhaps the most significant contribution in this area was made in 1950 when Anderson and Friedel published the equations that predict the isomer and carbon number distributions of the FTS products. Although the original version of their equation was later improved by Anderson and others, the basic form remains valid today and is used in most FTS publications that report product distributions. Anderson later referred to the equation as the "Bureau of Mines equation" but it is now most often referenced as the "Anderson-Schulz-Flory equation". Many of Anderson's contributions from this period were published in Emmett's series on Catalysis and in the now classic reference text by Storch, Golumbic, and Anderson entitled *The Fischer-Tropsch and Related Syntheses* (1951). In recognition of the very significant contributions Professor Anderson made in this area, he was awarded the Ipatieff Prize of the American Chemical Society in 1953 and the Pittsburgh Award in 1960. In 1966 the U.S. Department of the Interior bestowed on him its highest honour, the Distinguished Service Award.

At McMaster University, Bob Anderson established one of the strongest catalysis research laboratories in Canada. He was a teacher and mentor to undergraduate and graduate students, postdoctoral fellows and other visiting scholars, many of whom remain active in catalysis research. Under his guidance, his students and post-doctoral fellows were able to make significant contributions in many areas including hydrocar-

bon hydrogenolysis, preparation and characterization of catalysts, Fischer-Tropsch synthesis and alcohol synthesis. He published more than 200 scientific papers, and wrote and edited several books and monographs. Professor Anderson and Don Woods gave workshops on catalysis and surface phenomena.

His other very important contribution to the research program in the Department was his availability as a consultant to other research groups, particularly in the hydrogenolysis of small paraffinic hydrocarbons. Terry Hoffman and his students used the hydrogenolysis reaction of butane on a silica-supported nickel catalyst to study chemical reactions in fixed and fluidized bed reactors. This same reaction was used by Joe Wright and his students to study the advanced control of highly exothermic chemical reactions in a fixed bed. Bob Anderson also provided some real insight into some features and modelling of the oxidation of ortho-xylene on a silica-supported, vanadium pentoxide catalyst. This reaction was used by students in Terry Hoffman's group as a test reaction in the study of a pilot-scale reactor where the catalyst was transported upward in a tubular reactor. He also provided guidance on catalytic reactions in other research areas and reactor modeling in the simulation of industrial processes.

Bob Anderson officially retired from McMaster University in 1981, but as Professor Emeritus continued an active research program at the university. As a retirement project he wrote the book, *The Fischer-Tropsch Synthesis*, published in 1984, which was an update of research on the Fischer-Tropsch synthesis from 1955 to 1983.

He was a member of the Editorial Board of the Journal of Catalysis, session chair at various international conferences, and served on the executive of The Catalysis Division of The Chemical Institute of Canada. In recognition of these contributions, Professor Anderson received a number of awards including The Catalysis Award of The Chemical Institute of Canada in 1979, Fellowship of The Chemical Institute of Canada, and Fellowship of the Royal Society of Canada in 1983. In 1984, a Special Fischer-Tropsch Session was held in his honour at the 9th Canadian Symposium on Catalysis in Québec.

As co-chairman, with Harry Habgood, he was busy organizing the 9th International Congress on Catalysis held in Calgary, Alberta in 1988, when he died suddenly on October 24, 1987.

A prize, The Robert B. Anderson Memorial Prize for Leadership and Excellence, was established in his memory, to perpetuate the spirit of human compassion and research excellence that he so clearly demonstrated during his years at McMaster. The prize is awarded annually to a worthy graduate student on the recommendation of the Department of Chemical Engineering.

Chapter 7 Water and Waste Water Treatment

In 1961, Dr. Keith Murphy joined the Department of Civil Engineering following completion of his Ph.D. at the University of Wisconsin, Madison. During the next five years, Murphy established an excellent program in environmental engineering in the Department of Civil Engineering. Within a small Faculty, easy interaction with colleagues and prior contact with Don Woods in Madison led Murphy to realize that the core areas of Chemical Engineering, notably reactor design and heat and mass transfer, offered a rich potential for application to waste water treatment.

Murphy also interacted extensively with the professional community and associations. He instituted many connections beyond McMaster, for example, the annual trip of the faculty and all graduate students to the Purdue Waste Water Conference.

In 1966, Dr. Jack Norman was appointed as Assistant Professor in the Civil Engineering Department, with associate membership in the Department of Chemical Engineering. Given Norman's academic education in chemical engineering, with his Ph.D. from Rice University, he was a key to achieving the blend of civil and chemical engineering technologies in their joint application to waste water treatment.

In the fall of 1967, Dean Hodgins arranged the transfer of all waste water activities to the Chemical Engineering Department. During the winter of 1967-68, Norman applied for and received from the Federal Department of the Environment a five-year training grant for developing advanced waste water treatment technology. Technical support staff, namely Anna Addie and Henry Behman were appointed and a strong graduate degree program in waste water quickly developed. The environmental program flourished, with large numbers of graduate students, post doctoral fellows and visiting professors, and extensive interaction with industry.

In 1969-70, the wastewater group worked with those from the simulation area in the Department on a senior design project of the British Petroleum refinery waste water treatment process. Andrew Benedek was appointed as Assistant Professor in 1970, after completing his doctorate at the University of Washington, Seattle. Benedek's area of research was on the adsorption of pollutants on adsorbents such as activated carbon.

In 1973, Jack Norman resigned as Associate Professor to establish his own company, Pollutech, in the waste water treatment field. Keith Murphy left in 1976 to join IEC International Consultants. With the end of the Department of the Environment grant in 1972 and the resignations of the two principal leaders, the momentum of the graduate program in waste water treatment was somewhat reduced.

The program continued with faculty contributions from Dr. Andrew Benedek (until 1981 when Andy left to establish Zenon Environmental), Bill Snodgrass (1974 to 1982) and Marios Tsezos (as a graduate student from 1975-77 and later as a faculty member from 1981). Bill was a joint appointment in both Civil and Chemical Engineering, with a specialty in pollutant levels in fresh water bodies. Marios studied the absorption of pollutants by micro-organisms (biosorption).

The interests in the group generally emphasized water and waste water treatment and the interaction outside the University continued to be extensive. Keith and Jack created the annual paper presentation conference with Phil Jones and Gary Heinke, the Toronto-Waterloo-McMaster consortium.

Don Woods, with his research interests in physical separation, surface phenomena and oil-water separations, joined the group and supervised students in waste water treatment, such as the AISI project with Stelco to handle their oily waste through coagulation and flocculation, cyclonic separations of oily dispersions and decanter design.

In the late 1970's Murphy served as consultant for Canada Mortgage and Housing Corporation to identify research needs in the area of storm water management. The establishment in 1967 of the Canada Centre for Inland Waters and the Wastewater Technology Centre in Burlington provided a natural extension of our expertise with shared seminars and shared research facilities at the Wastewater Technology Centre.

In addition to the developmental grant, the individual faculty associated with the program was very successful in obtaining research funding for their various projects. The topics ranged from denitrification, phosphorous reduction, rotating biological reactors, residence time distributions, distinguishing between dead and live microorganisms and miniature hydrocyclonic separations.

Several of the program's graduates have distinguished them-

selves in international circles and continue to make us proud. Ph.D. graduates, Warren Wilson and Bob Dawson, have been internationally recognized for their developments in bioreactor technology.

The company in which Bob Dawson is a principal, Stantec Inc, won a contract from the USEPA to be the lead consultants on a landmark project covering all discharge to the Chesapeake estuary, including Washington DC, Baltimore and “DelMarVa” Peninsula. His team established design criteria, and built and operated a pilot plant for more than two years. This established all process design criteria for the full scale plants whose detailed design would be divided amongst several major US consulting firms.

The firm in which Warren Wilson was a principal was the process subcontractor for the dephosphorization part of this effort. Previously, both had distinguished themselves in the B.C. interior (Okanagan, Penticton, Kamloops), and in the US Pacific Northwest, where phosphorus and nitrogen limits in discharges are equal to the most stringent worldwide.

Peter Melnyk has served in major roles in environmental control in the Pacific Rim areas, first from Hawaii, then subsequently based in Guam. Gary Heinke became Dean of Engineering of U of Toronto and subsequently contributed to the development of a green field University in Hong Kong. He continued on in the Hong Kong University of Science and Technology as head of a major Environmental Institute.

Among Post Doctoral Fellows, Aharan Netzer became a professor in Environmental Engineering at the University of Texas at Dallas. Gary Vigers became a principal in a prominent west coast environmental consulting firm. Brian LeClair has had a senior role in the Ontario Ministry of Environment for many years. Masters graduates have all done well as problem solvers in consulting engineering firms. Many others have served in prominent technical roles in the Ontario Ministry of the Environment.

Steve Nutt is still a senior partner in XGC, who have become probably the most technically creative environmental consultant in Ontario. Patrick Tan returned to Singapore where he rose to a senior position in their government. Patrick received an honorary D.Sc. from McMaster University in 2003.

Chapter 8 McRaP and Process Metallurgy

In 1978 an interdisciplinary group of chemists and engineers was formed under the leadership of Sanjoy Banerjee (Engineering Physics), to tackle the problem of radioactive tailings from uranium mines. Our approach was to look for ways of leaching the radium efficiently and selectively from the tailings, thereby reducing the radioactivity levels. The project had the acronym McRaP (McMaster Radium Project). Chemical engineering participants included Malcolm Baird, Les Shemilt, Marios Tsezos, Don Woods, Doug Keller, Inderjit Nirdosh, Shiv Vijayan and Sirugamani Muthuswami, with assistance from Anne Molgaard and Cindy Walker. Other colleagues from the Chemistry Department included Klaus Fritze, Alfio Corsini, Alan Nixon and Alice Pidruczni.

McRaP was started at a time of perceived high demand for uranium for nuclear power generation, with two companies (Rio Algom and Denison) operating mines and refineries in the Elliot Lake area of northern Ontario. The uranium extraction process produced a large amount of sand-like “tailings” containing a small but measurable amount of radium, which decays over a half-life of 1600 years to emit radon gas. Malcolm recalls flying back from Elliot Lake, carrying a plastic bag of tailings as hand baggage; airline security was less of an issue then than it is now. They had all worked hard on the project, held innumerable meetings and written several papers, when unexpectedly in 1982 our N.S.E.R.C. Strategic grant was not renewed. Soon afterwards the price of uranium fell and the Elliot Lake mines were closed, while our radium recovery results went into the periodical and patent literature.

The McRaP research effort, though short-lived, was significant because it started a “wave” of departmental interest in process metallurgy and its environmental impacts. At the undergraduate level, the milling of brannerite ore was a final year design project from 1981 to 1986. The projects were completed with help from the late Ken Hester who had retired from Rio Algom and Dr V. Lakshmanan, Ontario Research Foundation (ORTEC). At the research level, Indirjit Nirdosh carried his interest in mineral flotation to Lakehead University when he moved there as a faculty member. At McMaster, Marios Tsezos was the leader in ongoing research on the use of inactive biomass to remove radium from liquid effluents. Don Woods continued work on surface phenomena applied to mineral flotation. Later, Malcolm Baird began a major involvement with Inco Ltd. on copper/nickel refining.

Chapter 9 Conclusion

During the period of the sixties and seventies, the Department benefitted from the dramatically rapid development of main-frame computers. Their applications to chemical engineering reached into every field of research and teaching. With the introduction of the personal computer (PC) by IBM in 1981, a new revolution in computing had begun. As we have all experienced, the explosive growth in ever more powerful and cheaper PCs has totally changed every aspect of electronic communication. The impact of email alone has made instant transmission of messages a routine task. Word processing, spreadsheet and presentation software have all changed our lives. The fact that PCs and mobile phones are now available to all students, whether in a university cluster, a library, at home or in their backpacks, means that they have ready access to all of the resources of the Internet. The history of the Department of Chemical Engineering at McMaster University after 1982 remains to be written, but it has been unavoidably and fundamentally affected by these revolutionary advances in electronics.

Over the first two decades of McMaster's chemical engineering program, there was a steady increase in the enrolment of students. Class sizes grew from about ten in the earliest years up to around fifty in the latter years. This growth imposed significant pressure on the ability of faculty to continue to manage the courses that required extensive interaction between teacher and individual students. The courses that were most affected were Technical Communication, Problem Solving and the final-year Design.

Appendix A - Collected Reminiscences

Former Staff

Sally Gravestock, Chairman's Secretary (1964-69)

When I was asked to put together some information on my time with the Department of Chemical Engineering at McMaster my first thought was “great” but then as time has gone on I realized that 36 years is a long time to go back to try and remember those days in detail.

I do remember some of them though, they were fun, busy, and industrious and there was an awful lot of paper! We thought the age of the computer would bring less but – has it? Not at all but in those heady days of the late 60's there were few students in the department who had any idea of the volume of paper which awaited Linda Watson and me (and latterly Ora Orbach and Barbara Coverdale) on our return to our desks be it after a weekend or even, just overnight. The faculty were prolific writers – Ab Johnson would have scored very high on any scale.

When I first joined the Department of Chemical Engineering, Ab Johnson was the Chairman. He seemed to spend every waking moment in his office writing memos, letters, student notes, dittos. Do you remember those dreadful things – “dittos”? They were used for class notes and had to be run off on a special machine. Apart from the frustration of covering yourself with the carbon if you made a mistake, there was the running off and the collating. How things have changed.

Terry Hoffman assumed the role of Chairman and while he also was prolific with the written word, Ab Johnson seemed to have the edge on everyone. Bob Anderson was writing one of his many tomes when I joined and I was given the pleasure of typing up the manuscript. The publishers weren't too impressed however as I changed all the spelling to English – z's to s's as an example. Bob Anderson had to go through and change all that and return it to me for retyping. No quick “find” and “replace all” in those days so it was an arduous task involving the retyping of many pages or, even trying to get the paper back in the machine after using Snopake® and lining up the words!

In those days FORTRAN was the only program used by the students. They didn't have the benefit of laptop computers for their notes – everything was the written word involving many many hours of testing, writing and scheduling their time. The mail for students was posted in pigeon holes up in the penthouse and students advised when this was

done so that they could keep “up-to-date” with life generally. What a change to-day, e-mail, online photographs and a wealth of other things besides.

We poor office staff had to use typewriters, correct mistakes on bond paper, scrape dittos with special razor blades. What a nightmare – how our lives have changed with the birth of the desktop computer.

I remember the faculty having to scrape together enough money from some of their grants to buy me the fancy IBM machine with the variable spacing. It was a great machine and made life so much easier to write the Chemical Engineering Department handbook for 1967-1968. How formal we all were in those days too. No first names in the book – messages from T.W. Hoffman, J.W. Hodgins. What suddenly happened when it came to the Chairman of the ChE Club and its representatives – first names suddenly appeared but it didn’t last through the rest of the yearbook. It wouldn’t happen now; it would be first names everywhere but hopefully with the continued respect that the formality held.

Somebody once said to me during my time at McMaster that student days are the best days of your life. They probably are but there is so much more to en-joy too once you get out into the “working world”. The biggest gift is the friends you make along the way.

There was great camaraderie at the University and lots of fun times – ice sculpture competition, lots of parties and generally good times together with the serious work. Professors were very accessible and “good friends” to their students. I am sure this has continued. I hope the fun times have too as they are important to making it a worthwhile journey.

I was asked to think of some stories – that’s hard. There were some pretty fraught moments with lecture notes and general administration but the time was special and great fun, made so by the many who were there from September 1966 to September 1969. Thank you to those who made it “special” and especially to those who worked with me in the office, Linda Watson, Ora Orbach and Barbara Coverdale.

Ora Orbach, Secretary (1967-71)

September 1966 was the time we arrived in Canada. Our plan was to live in Toronto so that I could perhaps work at the Israeli consulate, and Oded would commute. Little did we know how much time Oded needed for study, so after a month in Toronto, and with Oded stay-

ing at least part of the week in the YMCA in Hamilton, we had to find a furnished apartment in a Co-Op on the border of Dundas/Hamilton, across from University Plaza.

After I took a course in Pitman shorthand in a business school in downtown Hamilton, we exhausted our finances and I needed to find a job in a hurry. I think that Oded's stipend was about \$250.00 per month. It was very gratifying to be given the opportunity, by the Department of Chemical Engineering, to try and prove my capabilities. Dr. Crowe personally escorted me to the Personnel Department, to introduce me and to do the necessary paperwork.

I recall the first day I reported to work, during lunch time everyone disappeared, and I was alone trying to handle the telephone lines, ringing all at the same time. Taking phone messages onto the pink slips, the names being so foreign to me, was quite an experience.

The atmosphere was terrific - so civil and friendly. We were so well received and looked after by the academic staff and their spouses and were treated in many respects like family members.

The campus itself was quite beautiful in that it was small and cozy, with the sunken gardens prior to the Medical Centre being built on the grounds.

There were schedules to be met, projects, seminars and workshops to organize, travel arrangements to be made, committee meetings, annual NRC applications to complete, research proposals, papers to be typed, books published, the inception of the Engineering & Management's five-year program, the processing of graduate applications and related correspondence, class notes to be typed, and piles of paper, the purple ditto copying before Xerox machines. There was a lot of activity. IBM Dictaphones were purchased, and I al-ways was afraid of hitting the wrong button and erasing the contents.

Sally Gravestock was very experienced and organized and I learned a lot from her. There were also Charlotte Traplin, Sheelagh Courtney and Maureen Lees. I think we worked in total harmony. There were also friendships with graduate students from Canada and around the world, so that exposure to different cultures helped to make us aware of the politics and economics of North America. The whole experience was very positive and educational. Above all, were the outstanding human relationships and the respect accorded by faculty members to students and staff.

There was the Penthouse where some of the graduate students shared space and where sometimes one could hear James Lee play his violin or listen to Soo-Il Lee philosophize. The allocation of research grants was an important morale booster, in particular I recall the large sum for the Wastewater group. I think everyone was driven, working hard and trying to do the best they could.

Charlotte Traplin, Secretary (1969 –71)

Happy 50th Anniversary Chemical Engineering! Thoughts and memories gather as words show up on my computer screen. I ‘typed like the wind’ in 1969.

The Chemical Engineering Department had IBM Selectric typewriters, ideal for preparing letters, documents, papers and theses. We had state of the art technology with white corrective tapes to fix typos. Wow! The days of reproducing three copies of a thesis using carbon paper had dwindled with the introduction of photo copiers. Be in awe should you happen to read from a carbon copy edition. Imagine correcting and editing errors in between flimsy carbon paper that smudged and tore easily? Luckily, I was saved from that horror thanks to advancing technology.

Back to the Selectric: an aluminum sphere the size of a golf ball topped with a clip lever and embossed with letters and symbols delivered the magic. Depending on what ‘font’ was required, a ‘selection’ was made from an assortment of ‘golf balls’ that were interchangeable. Grab it by the clip, pop it on to the centre post and click. After the click it was ready to go speeding back and forth with each key punched. I got very good at it. As fingers flew around the keyboard I learned to click a new ball on and off in mini-seconds transcribing chemical engineering lingo into text, charts, graphs and equations made up of symbols and other beautiful characters. I typed thousands of pages that, at most, were written in a language I didn’t understand. Accuracy was a *must*, and once deciphered from writing that appeared like ‘chicken scratch’ too much of the time (you know who you were!), works of art were created. At least that’s what *I* like to think. Today it’s much easier: $\sum \Delta \mu \square \{ \} \sim \pi \lambda \chi \beta -$ lest I forget. Typing was a huge part of my job.

There were four of us taking up the administration space at that time: Maureen Lees, Sheelagh Courtney, Ora Orbach and myself. Doctors Johnson and Hoffman had the window offices when I first arrived. When Dr. Hoffman became Chairman, Dr. Crowe took his office. They would hurry to lectures, meetings and to the labs or work quietly in their

offices deep in thought and writing. “Hurry” was the operative word. With papers tucked under their arm, head down, off they’d charge to get to where they needed to be – in constant flux – so to speak. Probably hasn’t changed much. Faculty and students were in and out during the day, each one bringing in something different and new: work to be done, a joke, a smile, a topic to be discussed usually laced with technical and engineering terms.

We worked well together allowing room for loads of laughter, understanding and treats. Maureen took care of the Chairman’s administrative work. Sheelagh, Ora and I managed the tasks that came with a busy and growing department. Between churning out academic papers and correspondence, we planned for visitors from overseas, coordinated trips locally, to the US or Europe for meetings, conferences, sabbaticals. People were coming and going - flying in and out of the office and the country too. We took turns doing the mail – sorting and delivery to the professors’ offices and to the student lounge where ‘pigeon holes’ were filled with messages, engineering journals, memos, flyers, junk mail and often letters from home. I collected some nice stamps. My memory turns vague when it comes to names of our students at the time; but I do remember having a crush on a few and enjoying their wit and charm. The treats would be lunches at the faculty club, kind gestures, and gifts from the professors and students. When I was talking with Don Woods the evening he called to ask me if I would put a piece together for this book, I mentioned to him that I was looking into my dining room and could see the crystal sherry decanter and glasses the department gave me when I went away. I fill a Pewter bud vase from Holland with a rose from my garden, and occasionally wear a turquoise ring from Turkey; all reminders of my ‘chemical engineering’ days with thanks. There are many memories I could write about, but two pages of typing is enough and I tend to get carried away. Remember, I type like the wind. There is though, room for what comes next.

The McMaster Department of Chemical Engineering is where I got my first glimpse at the international scene. Meeting and working with wonderful people from different corners of the world nudged my curiosity. I was young and itching to see the world beyond Hamilton. And I did.

Here is where I made a lasting friend. Sheelagh Courtney and I enjoy our friendship still. We reconnected when I returned to Hamilton a few years ago after a thirty year gap of life in between.

Here is where I set my guidelines for what I wanted in a working environment. The Department of Chemical Engineering, McMaster University set a benchmark for me in 1969.

That dash of life has stretched with age and changed into what is now. My career, like an engine, has stopped and started. Travel, marriage, a family (two beautiful daughters), and life has happened. I write honestly that I never worked in such a familial, cheerful, productive environment again. Some came close, but not quite. It was a happy time. I had a great job. The inner sanctums, hallowed halls, classrooms, playing fields and pubs pulsed with ideas, activities and events. I was young, single, and loved being a part of it, if only for a little while. Those were the days! Thanks for the memories.

Maureen Ash (formerly Lees), Secretary (1970-73)

The opportunity to work as Chairman's Secretary in Chemical Engineering was a stepping stone for me. I arrived in Quebec City from England in 1968. I was newly married and I had grown up in a northern English textile town called Oldham. I left school very young - most of us did - and started work in a Dickensian mill office as a junior. I also attended Commercial College one day a week and night school while I was working, so at the age of 24 I had been working for almost nine years.

However, I turned an important corner when I answered an advertisement in the Spectator for a secretarial position at McMaster University. For better or worse I got the job and arrived in Chemical Engineering. It was a challenge indeed. At that time I had worked as a shorthand typist for seven years, but never in an academic setting and I was very intimidated by professors and academia in general. I was challenged by the demands of the job. We produced a graduate handbook, an annual report and I also took departmental minutes and the minutes of the annual Industrial Advisory Committee. Accuracy and good hearing were important because in those dark and distant times we had no computers, and copier machines were just appearing. A typewriter and *Roneo*® sufficed to do the job. However, it was an exciting time - a new country, a good job and the opportunity to meet students from all over the world. I worked closely with the Graduate Student Advisor: Dr. Crowe. I remember many of the graduate students: Jorge Cardenas from Chile, Alejandro Lozada from Mexico, Jonathan Tutleman, a Jewish Londoner, and many more. I worked hard to keep abreast of everything.

The professors I distinctly remember: The Chairman was Dr. Hoffman and my direct boss; Dr. Anderson brought us flowers from his garden; the enthusiastic and kind Dr. Woods; the hardworking Dr. Johnson and Dr. Hamielec, who had just returned from the USSR; Dr. Jack Norman, Dr. Keith Murphy and the young Dr. Wright; and of course Dr. Crowe who told me how to correctly pronounce Tucson - the quiet and shy Dr. Baird reminded me of home.

I remember the secretaries: Ora Orbach - who asked me what "crikey" meant. "...that word you are always saying."; Charlotte, young and friendly, just from high school, and probably not much younger than I was. Later on we were joined by Sheelagh Courtney, straight from Ireland. She was embarrassed when I introduced her as a "native of Ireland." Sheelagh took over my job when I left. I also remember going to her wedding. She married Don, a Northern Ireland Protestant, quite a bold step merging the orange and the green - only in Canada!

I could ramble on, but I won't. I was introduced to academia. Initially I was in awe of it and then I joined it. I received a B.A. in English and went on to get a Master's degree in Education. I wonder if I would have gone down that path if I hadn't answered the "Secretary Wanted" advertisement so many years ago. I retired from teaching English Literature at the secondary school level three years ago. The opportunity to work in Chemical Engineering was indeed a stepping stone for me.

Sheelagh Courtney, Secretary (1971-77)

I arrived in Canada in the cold snowy Jan. of 1971 and immediately applied for work at McMaster because it was within walking distance of my apartment. By early February, I was warmly settled and employed in the Chemical Engineering Department where I remained until September, 1977 when I started my family and moved to Ottawa.

Dr. Hoffman was Chairman at the time and Maureen Lees, Ora Orbach, Charlotte Traplin, Ingrid Ellis and I were the secretarial staff. We had our "in" and "out" boxes on our desks and my overriding memory is a constant "to and fro" of professors, post-doctoral fellows and graduate students in the office and there was always personal chit-chat and interaction that went along with the work they brought in.

It is amazing to me, in hindsight, how fortunate I was to find myself in a job where those I worked for and with went out of their way to help as I adjusted to life in Canada. To name a few instances, Dr.

Wright did my Income Taxes, my sister, who was visiting from Ireland, and I spent our first Christmas with Dr. Woods, Diane and their young family. Charlotte's family had me for dinner just about every night and Maureen and Ora, who were not long in Canada themselves, provided lots of advice.

Among Department activities, I went on my first ski-trip, my first barbecue at Dr. Hoffman's house and my first summer picnic in a beautiful park. We had the opportunity to earn extra money by being allowed use of the office after hours to type graduate theses. We were regularly treated to lunches at the Faculty Club.

From what I remember the Chem. Eng. faculty was prolific publishers so these "modes" of working were efficient and effective for their time.

Some of the memories that come to mind are:

Dr. Brash's and Dr. Feuerstein's talk of Biomedical Engineering.

Dr. Hamielec's exotic Russian hats and how he often arrived into work bent over after putting his back out and I often took advantage of his "easy chair" on my lunch breaks.

Dr. Woods' passion for teaching.

Dr. Hoffman walking into the glass door of the Senior Sciences building.

Dr. Vlachopoulos' motto "Moderation is the key to a happy life".

Dr. Shemilt's interest in Sherlock Holmes.

Dr. Norman and Dr. Benedek (later, Dr. Snodgrass) down in the Waste Water Management office.

Dr. Baird's quiet, unfailing politeness, and the stories of his famous father.

Dr. Crowe's love for intellectual pursuits and music.

Dr. Anderson, whom I always thought of as a Teddy Bear.

During my time in Chem. Eng., I was fortunate to work for Dr. Hamielec, Dr. Hodgins and Dr. Crowe. Dr. Hodgins sent me to Toronto for an Administrative Assistant Workshop. Maureen Lees, Ora Orbach, Charlotte Traplin and Ingrid Ellis moved on and we then had Sara Gallo O'Toole, Peggy Johnstone, Sandi Evans, Debbie McCreath and Amy Stott. I loved the summer when everything was quiet and relaxed and I

also loved the hectic buzz and excitement as we prepared for the coming Academic year in August.

The Department, to me, was a framework for embracing and appreciating human diversity. I remember the stories from countries all over the world - Egypt, India, Mexico, Greece, Australia, Iran, USA, England, to name a few. I have many mementos brought back to me from these countries in my home today.

I met my husband and made many life-long friends at McMaster and absolutely loved my work and time in Chemical Engineering Department.

Sara Gallo O'Toole, Secretary and Administrative Assistant (1972-78), Chairman's Secretary (1978-81), Administrative Coordinator (1981-99)

It is indeed an honour to be asked to contribute to the history of the Chem. Eng. McMaster University by reminiscing what the department was like up to 1980. The sojourn began November 20, 1972, with the Wastewater Research Group which was part of the Department. I was transferred as Chair's Secretary with Cam Crowe during Archie Hamielec's research leave and later promoted to Administrative Coordinator for a life span of 27 years. As I reflect I have many, many fond memories of this extraordinary Department which bring much joy to my heart. Although I have not been there for many years, I wish I could turn the clock back and start over; however, I do revisit in my dreams. They are unspoiled, wonderful dreams.

Even though I was asked to bear in mind the time period to 1980, the strong characteristics of the Department were well established by then; faculty members were in place and the esprit de corps continued during my stay. Faculty members respected each other and realizing each has differences, when it came to big decisions, they were in tune. They were very dedicated to their profession and tried to maintain a good balance between their teaching, research and professional activities. They tried to set and maintain the highest standards for their students, PDFs and other researchers. New faculty hired complemented each other in their areas of expertise and fitted into the department. There were three main research areas: computing and process control, polymers and environmental engineering. The fate of every undergraduate and graduate student was carefully and fairly considered.

I loved my work with the students, PDFs and other visitors especially the international ones. In some ways I associated with them by recalling how strange I felt when I arrived to Canada at the age of nine. I tried to help them as much as possible and make them feel welcome. I saw an endless number of remarkable Master's and PhD students enter, obtain their degree and leave. I was happy for their accomplishments but sad to see them go and then later happy when many visited, wrote or called.

There was a feeling of family among the faculty, staff and students which was particularly evident at Departmental social functions. In September, we held the Corn Roast at Canterbury Hills as part of the orientation for new graduate students. We husked corn and faculty wives cooked it to perfection. Bill Snodgrass was at the piano and Don Woods led the sing-songs.

Faculty, staff and spouses looked forward to the Christmas pot-luck dinner usually held at the Chair's home or at the Woods'. Faculty and staff attended the Christmas luncheon at the Faculty Club and the faculty were very generous with their gift to us. Many dined and danced at the Engineering Christmas dinner and dance normally held at the Faculty Club. In those days, there were large groups primarily from Chem. Eng., Civil Eng. and Mechanical Eng.

In late Jan. or early Feb., the senior under-graduates, graduate students, faculty and staff went down-hill or cross-country skiing at Horseshoe Valley. When the 2 or 3 buses returned, we were treated to delicious cabbage rolls, compliments of the wives of the faculty.

Senior undergraduates were taken on design project trips. I recall one year Terry Hoffman took them to Polysar in Sarnia.

There was much laughter at the annual "Roast the Profs" by the undergraduates and Don Woods' reading of his card as a tribute to them. In May, many faculty attended Convocation. If faculty had graduate students graduating in November, they would also attend.

We celebrated the end of the Chair's term with thanks and the welcoming of the new Chair with a special luncheon, e.g. at the Old Mill in Ancaster, when Archie Hamielec's period ended and Don Woods' began. The Chair would treat the secretaries to lunch in honour of their birthdays. Some faculty spoiled us with mementoes from their vacation/other trips, e.g. bracelets, jewelry boxes, T-shirts, vases.

Some of us played baseball on the Chem. Eng. Baseball team against other University Departments. This was all in fun and we had red

T-shirts done one year. I am still using the Cuisinart® food processor, bean-pot and clock (from RBA) and gifts from faculty when I remarried.

The Wastewater group also had lots of fun parties at the Murphys', Benedeks' and Snodgrass's. I remember Keith Murphy's trains at his home on Little John Rd., Dundas. Ruth could not keep up making Caesar salad with her homemade dressing; we kept dancing to a French tune to late hours; I was introduced to Scotch. Who could ever forget Bill Snodgrass cooking Thanksgiving dinner for new students? Bill's birthday and mine were two days apart so the two Scorpios celebrated over lunch; the last one was at the Pagoda.

One very special occasion which Brian and I will never forget was in August 1980, when Keith and Ruth Murphy picked us up with their boat while we were vacationing in Fenelon Falls and took us down the Trent Canal System. Keith parked his boat on Balsam Lake; our two young boys swam; we sun bathed and had sandwiches and wine. It's all captured in pictures. I am still using the cookbook which Ruth gave me which was prepared in 1976 to honour the 20th Anniversary of St. Mark's United Church, Dundas. I shall forever be grateful for the love, support and protection extended to me by Keith and Bill in particular during the separation of my first marriage.

It wasn't all play in Chem. Eng. Everyone worked very hard. The workload was heavy however the atmosphere in the office was great with lots of laughter. The secretaries were very loyal and very efficient. Of particular mention are two wonderful ladies, Peggy Johnstone and Amy Stott. Who could ever forget Don Woods doing couch-dancing in the office with Amy and Peggy? There were no computers and no photocopiers. We typed on IBM Selectric typewriters, later with correcting tape. Course notes were either typed on dittos for duplication or on plain paper if they were submitted early enough for the printers. Carbon paper and onion skin paper were used for extra copies of letters. Carbon paper was also used for duplicate copies of forms. We aimed hard at accuracy otherwise, there was a lot of Snopake® and cut and paste. We were not too fussy then. Faculty dropped off their work in a wire basket. The secretaries picked up the work from the pile and it was done. Faculty produced many publications and so many research papers to be typed. The many students kept us busy too. There was a lot of mailing of preprints and reprints, not like today where one can download them. We had an antique paging system in the office to reach people in the labs or in the Penthouse.

I remember like it was yesterday our head technician Bob Dunn, and head machinist, Joe Newton, two men in white lab coats, with big smiles, ready to listen, eager to please, and also quick to express their opinions if something could not be done or done differently. The Wastewater Group, when it was at its peak, received many contracts and grants, e.g. from Environment Canada and Ministry of the Environment, so we had the ability to hire a large group of researchers. I loved the interaction I had with all of them, in particular Anna Addie, Henry Behman, John Bancsi and Pat Usenik. Pat and I enjoyed many weekly dinners at the Black Forest even after Pat's appointment ended.

Space was always a problem, i.e. space for faculty, staff, researchers, graduate students and labs. There is so much to tell. It's hard to stop. It all started in JHE-136. While reminiscing about the faculty, if I was asked to summarize in a few words how best I remember them I would say: Bob Anderson: clocks, snooze, cross-country skiing. Malcolm Baird: wit, sense of humour, television. Andy Benedek: revealed to me in the mid '70s that his water filtration system would be famous one day and would be used by many all over the world (i.e. Zenon, which started in a house in Hamilton). John Brash: gentleness, biomedical vision. Cam Crowe: fairness, wine master. Archie Hamielec: entrepreneur, polymers. Terry Hoffman: laughter, never walked alone, a trail of students always followed him, family man (advised me no matter how many hours I worked, it was important to have dinner with my family and then return. Thanks Terry.). John MacGregor: control and stats., brilliant, brilliant. Jack Norman: cigars, wine and plane. Keith Murphy: hope the Angels are looking over you. Les Shemilt: never at a loss for words. Bill Snodgrass: very caring, ability to pick moods. Paul Taylor: control, software. John Vlachopoulos: youthfulness, gracefulness. Don Woods: esprit de corps, PS, Oh-boy Friday. Joe Wright: control, comes in like the wind. If I left anyone out, sorry.

Former Undergraduates

Rudy van Soest, B.Eng. (1969)

After five years as an engineering officer in the Dutch Merchant Navy I immigrated to Hamilton in 1961. In the first three months I had an interim job as Orderly at the Nora Francis Henderson General Hospital. Then I met Dr. Jack Hodgins who offered me a job as Technician in the Chemical Engineering department. To me there has never been, nor will there ever be, a finer person in this world than Dr. Jack Hodgins. He apologized profusely that he could not offer me a better position but my "papers" were somewhat unconventional. I was born in Jakarta in 1936 of Dutch parents and after 4 years of Japanese Concentration Camp - where no education was allowed - went through an accelerated Grade & High School system. This was followed by a post secondary education that blended practical mechanical engineering with marine engineering. This last was part of fulfilling my military draft call. Dr. Jack Hodgins promised that he would help me advance myself, which he did and then some. And he was not alone in this. All the professors and graduate students were most supportive throughout my stay at McMaster.

My job was to run the Chemical Engineering Laboratories and to fabricate most of the equipment used by Masters, PhDs and post-doctoral students. Often I (re)designed parts of an apparatus and debugged them, sometimes prior to the student beginning experiments. I learned a lot as we went along. You can't build it if you don't know how it works. One day Dr. Hodgins requested me to make a 4-foot tall falling water screen. It took Harry Deem, the Chemical Technician, and I five weeks of experimenting with wire etching and wire tension controls to produce it. Dr. Hodgins had a lot of fun when he told us that someone had stated in a PhD thesis that such an experiment was theoretically impossible. If you don't know that it cannot be done, you just go at it and do it.

I recall also building a solvent extraction column for IBM (as part of some grant money) to be used to demonstrate their computer's process control ability. However, our simple hardwired plug did a much better job than their computer.

As technician I had a little workshop at the NW corner of the Engineering Building (now called JHEB). I saw the first graduating class in 1961 and celebrated with them at Paddy Greens. They were the first recipients of the Iron Ring at McMaster. After the ceremony many came straight to my little shop and ask me to make a copy of their Iron Ring from stainless steel. I made one for myself which I used throughout my career.

We had a post-doctoral fellow, Takehashi Akehata, from the Tokyo Institute of Technology whom we teased when he refused to show his school's initials on his jacket.

I will never forget the staff and graduate students of the Chemical Engineering department and the wonderful atmosphere of friendship and mutual support there always was. During my period as a technician, we regularly had departmental poker parties (Liars' Dice) at the home of one of the professors or our apartment. I was the only one with cable TV (We lived in a brand-new apartment building in Stoney Creek) and could offer the famous 2:10-minute Sonny Liston - Floyd Patterson fight on 23 July 1963. A couple of graduates went to get more beer from the car and missed the fight as well as the instant replay entirely. As part of these "Socials", I had to yearly sterilize the big Distillation Column in the undergraduate lab in order to "fortify" the home-made wine of several of the professors. Dr. Archie Hamielec and Dr. Terry Hoffman were the more serious winemakers. I remember one wine tasting poker party at - I believe Terry Hoffman's place - where we made drawings with crayons on walls. He said he was going to paint them anyway. And then found he couldn't because the paint didn't stick on crayon.

I will always remember 22 November 1963. I saw Dr. Hodgins walk down the campus and enter our building through the NW-entrance. He came straight into my workshop and, almost in tears, told me about the killing of President Kennedy. And then later on his brother Robert was also killed. Remember, this was the time of the Cuban crisis, campus revolts, Kent State killings and Woodstock. These were tumultuous times.

At times I marked engineering drafting papers but was careful not to let the students know this, it might be humiliating. In the mean time I was allowed to attend classes in various subjects (calculus etc.). After a few years I was told that it would be best if I attended classes full-time, which I could not afford to do. So Dr. Hodgins helped me get a far better paying job as a research technologist at Dofasco. While there, I felt the need to learn more about Metallurgy so I signed up for 3 years worth of extension classes for Dr. Ives' Metallurgy Extension Course. When he discovered I took all three years in one year he made me drop one, although I had already successfully followed all three well past the halfway mark. After a year there Dr. Hodgins called me and gave me an ultimatum. Get your act together, come back and attend classes full-time for the last three years. He would give me a 30% course load reduction and fill that time with paid work for him and the department. I accepted and attended Chem. II, III and IV, graduating in 1969. Dr. Hodgins

would later help me get certified in the State of Wisconsin and put in a good word for my consulting company when he was Research Director at Domtar. In 1968 he asked me as a favour to him to accept the responsibility of initiating the Student Representation on the Engineering Faculty in 1968, which I gladly accepted. Because I was so much older than the other students I could take this on with a more mature approach, although I was not a push-over and could make it quite hot for the faculty. But since they had already known me for such a long time already we had a much better understanding of each others' needs. I remember being allowed to drop Ab Johnson's simulation project in year IV in exchange for a thesis project for Jack Norman. I found out later that I was completing an unfinished part of a Master's thesis.

I retired in November 1998 from a very exciting and fulfilled life with the position as senior project director for international projects for the Pulp & Paper Division of SNC-Lavalin Inc. I had managed projects all over the World.

Roy M. Verstraete, B.Eng. (1970)

I came to McMaster in Sept 1966 straight from our beautiful productive family farms (tobacco, potatoes, tomatoes, corn, wheat, soy-beans and limited livestock) near Chatham, Ontario.

I had the good fortune of being accepted in Engineering at Waterloo, Queens and McMaster - and chose McMaster because it had a nuclear reactor! - Remember the Cold War - nuclear threats etc - how peculiar that key reason sounds today.

Then in my very first day of engineering school we were seated in a large lecture hall and asked to look to our left and our right - then we were told that only one out of every 3 of us would graduate as Engineers - what a scary introduction!! And it ended up true.

Arriving in that era to live in Whidden Hall Residence still included a Frosh week - how much FUN - the first week together - what an experience to build our connectivity across our floor and our Residence - both within our year and across the 4 years of fellow students in residence.

Residence life for my first two years provided a great maturing and enriching experience - I gained friends across a cultural and ethnic

diversity that did not exist in our rural community. This has been a life-long value as I have worked in various continents since then.

A valuable aspect of my Chemical Engineering training included being in charge of drink mixing and creation, especially during the Residence years. There are many fond memories of successful mixes as well as some bad tasting attempts.

As I sit at my laptop typing this - I remember my Slide Rule, which I still have as a memento - this was for my first 2 years - then onto an electronic calculator! What a relief - speed, accuracy easier - what a technology advancement!

And how about our Computer course, Fortran IV, and doing all the card punching - oh my how far have we come - this memory is more of a nightmare than a fond musing of how good it used to be!

Another item I reflect on is that we had so many hours of class and labs - it was near 50 hours a week before home work - projects. I compare that to our two sons who have also done Engineering (one Chemical, one Electrical/computer) - they had less class time and a broader sprinkling of non-engineering elective opportunities. On the other hand it certainly was an outstanding boot camp for going to work with a strong work ethic.

I married after my first two years at Mac - first married person in our Chemical Engineering class - and that, while seeming very hard at the time, was the foundation for my wife and me to have a very long term shared life. The Engineering ring experience still is a strong memory for me especially as I was able to participate with one son in his ring ceremony.

John Harling, B.Eng. (1973)

In fourth year, we students were assigned to perform experiments on operating chemical systems in the spacious Chemical Engineering lab. Some of us worked on fractionation, some on air-conditioning, some on heat exchangers – but the most challenging one may have been the one to which Tony DiClemente and I had been assigned.

Our job was to test the activity of bacteria in the sewage treatment plant. Ours was the only project where we were directly involved in obtaining feedstock from a source (the City of Hamilton Sewage Treatment Plant) and bringing it to the lab at McMaster. In this, we had our first hurdle to overcome. We both had some access to motor vehicles

but this feedstock transfer would require carrying a trunkful of 5-gallon cans of the concentrated sludge recycle. There would almost certainly be some spilling of the contents. I recall that Dr. Don Woods loaned his own car for the day although we could see that he wasn't entirely happy about it. We grabbed the 5-gallon cans and held them in an open sluice while the sludge trickled in and the air bubbled out.

We carried the cans of sewage into the lab and set up the tank to bubble air through the sludge so that the bacteria could survive. The idea was to feed the bugs and then turn on and off the air to see how fast the oxygen was used up, thus giving a respiration rate. But the respiration rates of the other students became more of an issue as the full aroma of the concentrated raw sewage wafted to all three floors of the lab wing. The experiments required fairly long run times so that the offensive odour lingered for a considerable time. By *vox populi*, we were constrained to run the tests at night, leaving only the two of us, alone, in the search for science.

It was Don Woods' courses that really prepared us for the world out there. We had to submit papers on sulfuric acid plants that looked like a corporate cost estimate and design. Within a year of graduating, I was using all those skills. We got to see the inside of pumps and towers and learned rules of thumb for the chemical industry. We cleared many a pump strainer to solve a problem while engineers from other schools tried to use equations to solve the problem. The sample problems (remember the Twitchell Tubs?), gave us an inkling of the real problems we would soon face and how best to solve them.

McMaster is a truly remarkable school of the best chemical engineering professors I have ever seen. The McMaster students always seem to be the best at hands-on engineering. I must mention the advantages of the multi-cultural makeup of the student body. With the help of the foreign students, we learned to put a wicked spin on a ping-pong ball in the basement hallway.

Frank Mok, B.Eng. (1973)

I left McMaster University after graduation in 1973. I have never gone back since. Even for the things I learned in chemical engineering, I was able to apply them only in the first three years of my working career in Canada while I was employed with SNC GECO, a subsidiary in Toronto of what is now known as SNC-Lavalin. After a brief stint in environmental projects, I made a career change first to corporate finance

and then to pension administration, thanks to a MBA degree and further studies in actuarial science. I retired in the beginning of 2004 as Manager of Pension Administration with Ontario Power Generation Inc. Currently I am freelancing in consulting work on pensions.

In those days in Hong Kong, the USA was the country of choice for pursuing a post-secondary education. I chose Canada because it was less expensive. I came to McMaster University because I had two other high schoolmates who also wanted to come at the same time. After we landed, to our surprise, we found a lot of Chinese students at McMaster University, not only in engineering but in other disciplines as well. A little more than a third of my graduating class in 1973 were Chinese students. McMaster University must have had a good reputation outside the country.

In 1970 I chose a course offered by Dr. Anderson in Catalysis, which was his specialty. I remember that there were only three students including myself who had elected this course. Dr. Anderson gave lectures in his small office at the back of the chemical engineering lab. This was in stark contrast to the first year Calculus course where the lecture was given in a big auditorium by a flamboyant professor with a German accent. The lecture was televised to students in two other locations.

In the basement of the Engineering Building, certain areas were reserved for engineering students to study or relax. Our class was quite close to one another and I remember quite often we used the designated area to do homework together.

There were out of class social events and extra-curricular activities too. I remember Dr. Crowe invited the class to his home. I remember it as the first time I had been to a spacious home in a nice neighbourhood compared to the crowded space we had back home in Hong Kong. In one year we had a hockey game with some of the faculty members in a local arena. We had a fun time except for an unfortunate accident where a faculty member lost a tooth as a result of a collision with a student player.

I remember other aspects of my experience with McMaster University, but they are related to life on campus rather than studying. How can I forget the orientation week and the treatment I received? I hated it at first, wanting to go back to Hong Kong right away. I remember attending a concert by Neil Diamond who came to the campus. And the favourite pub on campus, Downstairs John. Surprisingly I remember more of those fun times than the time to pursue higher education.

Valerie Davidson, B.Eng. (1975)

I have to give credit to Colin DiCenzo - not only did he convince me to enroll in the first year engineering program, he also said (in his direct and inimitable style) that chemical engineering should be my choice for second year. At the time I was thinking about pre-med options and I knew very little about engineering but it was good advice.

There were four female students in the first-year class in September 1970. Only Stella Tse (Wong) and I continued on to second year and we both chose chemical engineering. The Chemical Engineering class of 1975 was fairly small but two female students did represent a minority. At that time there were only a few women's washrooms in the engineering building. I do remember climbing at least two flights of stairs from our basement study room to reach a women's washroom and I often thought of using a can of black spray paint to mark "wo" on a few of the men's facilities.

Educational experiences and memories that stand out - my incredible slide rule (a birthday gift in second year for those really tough courses from Drs. Crowe and Hoffman), the unit operations labs that often failed spectacularly (e.g. blowing all of the spent cracking catalyst out of the fluidized bed) and then required a certain creativity in writing a lab report, explaining the colour change through the dialysis unit at open houses... Looking back I realize that there were many opportunities to explore traditional chemical engineering areas as well as new directions into biological applications. Faculty were demanding but also supportive and several were key mentors for me. As a result I continued in engineering rather than moving into medicine.

The social community within Chemical Engineering, as well as the faculty, was also a positive factor in my McMaster experience. Undergraduates, teaching assistants and faculty came together to unwind at pubs, ski trips and other parties. Terry Hoffman got me started on a life-long hobby of wine-making. I am proud to be a McMaster alumna and I am glad that I have opportunities to return to the department. I am looking forward to reading the stories that come together in this history project.

Leslie K. (MacLeod) Kilgour, B.Eng. (1978)

Wow, remembrances from my days at McMaster University – now there's a pretty heady subject!

There are the usual things that any eighteen year old might remember about going off to University such as the trip they took to get there. I remember my parents driving me from Thunder Bay to Hamilton to start my first year at McMaster. They helped me get organized in my room at Brandon Hall and when it finally came time for them to leave, I remember feeling more excitement than homesickness (that would come later!).

There are memories of that whole adventure of living in residence, having a roommate, pranks we would pull on each other and stunts that the guys from the men's residence next to ours would do. I will never forget coming home one evening after celebrating my birthday with some friends and seeing all of the furniture from my room out on a second floor balcony of the men's residence. Getting that furniture off that balcony and trying to explain to the ladies at the front desk of Brandon Hall why I was bringing that furniture back to my room is a memory that will always stick with me.

I had originally gone to McMaster University with the idea of some day getting in to their Medical School. Part way through my first year in Natural Science, I realized that there were many of us with the same goal in mind so I requested a change to Chemical Engineering. Some of the courses were common to science and engineering students so I already knew many of the students who were in Engineering and that helped make my transition easier.

One of the most exciting times for me came in my second year. I had picked up an Industrial Design Course which I had missed in first year and part of this course involved submitting a major design project in the second half of the year. The theme was "Designing with Wire" and the best designs from the class were entered in the first annual Design with Steel Wire Competition sponsored by the American Iron and Steel Institute. It was both a surprise and an honour that my design won not only among the Canadian Universities entered but in the overall competition in New York City!

I was fortunate to be at McMaster University at a time when a unique "experiment" was underway in the Department of Chemical Engineering. A group of professors were working together to try and improve ways of teaching Problem Solving to their students. One of the

professors, Dr. Don Woods, was sent back to school to be a freshman and he went through the four years of Engineering with us. I remember thinking that was pretty “cool”. Dr. Woods would be in lectures with us and then work with us in a two hour tutorial every week to learn new techniques for solving homework problems. The tutorial was voluntary and not for credit but there was a good turnout every week with a really fun group of students. We learned many new and useful tools for solving problems such as Creative Brainstorming and Visualization Techniques. And once we had an answer, we learned my most favourite tool – the Test for Reasonableness! When we got to the end of a problem and we thought we had the solution, we were to apply the Reasonableness Test to be sure the answer made sense. I love this tool and I have used it in work and personal situations ever since.

Little did I know during those Problem Solving tutorials how useful those skills would become later in my career. I worked for a few large corporations and most of them were trying to promote Creative Problem Solving skills in their employees. I was able to use many of the techniques I had learned at McMaster and I got great enjoyment out of passing these skills on to my employees.

I have tried to keep involved at McMaster since graduating in 1978. I taught Problem Solving Skills (which became part of the regular curriculum) in 1985-86 and I was fortunate to be asked to participate in the Iron Ring Ceremonies for a few years. I have only good memories from my years spent at a Great School!

Bill Heikkila, B.Eng.Mgt. & Anita (Weygang) Heikkila, B.Eng. (1980)

We have so many fond memories of our days in McMaster Engineering, including:

- Chem. Eng. ski days, where wine skins were more than just a fashion accessory,
- the Chem. Eng. year-end banquet and prof roast, where the laughs never stopped,
- Dr. Woods’ troubleshooting classes, which were like “CSI Hamilton”,
- the solemn Kipling ceremony and banquet, with guest speaker Dr. John Hodgins,

- the 1980 Canadian Chemical Engineering Conference in Sarnia,
- serving on the McMaster Engineering Society (MES) executive,
- pick-up hockey every Friday morning at 5:30 am in Westdale,
- “hanging” with the other five Chem. Eng. & Management (Pseudo) engineers,
- the soap box derby where we finished in a respectable second place,
- engineering “smokers”, the Downstairs John and the Rat, and Fireballs,
- our personalized study carrels in the basement of the Engineering Building,
- countless job interviews and offers (1980 seemed to be the peak year for this),
- And, of course, meeting each other.

Upon reflection, we’ve realized that most of our memories were from outside of the classroom – but all were with the friends that we made in the classroom. Our technical and other training at McMaster prepared us well for the working world and a career, but our experiences with our friends at McMaster prepared us for life.

When we attended our 25th anniversary event at McMaster last summer, we were thrilled to see so many of our (not so) old classmates and professors. We were most amazed to learn that our professors had not aged at all during the past 25 years – there must be something in that McMaster water that keeps the professors both young in body and young at heart!

David Mitges, B.Eng.Mgt. (1980)

On a fateful Friday evening in September 1975, my mother dropped Dave Millar and me off at the campus for a "special meeting of new engineers" at the front of the Engineering building, "Have a nice night she said."

Who could forget that evening? We were engineers! Colin Di-Cenzo soon spoke to us all in the big lecture theatre at Burke Science: "Look to the left!, Look to the right! He said, "One of those people won't be in Engineering next year", so you better work darn hard. Yessir Ad-

miral!

Chemistry (uncertainty, quantum mechanics), Physics (how many equations did you memorize one certain April, that were gone from your mind forever in May?), Calculus, Applied Math (with Dr. Field who used two overhead projectors at a stunning rate), drawing class, economics for some (skipping boring class for billiards and "Pong" in Hamilton Hall for Chris Honda and me).

Ice skating in front of the Engineering Building, "Lake McMaster" in front of Burke Science in March, trudging off to the Med centre library to study for exams on a warm sunny April day (whilst others threw footballs and Frisbees), meant, yes, you were in Engineering!

Summer jobs, and then we join the Chem. Eng. Faculty. Many first year friends go different ways, some to 4 yr program, some to other disciplines, me to the 5 year Chem. Eng. Management program and new friends (Bill Heikkila, Nick Javor, Brian Bethune, Arnie Gerum and Mike Monteleone).

Each of us dutifully putting in our time with Chem. Eng. lectures, some interesting (basic concepts), some positively snooze-inducing (thermodynamics). Always wondering whether just maybe one day you would actually do something in the big chemical engineering wing with all the "big equipment stuff". Assignments, labs, learning that engineers cooperate unusually well on these. Taking organic chemistry, smelling pyridine, washing hands with toluene. Advanced numerical methods, Heat Transfer, Fluid mechanics. Pubs in Senior Science cafeteria. "Macho Man" JV.

Getting involved in hockey teams, in the Engineering Society. Reading the Silhouette, the Plumblin, going to the John and the Rat, yearning and yearning for Kipling. This is taking forever! More mid-terms. More assignments. Certain arresting developments for Dave & me. More exams. More summer jobs. Then finally, final year, securing your very own carrel in the Chem. Eng. room in the basement. Then re-sumé time, and waiting for responses, watching the posting of the rejection letters on the carrels. First interviews, travel to second interviews, offer(s), acceptance and then hurrah!, almost over. Kipling, a new little ring, Fireball, final exams, and smile.

Travel, move away from home, and start career. Fondly remember the fun times at Mac.

Pat (King) Stevens, B.Eng. & Mark Stevens, B.Eng. (1980)

Our most vivid memory of Chemical Engineering at McMaster was the profound sense of community. From the moment we entered the department, we felt as though we were part of a group of people who were interested in each others' success and well being. This sentiment was fostered by the many activities arranged by the department and students including; smokers, where staff and students had the opportunity to just chat, the annual ski trip and, last but not least, the Chemical Engineering Conferences. Professors and TAs alike were always willing to take time to discuss everything from homework questions to questions about life after an undergrad degree.

Also, successfully completing the chemical engineering program seemed to be viewed by our class ('80) as a 'team sport'. There was minimal competition amongst our classmates and even the brightest academic stars were always willing to take a moment to help those of us who needed some help to understand a difficult question. This created an incredibly positive environment in which to learn and to grow.

We'd be remiss if we did not make mention of other, equally notable memories including; Dr. Vlachopoulos' white disco suits, Dr. Crowe's skiing prowess, Dr. Woods' energy and problem solving course, video- taping presentations in Dr. Brash's biomed course, and drinking beer with Dr. Hoffman at the '80 Chemical Engineering Conference in Sarnia! As you can tell from our comments, we received a well rounded education.

What is particularly wonderful for us to see is that Mac Chem. Eng. has not changed much in the 25 years since we've graduated. Sure, the class sizes have increased and yes, there are more women in the department. But, the fundamental element of success is still there - the quality of the people.

Former Graduate Students

Walter F. Petryschuk, M. Eng. (1965), Ph. D. (1967)

When I arrived at McMaster's Chemical Engineering Department in September of 1963, the Engineering Faculty had a computer that I operated on many occasions, the IBM 1620. This was the machine that I had helped commission at Polysar Corporation in 1962 and one with which I was especially familiar having spent many an evening debugging programs. In January of 1964, McMaster installed a much larger computer, an IBM 7040 with tape drives and a lot of disc storage. This was a part of the provincial government's program to outfit Ontario's universities with the latest technology and this initiative was a coup for the local universities since such action was ahead of competitors in the USA and the other provinces. I recall that the University of Waterloo and University of Toronto obtained IBM 7094s that were more powerful than the machines for McMaster, Ottawa and Queens.

However, the IBM 7040 was adequate for the tasks involved in pursuing the modelling and simulation studies for my master's and doctoral theses. The calculations from my work that involved 7600 nonlinear algebraic equations for the steady-state representation could be computed in a reasonable time measured in minutes instead of days. The equivalent system studying transient behaviour could simulate 20 minutes of real plant operation in approximately four hours of computation – hardly reasonable for any control purposes.

Software for this computer was not well developed and a lot of personal programming had to be done to use this machine effectively. As an example, there was a need for a multi-variable, nonlinear regression capability to analyze data emanating from the chemical engineering department. Making such a piece of software available would be a boon to many of the students. Since we could see the need and were desperate to use such a capability for our own work, Peter Hill and I collaborated on creating the package and making it available for those in the department. It took us about two weeks to properly program this content which included input, calculations and output.

A graphical representation of the data and resultant curve-fit were not available and would have been time consuming to produce. As the program creators, Peter and I decided to have only numerical output. This program was the backbone of all multi-variable linear regressions in the department for years to come. In the light of where software evolved

over the next couple of decades, we should have copyrighted the work and gleaned some revenues from it in later years. However, I did not want to be distracted from my primary mission and that was getting on with course work and doing my master's degree thesis.

During the summer, the students and some professors played softball in competition with the other engineering disciplines. This activity was a vent valve for the pent up pressures of studies and research activities. Sharing the experience was a most enjoyable and rewarding social time for it created recreation as well as a team spirit. We played at least a couple of games per week. The position that I played was at first base while George Werezak was our shortstop. The one significant incident from the first summer was a ground ball that was hit to George and his throw to me. It was off to the right and at the limit of my reach. Rather than letting the ball go for an error, I reached with my bare right hand to give me the extra half-foot that was necessary. The ball glanced off the fourth finger. This jammed the finger at the joint and I let out a yelp as the pain was excruciating. The bones in the finger were damaged but typically, I refused to go the doctor to remedy this, leaving it to nature to repair my hurt. My finger still shows the resulting jammed bones at that joint. A souvenir of those glorious days in undergraduate school at McMaster's Chemical Engineering Department!

Mitsuru Aizawa, M.Eng. (1966)

It was in 1965 winter that a fourth year, undergraduate, design project of the Chemical Engineering Department at McMaster University—"Digital Computer Simulation of a Contact Sulfuric Acid Plant" using PACER—was achieved. Five professors and eight undergraduate students, and Professor Shannon of Dartmouth College were involved for the simulation. I partly joined in it to help the undergraduates debug the programs and get the whole model through the computer as I had been using PACER for my graduate thesis. Dr. A.I. Johnson was the leader and coordinator of the project and worked very hard throughout the study. This was, of course, collaboration not only between McMaster and Dartmouth, but also McMaster computer staff to provide us with strong support in programming and operations of the machine. As the project was developing, we confronted unexpected difficulties to break through, and so we were getting more absorbed in solving them and excited. We often stayed late at night and worked even the weekends to obtain outputs.

Finally, however, we could achieve our goal after hard work. I believe today that the undergraduates but also the staff through this project learned the importance of the team work and the pioneer spirit required to the engineer. I hope this spirit has been inherited through the Chemical Engineering Department of McMaster University. Personally I very much appreciate my graduate study provided by Chemical Engineering Department of McMaster University not only in the academics but also the engineering practice which greatly helped me later develop my engineering sense and spirit.

Julian Park, M.Eng. (1970)

I have fond and vivid memories of my 15 months at McMaster in the late sixties. It was amazing how friendly and supportive both the graduate students and faculty were then. Our first social gathering was hosted by Dr. Hoffman at his Ancaster home, where all the new grad students were warmly welcome to the McMaster fraternity. This broke the ice and established open communications. There was a majority of foreign students, all new to Canada, Hamilton and McMaster. Most of the grad students were far from home and some were speaking a second language (no Canadians could understand my Aussie accent then, some still can't). It was a diverse group with some from other commonwealth countries like Australia, South Africa, New Zealand and other countries where English was not their native tongue like Greece and Egypt. As we were all strangers in a new adventure, making friends was very easy. Even though I came from a hot climate, living in an attic apartment in July and August was not what I had expected and humidity took on a different meaning. Later I was fortunate enough to share a high rise apartment with two Canadian grad students, with air conditioning. Learning to walk in snow and ice would be the next challenge of the Canadian climate.

Some excellent sporting challenges were presented. Cricket skills developed as an opening batsman provided a good foundation for the challenges of inter departmental softball. I was not very good at this new sport but did impress by catching balls bare-handed, in true cricket fashion. Academically the work was challenging. All the professors enthusiastically lectured to the course masters candidates and were always available to consult on research challenges. I was fortunate to share a lab with a partner possessing good plumbing and mechanical skills. My contribution was more in software development and testing methodology.

The Chemical Engineering schooling was a first class but jobs were scarce in the early seventies and this meant leaving Hamilton for Sudbury. Computer control was just taking off and my first job was as a control engineer at INCO's new Clarabelle mill. Multivariable control may have become a commodity application 35 years later but in the early seventies this was extreme engineering. Shoehorning supervisory control code into 32K and reloading paper tapes was a joy! The M.Eng. degree provided an excellent platform for a career with both process industry operating companies and automation suppliers. I am still involved in the automation field with Honeywell in Phoenix and married to Judy whom I met while at McMaster.

Oded Orbach, Ph.D. (1972)

My recollection of the department of chemical engineering was the energy and focus on computerization and process simulation.

First, studying programming which was new to me. The computer room was on the 3rd floor of the engineering building where we stood in a line with a small deck of cards, and then to a window to get the results.

Later on, when the science building next door was complete and a much bigger computer was installed (CDC6400) the turnover was faster but our programs became larger and more complex. Then of course the process simulation took us on field trips to Shell in Oakville, Dow Chemical in Sarnia, and the most fascinating place for me, was Alcan Aluminum in Arvida, Quebec, a huge plant where it was necessary to travel by car from one section to the next. The actual simulation programs of the above plants took hours of computer time, and motivated the search for methodology to speed it up.

Workshops of process simulation took place in various locations, and I remember in particular, the one in Montreal at the Chemical Engineering Conference.

The department was very dynamic and friendly, and it was not unusual to be spending evenings and weekends there. We were constantly challenged with assignments by our professors.

Mark Wainwright, Ph.D. (1974)

The choice of a Canadian University to undertake my PhD was influenced by my interest in catalysis and a review of the literature attracted me to Bob Anderson's Raney Nickel work. The timing was wrong as Bob already had too many research students to take on one more. I was, however, encouraged by Terry Hoffman to take on a catalytic reaction project. Terry's letter was the friendliest and most encouraging that I received from the universities to which I applied, and so it was then I decided to become a "Mac Man". As an aside, I should have taken McMaster to court for false advertising. The University publicity of the time referred to the 'Banana Belt of Canada'.

I arrived at McMaster on 29 December 1969 after a five week trip by ship from Australia via the Panama Canal. So coming from an Australian summer to a Canadian winter was quite an experience. Shortly after my arrival Terry had a party at his house in Ancaster to meet members of his research group and I was encouraged to try to skate (without success) on the ice-rink in his back yard – my first and last attempt.

As always the project Terry had proposed was a difficult one and many times, in the little over four years, I felt it was a wee bit too difficult. However, when I completed it I realized I had the best possible training which created independence and self confidence that I found invaluable when I took up an academic position at the University of New South Wales.

Throughout my PhD Terry was extremely busy as Head of Department but he would almost daily drop by the laboratories and chat about progress (or lack of). Saturdays were always a treat as he would take his research students to the Faculty Club for discussions over lunch. I could never have completed the research without the outstanding support and advice from the technical staff Bob Dunn and Joe Newton. I learnt so much from them that assisted me in my future experimental research at The University of New South Wales. Bob, in particular, was a great influence on many of the research students.

Ours was a very friendly lab, as was indeed the whole Department. We all assisted each other. Jeet Khosla and Pieter Groeneweg had really tough projects too and we did our best to assist each other. Ian Shaw was also a very active member of the group. It was Ian and Al Orlickas who introduced me to skiing, which unlike skating I enjoyed during my time at Mac. Pieter and I enjoyed many beers at the Downstairs John, as one would expect from a Dutchman and an Aussie. I truly enjoyed the cultural diversity among the grad students in the Department.

I found the coursework very useful but was sure I did not pass the comprehensive exams and was sure that Cam Crowe's mathematics course must have had a pass mark of 20% for me to succeed. One could not graduate from McMaster without doing a digital simulation course and Ab Johnson's night lectures, after he had returned from Sarnia, introduced me to something completely new. With my strong interest in catalysis it was natural that I would do Bob Anderson's courses which were conducted in his small office with him rocking back and forth with a corn husk pipe in his mouth. Park Reilly's course in Experimental Design and Applied Statistics has always been most useful.

I vividly remember my PhD oral which I undertook with fear and trepidation. It was a bitterly cold day with snow flying. Four days later on March 4, 1974, I began lecturing in thermodynamics here at The University of New South Wales on a typical Sydney high temperature, high humidity summer's day. It took me at least a year to readjust to Australia and I longed to return to Canada. I did in fact return to McMaster for the second half of 1977 for sabbatical leave to eventually conduct Raney Catalyst research with Bob Anderson, and this has been the focus of much of my research since then.

Uninformed people would often ask me why one would go to Hamilton to live. One of my responses was that the GB Shaw Festival in Niagara on the Lake, the Shakespeare Festival at Stratford, and the many and varied performances at the O'Keefe Centre in Toronto that all enhanced my cultural experience alongside my PhD experience at Mac.

In June this year I retire as Vice-Chancellor and President of Australia's leading engineering university. I could never have achieved this without the experience I was given at McMaster. Having Terry as a supervisor and role model was a major influence, although those close to me sometimes think I may have learnt a little too much of his work ethic from him. To all the Faculty members at the time I express my greatest appreciation.

Marios Tsezos (Graduate Student, 1975-77, Assistant Professor 1981-89)

My first contact with McMaster dates back to August 1975, when I arrived as a fresh graduate at the Chemical Engineering Department and newly registered graduate student for a research M.Eng. degree. I still recall my first meeting with Dr. Andrew Benedek, the supervisor for my graduate work. Casually dressed with a pair of clogs, re-

laxed, friendly. It was the beginning of a friendship that has lasted up to now.

Keith Murphy, and Bill Snodgrass, are among my teachers still vivid in my mind as are the football games and the dye tracer studies we did at the creek in the park. I left McMaster in 1977 and went to Montreal for my PHD work at McGill University. Upon graduation I was awarded a NSERC Scholar award which was supporting me financially to choose a university to join as an Assistant Professor along with research funds to help start my independent career. That is how I found myself again, in 1981, at McMaster as a junior Assistant Professor, at the Chemical Engineering department.

The interaction of pollutants, especially metals, with microorganisms was an area of great interest to me. The work in the study of bio-sorptive phenomena continued. Strong research collaboration was established with CANMET of the Department of Energy Mines and Resources with Ron McCready as scientific contact. The result was the eventual construction and the operation at Denison Mines in Elliot Lake Ontario of the first industrial scale pilot plant for a novel in-situ, underground, integrated biotechnological process for the bio-leaching and the subsequent biorecovery of uranium. The process minimized all adverse environmental impacts. This biorecovery concept was also introduced in the McMaster MCRAP radium project.

The research effort transpired also into my teaching work. I can vividly remember the 4W4 senior design projects where the concepts of leaching, value recovery and environmental protection were beautifully integrated.

The research interaction and the friendly discussions on subjects other than research with my graduate students, were also a source of joy. Each student being different but also interesting. Among them, Soo Hong Noh stands vividly in my mind. I met Soo Hong Noh again in 2007 in Seoul Korea and to my satisfaction, he has become a very successful and active professor in Environmental Engineering at one of the most prestigious Universities in South Korea.

In 1990 I was asked to join the faculty at NTUA and by 1991 I had returned to Athens Greece As Full Professor at the National Technical University in Athens. I founded and I am still heading the Laboratory of Environmental Engineering which eventually acquired its own customized space, equipment, graduate students and a lot of research output.

Jules Thibault, Ph.D. (1978)

When I contemplated graduate studies, McMaster was on my short list of Canadian universities because of its enviable reputation in chemical engineering. McMaster, according to those I consulted, had a large number of excellent professors. I applied to a few Canadian universities and I received an admission only few days after I sent my application. I was so impressed by the efficiency of Cam Crowe, who was the Chair at the time that I immediately decided that I would do my graduate studies at McMaster.

I spent almost five years at McMaster from 1973-1978 working under the guidance of Terry Hoffman. His enthusiasm, energy level, engineering judgment and work ethics, both as a teacher and a researcher, had an immense impact on my career. I am truly honoured to have studied under his guidance.

I have also found memories of other professors. Cam Crowe impressed me by his intellect, philosophical mind and mathematical gymnastics. Don Woods with his glowing love for teaching and communication has inspired me to pursue an academic career. In addition to his enviable athletic abilities in golf and hockey to name a few, John MacGregor influenced me by his stimulating teaching style and unique perspective of chemical engineering. It was always fun to be around John Vlachopoulos for his youthful attitude. I enjoyed the fundamental discussions I had with Malcolm Baird on applied transport phenomena standing around his Karr column and the simple vortex ring generator he built.

I also have found memories of Bob Dunn and Joe Newton, two fine technicians who were instrumental in the success of my doctoral degree. Being French Canadian with a medium command of English and used to the North American accent, one thing I remember well is the initial difficulty that their British accents gave me. It took me a while before I could decipher a complete sentence. They became good friends.

Mario Costa, M.Eng. (1989)

When I arrived in Canada, the only thing that I had in mind was to find a job. Although I had had a couple of years of experience as an undergraduate research assistant a decade earlier, and had a chemical engineering degree from Argentina, these were not regarded as suitable qualifications for a job in Canada. Letters sent applying for engineering

positions were rejected because of my not having any Canadian work experience.

However, when I decided to apply for a Canadian graduate degree from the McMaster Chemical Engineering Department, a positive response letter was enough to brighten my day. Dr Baird's phone call a few days later encouraged me to hope that I might be accepted into the McMaster Chemical Engineering graduate program. Dr. Cameron Crowe was straight-forward: "If you pass these refresher courses, you will be admitted to our graduate program".

How fair and open-minded such a decision was can only be appreciated when account was taken of my previous years lived in Argentina. The problem with my resume was that six of my past ten years in Argentina had involved no academic or industrial activity because I was a political prisoner during those years. Once freed, and following graduation, there was no chance of finding a job in Argentina. The military dictators, still controlling every aspect of the country's life, would not allow that to happen.

The open-mindedness that I initially found at McMaster was soon enhanced when my M.Eng work started under Dr Jim Dickson's supervision. His helpful input was essential in academic as well as in human aspects.

We (I include here the four of us in our family) want to raise our imaginary glass in a toast for many years of continuity of the vital and positive action McMaster Chem. Eng. department has had in its first 50 years over individuals, community and national life.

Former Post-Doctoral Fellows, Research Associates and Faculty

Sang Done Kim, (PDF 1974-76)

More than 30 years ago, after I finished my Ph.D. defence on three-phase fluidized beds at the University of Western Ontario, Prof. Baird offered me a postdoctoral fellow position working on the axial dispersion characteristics in a Karr reciprocating plate extraction column. At the same time, I had another offer from the University of British Columbia to work on fluidized bed reactors but I thought it better to learn something different from fluidization.

At the first meeting with Dr. Baird, he gave me a paper on the measurement of axial dispersion in an extraction column by using step injection of a reacting tracer. He asked me to derive equations for the pulse tracer injection to determine the dispersion coefficient. I thought he did not have any solution to this problem so I spent a day or so preparing a solution, before meeting him at his office. He looked at my equations and opened his desk drawer and pulled out a sheet of his equations to compare with mine. I thought he was a gentleman from whom something could be learned. The project went well and I was trying to inject gas into the Karr extraction column for the first time, I believe. That is why Dr. Baird asked me about the effect of gas in the extraction column. My answer was easy on the basis of my Ph.D. project of three phase fluidized beds (Gas-Liquid-Solid), so that axial dispersion could be reduced significantly in the extraction column by simple injection of gas. These data were included in our publication (Can. J. Chem. Eng., 54, 81, 1976).

Also, Dr. Baird asked me to measure the velocity of a vortex ring in a water tank by using a platinum wire probe. However the probe tip would break after several impacts of the vortex, so that I had to solder the wire onto the probe many times. Finally, I became an accomplished solderer.

My last job at McMaster was to set up a rather large scale extraction column (6"-ID) that had been transported in a trailer truck from Chem-Pro Co., New Jersey, U.S.A. Unfortunately I did not have time to do any experimental work with this big column as I had to move to the Univ. of Illinois in Chicago. My successor, Dr. Nirdosh, carried on the work with the large scale extraction column.

I am very proud to have been a member of McMaster engineering team during the mid 1970s.

Tom Wairegi (Assistant Professor, 1974-76)

I was recruited to McMaster University in 1974 by Dr. Jack Hodgins as an assistant professor in the Department of Chemical Engineering. I had just completed my PhD work at McGill University in Montreal, Quebec. Jack and I hit it off right from the start. He was my mentor from the day I set my foot onto the campus. I remember him inviting me several times to his house for dinner with his lovely wife Jean. Jack was a special person – very caring, very intelligent, clear mind and excellent sense of humour. I stayed close with Jack though his time with Domtar until he passed away.

The first thing I did when I got to McMaster was to find a vehicle I could drive. I negotiated a good deal with Dr. Cameron Crowe for a 1967 Barracuda for \$250. That is the best deal I have ever had in my life. I drove that car for about two years without any major repairs or expenses. During those two years, I spent only \$35 to repair a torn seat. After two years, I sold it to my mechanics for \$250. Not a bad deal considering that I had driven it to Montreal twice, Ottawa once, and three-four trips to the United States. They don't make cars like those any more.

All the faculty, administrative, and student staffs at McMaster University treated me very well. I remember Dr. Don Woods who made every effort to ensure I was having an enjoyable time. He invited me to his house in Waterdown for dinner with his family several times. The other person that I worked very closely with was Dr. Terry Hoffman. I remember one day when Terry invited the third-year students and me to an Industrial tour near Niagara Falls. On our way back, we stopped in a bar for a drink. An African-American stage dancer spotted me among the others (the only dark-skinned) and came over to try to get me to dance with her. As you can imagine, I was terrified. The students protected me and prevented her from dragging me off to dance – Terry told her that I was his son and to leave me alone. I don't think she believed this dark-coloured man was his son but she left me alone. I was very grateful to both Terry and the students.

The other person I became a good friend with was Dr. Malcolm Baird. Dr. Baird and I have shared several research projects and published papers together. Dr. Baird has consulted for a few of the companies that I have worked with including Shell and Lyondell. I remember a

farewell party that was hosted for me by a friend before I left McMaster and Dr. Baird was invited. He showed up with a cardboard box and candle to demonstrate how vortices work. Everyone eagerly watched to see his demonstration which did not work to his disappointment. He tactfully explained what should have happened and asked for their pardon. Dr. Baird is a wonderful man.

Another memory that comes to mind is the farewell party that was hosted for me by the Chemical engineering students before I left McMaster. At the party, they presented me with a bottle of whiskey and a box of Exlax®. I appreciated the bottle of whiskey but up to this day, I don't understand why the Exlax®.

I think back on McMaster with fond memories. Not only did McMaster treat me well, but it also laid down the ground work for my future to be wife with whom I have now been married for thirty years. She worked in the Medical department while I taught in the Chemical Engineering department.

Inderjit Nirdosh (Research Associate, 1975-81)

I joined McMaster University in 1975, to work with Dr. Malcolm Baird as a Research Associate. The older part of the campus reminded me of University of Birmingham in England. It was a smooth transition for me. I felt very fortunate to have met great chemical engineers and mentors such as Drs. Malcolm Baird, Jack Hodgins, Bob Anderson, Les Shemilt, and many others such as Drs. Hamielec, Hoffman, Crowe, Woods, Brash, Vlachopoulos, and Benedek.

Going through the chemical engineering labs and storage areas in the basement of the Engineering Building was a treat. You felt as if you are on a treasure hunt. One could find many good pieces of apparatus for research without having to buy new materials. The other thing that gave me a jaw-dropping experience was a ride in the freight elevator, especially opening and closing the heavy doors.

The late 1970s saw the initiation of the Problem-Based Learning by Dr. Woods, the Polymer section started by Dr. Hamielec, and the McRaP (the McMaster University Radium Project) under a NSERC Strategic Grant which brought together expertise from various individuals (Sanjoy Banerjee from Engineering Physics, Malcolm Baird and Don Woods from Chemical Engineering, Alfio Corsini from Chemistry, etc.). We were joined by Ken Hester from Rio Algom Ltd. in Elliot Lake, and Shiv Vijayan from AECL. The project gave me a chance to work with

other researchers such as Allan Nixon, S.V. Muthuswami, Doug Keller and Anna Pidruczni. It was a high profile project for all, and resulted in quite a few patents on the removal of radium from uranium mine tailings.

Though I left McMaster in 1981, I have continuously maintained my ties with the department, especially through collaborations with Malcolm Baird. The time I spent at McMaster was very memorable for me and my family. I wish McMaster and the Chemical Engineering Department all the best for the 21st century.

Malcolm Baird (Professor Emeritus)

Before coming to McMaster University I was a lecturer at Edinburgh University in Scotland. The teaching load was light and I found myself with plenty of time to think up new research ideas, in particular in the field of oscillatory flow and its effects on transport phenomena, etc. However research funding was tight. Meanwhile Archie Hamielec, who had been my colleague at CIL from 1960 to 1963, was keeping me in touch with the rapid expansion of engineering education in Canada.

In 1967 I accepted an offer from Jack Hodgins and joined the department as an Associate Professor. By that time it was coming to the end of its formative period. There was a strong culture of collegiality and cooperation, along with a punctilious attention to detail. Everything was put in writing in the form of memos and reports, long before the days of personal computers and email. The culture was epitomized by Ab Johnson. I recall getting back from an overseas conference just before Easter 1969; because of jet lag I had woken up in the small hours on Good Friday morning, so I decided to go into the department and check my mail. At 5:30 a.m. the 3rd floor hallway was in almost complete darkness, but a light shone out through an open office door. As I walked by, Ab Johnson looked up from his desk and said "Hi, Malcolm." This was well into his normal working day and he seemed unsurprised to see me.

The weekly departmental meetings were held in the West Room of what was then the Faculty Club, now the University Club. Sandwiches and coffee were provided and draft beer was also obtainable from the bar next door, at 35 cents. Intense debates took place on teaching issues such as the curriculum which continued to undergo development and adjustment. The main participants were Terry Hoffman, Cam Crowe and Ab Johnson. While the debate raged, Bob Anderson, who had joined the department a few years earlier, would sit back quietly with eyes half closed, puffing at his pipe and no doubt thinking about catalysis. I was

able to keep my eyes open, sipping my beer and thinking about fluid pulsations.

The main direction of my research was set by the generosity of a New Jersey equipment manufacturer, Chem.-Pro Inc., who donated two of their Karr reciprocating-plate extraction columns (RPCs) for experimental study. In 1970 a 2 inch (5 cm) column was donated and it proved to be very versatile and easy to operate. Five years later a 6-inch (15 cm) column arrived and was installed with difficulty because its overall height was 5 m. Until 2003 these two columns stood in the department's main operations laboratory and they provided data for 38 papers in all. This work could not have been possible without the help of many talented graduate students and research staff including Zu Jun Shen (from East China University of Chemical Technology in Shanghai), Soo Hong Noh (now with KAIST in Seoul) and Inderjit Nirdosh who went on to a distinguished career at Lakehead University. In 1982 Dr. Nadella V. Rama Rao arrived from IIT Madras and he was to stay for over 20 years as my full-time research associate.

In parallel with my university activities I had a sub-career between 1969 and 1984 as Assistant Editor of the Canadian Journal of Chemical Engineering. The editor was my senior colleague Les Shemilt who had succeeded Jack Hodgins as Dean of Engineering in 1969. In his limited spare time, he was a devotee of Sherlock Holmes. My editorial work gave me an inside view of the world of "publish or perish".

Although my main research focus was for many years the RPC, I drifted in and out of other research fields on the basis of curiosity or chance observations. One such field was the study of vortex rings. As a party trick I made a "vortex gun" by cutting a hole in a cardboard carton, from which fast-moving rings of air could be projected across a room with enough force to blow out a candle. I collaborated first with Tom Wairegi and then with Brian Latto (Mechanical Engineering), producing papers on the effects of vortex rings on mixing and mass transfer. During the summer of 1978 I worked with the Canada Centre for Inland Waters on a special raft in Hamilton Harbour, trying to measure the effects of vortex rings being "shot" periodically downwards to the bed of the harbour. Brian Latto later formed a small company to develop practical vortex generators and the technology has been transferred to a multinational engineering company, Bateman Inc.

Between 1979 and 1982 I was part of an interdisciplinary group of chemists and engineers under the leadership of Sanjoy Banerjee (Engineering Physics), seeking ways of dealing with the problem of radioac-

tive tailings from uranium mines. Other chemical engineering participants included Don Woods, Doug Keller and Inderjit Nirdosh. At this time there was a high demand for uranium for nuclear power generation and two companies (Rio Algom and Denison) operated mines and refineries in the Elliot Lake area of northern Ontario. The uranium extraction process produced a large amount of sand-like “tailings” containing a small but measurable amount of radium, which decays over a half-life of 1600 years to emit radon gas. The project was entitled the McMaster Radium Project and it was known as McRaP. We got one of the newly inaugurated N.S.E.R.C. Strategic Grants to examine the possibility of chemically removing the radium from the tailings before they were discharged from the uranium extraction process. I recall flying back from Elliot Lake with a plastic bag of radioactive tailings in carry-on baggage; airline security was less of an issue than it is now. We all worked hard at the project, innumerable meetings were held and papers were written. Then unexpectedly after 3 years the grant was not renewed. Soon afterwards the price of uranium fell and the Elliot Lake mines were closed, while our radium recovery results went into the periodical literature. This project raised my interest in process metallurgy which was to become a major theme of my research in later years.

John Brash (Professor Emeritus)

I joined McMaster in the fall of 1972 following a position at the Stanford Research Institute (SRI) in Menlo Park, California. My appointment, at the rank of Associate Professor, was officially joint between the Departments of Chemical Engineering and Pathology, with a strong connection to the Institute for Materials Research (IMR, now the Brockhouse Institute, BIMR). I was never privy to the details of the discussions that led to this rather unusual (for the time) type of appointment but I know that Jim Morrison, then the Director of the IMR, and Fraser Mustard, then the Dean of the Medical School (later to become the Faculty of Health Sciences) were heavily involved. The role of Chemical Engineering was not precisely defined. As far as I could tell it was thought that although the fit was not entirely perfect, Chemical Engineering was as close as it got in Engineering or Science. My undergraduate degree was in Applied Chemistry (University of Glasgow) which was a hybrid of chemistry and chemical engineering, although my subsequent activities had emphasized the chemistry more than the chemical engineering. In addition Irwin Feuerstein had been recently recruited by the Department and was struggling to establish biomedical engineering as a research direction; it was no doubt thought that I would fit well with that.

Another connection at the research level was to the polymer area led by Archie Hamielec.

My specialization from graduate and later work was polymer science, and my career at SRI, which had begun with work on the radiation chemistry of rubber (funded by the US Air Force which at the time had an interest in a nuclear powered bomber), had soon taken me into the biomedical field to work on NIH-funded projects on membranes for hemodialysis. This work gave me a start in the fledgling field of biomaterials; that was the attraction for the IMR and the Medical School, and biomaterials was to remain the focus for the rest of my career.

I do recall feeling somewhat outside the mainstream of the Department in the first few years, due in part to my own sense that the fit might not be perfect, and to the perception that others were not quite sure what to make of me. I had obtained external salary funding which limited my availability for teaching, and in addition there were many courses in the ChE curriculum that I did not have the background to teach. Anyway over the years I came to feel completely at home and valued by my chemical engineering colleagues.

Having an appointment in the Medical School made me eligible for research funding from the Medical Research Council and I was immediately successful in obtaining what was then called a Development Grant. This provided quite generous funding (compared to the typical NRC grant of the time) for a period of three years and included money for equipment that allowed me to set up a lab in the Medical Centre for our biomaterials work. I have occupied space in that building ever since and the proximity to biomedical facilities and resources has been of immense benefit. I have also benefited from funding from the MRC, now the CIHR, over the years.

The theme of my work has been, and still is, protein and cell (mainly blood cell) interactions at interfaces. The initial motivation for the work and the main application was the development of materials for blood contacting applications such as catheters, heart valves, vascular grafts, blood pumps, sensors, stents and many others. The fundamental importance of proteins at interfaces has since been recognized in all biomaterials applications as the initiating event in the response of the biological system to the material. The list of applications has continued to grow over the years and includes, notably, eye applications like the fouling of contact lenses, bioseparations, solid phase immunoassays, and the fouling of process equipment in the bioprocess industries among others. So it turned out to be an excellent choice of subject. An immense litera-

ture has been generated and since I was one of the first to work in the field I am seen as a “pioneer”.

For the first few years at McMaster, through the seventies, I collaborated with Irwin Feuerstein, he contributing expertise in mass transfer and fluid flow, and I in materials aspects. I also worked with Archie Hamielec, although this was more traditional polymer than biomaterials oriented.

Going back to the seventies and my first few years in the Department, I can say in retrospect that we were quite a sociable group, with frequent get-togethers, notably chez the Crowes, the Hoffmans, the Hamielecs and the Woods. These were always fun occasions, well lubricated and relaxed. Other notable events were the annual ski trips (including the pot luck dinners in the “Senior Sciences” Cafeteria), and the welcoming parties for the new graduate students in September (Don Woods, whip in hand, leading “She’ll be comin’ round the mountain” with the new international students looking confused but smiling politely anyway). Later we had annual golf tournaments that were invariably won by John MacGregor despite efforts to handicap him out of contention.

From a personal point of view I can say that McMaster University, and the Department of Chemical Engineering in particular, has provided me with a good home for the major portion of my working life. I thank all my departmental colleagues for their support over the years.

Appendix B

Honours to Chemical Engineering Faculty

Robert B. Anderson

Distinguished Service Award, U.S. Dept. of Interior
Petroleum Research Fund International Award, Dept. of Chemistry, Queen's University, Belfast 1965
Fellow, Chemical Institute of Canada 1968
Catalysis Award, Division of Catalysis, Chemical Institute of Canada 1979
Annual Award, Pittsburgh Catalysis Society 1983
Fellow, Royal Society of Canada 1983

Malcolm H.I. Baird

Associate Editor, Canadian Journal of Chemical Engineering 1969-73, 1975-76, 1981-84
Fellow, Chemical Institute of Canada 1974
Secretary, International Solvent Extraction Conference, Toronto 1977
Associate Editor, Chemical Engineering Research & Design 1990-99
Best Paper Award (co-author), Canadian Metallurgical Quarterly 2000

Andrew Benedek

Outstanding Paper, International Ozone Institute 1977
Chemenviron Prize for Outstanding European Research Paper on Water Treatment (with J. Mallewialle & F. Feissing) 1980
Environmental Division Award, American Institute of Chemical Engineers 1983

John L. Brash

Editor, Colloids and Surfaces B: Biointerfaces, 1992-present
Chair, Gordon Research Conference on Biomaterials and Biocompatibility, 1993
Clemson Award for Basic Research, U.S. Society for Biomaterials, 1994
Fellow, International Union of Societies for Biomaterials Science and Engineering, 1996

Honorary degree, Docteur *Honoris Causa*, Université Paris XIII (Paris Nord) 1996
University Professor, McMaster University 2001
Festschrift in his honour, J Biomaterials Science Polymer Edition, volume 13, 2002
Fellow, Royal Society of Canada 2004
R.S. Jane Memorial Award, Canadian Society for Chemical Engineering 2006
Guest Professor, Wuhan University of Technology, Wuhan China 2007
Founders Award, U.S. Society for Biomaterials 2009

Cameron M. Crowe

C.D. Howe Memorial Fellowship 1967-68
Associate Editor, Canadian Journal of Chemical Engineering 1975-81
Fellow, Chemical Institute of Canada 1978
Benjamin J. Dasher Outstanding Paper Award (with D.R. Woods, T.W. Hoffman and J.D. Wright), *Teaching Problem Solving Skills*, IEEE Frontiers in Education Conference 1979
President, Canadian Society for Chemical Engineering 1991-92
Wickenden Award (with D.R. Woods, T.W. Hoffman and J.D. Wright) for Best paper in J. Engng. Education 1997
President's Award for Excellence in Course Design (with D.R. Woods), McMaster University, 1999

Archie E. Hamielec

ERCO Award, Canadian Society for Chemical Engineering 1974 (now Syncrude Canada Innovation Award)
Protective Coatings Award, Chemical Institute of Canada 1978
Fellow, Chemical Institute of Canada 1984
NSERC Industrial Research Chair in Polymer Production Technology 1986
Fellow, Royal Society of Canada 1987
CIC-Dunlop Award in Macromolecular Science and Engineering, Chemical Institute of Canada 1987
R.S. Jane Memorial Lecture Award, Chemical Institute of Canada 1994
Doctor of Engineering, University Waterloo
Century of Achievement Award, Canadian Society for Chemical Engineering 1999

John W. Hodgins

Chairman, Chemical Engineering Division, Chemical Institute of Canada 1961-62

Fellow, Chemical Institute of Canada 1966

Canadian Centennial Medal 1967

Engineering Medal, Association of Profession Engineers of Ontario 1970

Fellow, Royal Society of Canada 1971

Fellow, Engineering Institute of Canada 1975

Doctor of Science, *honoris causa*, McMaster University 1978

Honorary D.Eng., Carleton University, Ottawa, Ontario

Doctor of Science, *honoris causa*, Royal Military College, Kingston, Ontario 1979

Terrence W. Hoffman

Best Paper Award, Canadian Journal of Chemical Engineering 1961

Ford Foundation Residency for Engineering Practice, Hercules, Inc. 1966-67

ERCO Award, Canadian Society for Chemical Engineering 1970

Fellow, Chemical Institute of Canada 1970

Member, Scientific Organization Committee of the International Centre for Heat and Mass Transfer, Belgrade, Yugoslavia 1971 - 1982

Benjamin J. Dasher Outstanding Paper Award (with D.R. Woods, C.M. Crowe and J.D. Wright), *Teaching Problem Solving Skills*, IEEE Frontiers in Education Conference 1979

NSERC Senior Industrial Fellowship 1979

Award in Industrial Practice, Chemical Institute of Canada 1991

Wickenden Award (with D.R. Woods, C.M. Crowe and J.D. Wright) for Best paper in J. Engng. Education 1997

Fellow, Engineering Institute of Canada 2004

Albin I. Johnson

U.S. Manufacturing Chemists' Association Teaching Award 1965 (First Canadian chemical engineering professor to be so honoured)

Fellow, Chemical Institute of Canada 1965

Canada Centennial Medal 1967

John F. MacGregor

- Fellow, American Statistical Association 1993
- W.G. Hunter Award, Statistics Division, American Society for Quality Control 1993
- Engineering Medal, Association of Professional Engineers Ontario 1993
- President's Award for Excellence in Graduate Student Supervision, McMaster University 1996
- Computing in Chemical Engineering Award, American Institute of Chemical Engineers 1997
- Bell Canada Forum Award, Corporate Higher Education Forum 1997
- Shewhart Medal, American Society for Quality 1997
- Century of Achievement Award, Canadian Society for Chemical Engineering 2000
- Herman Wold Medal, Swedish Chemical Society 2001
- W.G. Fisher Award, Systems & Control Division, Canadian Society for Chemical Engineering 2001
- Kalev Pugi Award, Society of Chemical Industry 2002
- Shewell Award, American Society of Quality and American Statistical Society for best paper at 2001 Fall Technical Conference 2002
- Fellow, Canadian Academy of Engineering 2002
- McMaster Alumni Gallery 2003
- University Professor, McMaster University 2003
- NSERC Synergy Award, with Dr. T. Kourti, Dofasco and Tembec 2003
- Dr. Guido Carlo Stella Award, World Batch Forum 2005
- Award in Industrial Practice, Canadian Society for Chemical Engineering 2006
- Fellow, Royal Society of Canada 2007
- Award for Outstanding Achievements in Chemometrics, Eastern Analytical Society 2008
- Nordic Process Control Award 2009
- NSERC Synergy "Leo Derikx" Award to the McMaster Advanced Control Consortium 2009

Keith L. Murphy

- Diplomate, American Academy of Environmental Engineers 1992-98

Jack D. Norman

President, Pollution Control Association Ontario 1975-76
Arthur Sydney Biddell Award, Water Pollution Control
Federation 1982
Diplomate, American Academy of Environmental
Engineers 1984
President, Canadian Association on Water Quality 1991
President, Water Quality International 1996-98
Outstanding Service Award, Canadian Association on Water
Quality 1998
Distinguished Service Award, International Water Association
2000

Leslie W. Shemilt

Fellow, Chemical Institute of Canada 1956
Editor, Canadian Journal of Chemical Engineering 1967-84
Canadian Centennial Medal 1967
President, Chemical Institute of Canada 1970-71
Honorary Fellow, Royal Australian Institute of Chemistry 1971
Fellow, American Institute for Chemical Engineers 1973
Queen Elizabeth II Silver Jubilee Medal 1978
Fellow, Engineering Institute of Canada 1980
Fellow, Royal Society of Canada 1985
R.S. Jane Memorial Lecture Award, Canadian Society for
Chemical Engineering 1985
The Engineering Medal, Association of Professional Engineers
Ontario 1986
Fellow, Canadian Academy of Engineering 1987
Honorary Fellow, Chemical Institute of Canada 1990
Officer, Order of Canada 1991
Doctor *Honoris Causa*, St. Stanislaus University of Mining and
Metallurgy, Cracow, Poland 1992
125th Anniversary of the Confederation of Canada Medal 1992
Julian C. Smith Medal, Engineering Institute of Canada 1993
Honorary Doctor of Science, McMaster University 1994
Montreal Medal, Chemical Institute of Canada 1995
Honorary Doctor of Engineering, University of Waterloo 1996
Century of Achievement Award, Canadian Society for Chemical
Engineering 1999
Queen's Golden Jubilee Medal 2003

John Vlachopoulos

Fellow, Chemical Institute of Canada 1985
Chairman, Canadian Rheology Society 1986-88
Fellow, Society of Plastics Engineers 2001
Fred E. Schwab Education Award, Society of Plastics Engineers,
Dallas, TX 2001
Distinguished Achievement Award, Extrusion Division, Society
of Plastics Engineers, Chicago, Ill. 2004
President, Polymer Processing Society 2005-07
S. G. Mason Award, Canadian Society of Rheology 2007
Special Honour Symposium, Polymer Processing Society, 26th
International Meeting, Banff, AB 2010

Donald R. Woods

C.D. Howe Memorial Fellowship 1970-71
OCUFA Teaching Award 1974
Benjamin J. Dasher Outstanding Paper Award (with C.M. Crowe,
T.W. Hoffman and J.D. Wright), *Teaching Problem Solving Skills*, IEEE
Frontiers in Education Conference 1979
McMaster Student Union Award for outstanding contribution to
Undergraduate Education, 1980
Fellow, Chemical Institute of Canada 1983
3M Teaching Fellow 1986
Faculty of Engineering "Innovation in Education Award" 1989
President's Award for Excellence in Educational Leadership
1993
ASEE Corcoran Award for the best paper in Chem. Eng.
Education
Fellow, American Institute of Chemical Engineers 1994
Honorary Doctor of Science, Queen's University 1996;
University of Guelph 2001, McMaster University, 2007
McMaster Student Union Lifetime teaching award 1997
Fellow, Japanese Society for Promotion of Science 1997
Wickenden Award (with C.M. Crowe, T.W. Hoffman and J.D.
Wright) for Best paper in J. Engineering Education 1997
President's Award for excellence in course or resources design"
(with C.M. Crowe) 1999
Century of Achievement Award, Canadian Society for Chemical
Engineering 1999

Lifetime contribution to Engineering Education, Amer. Soc. Eng. Education 2000
Wickenden Award for the Best Paper in J. Eng. Education 2001
Distinguished Visiting Teaching Professor, University of Guelph 2003
President's Award for Excellence in Instruction 2006

Joseph D. Wright

Benjamin J. Dasher Outstanding Paper Award (with D.R. Woods, C.M. Crowe and T.W. Hoffman), *Teaching Problem Solving Skills*, IEEE Frontiers in Education Conference 1979
Control Systems Society Award for the Outstanding Paper, IEEE Transactions on Automatic Control, Volume AC-25 (1980), E.J. A. Davison, P.A. Taylor and J. D. Wright, *On the Application of Tuning Regulators to Control of a Commercial Heat Exchanger*, IEEE Trans. On Automatic Control, AC-25, pp 361-375, 1980.
Award as co-editor of CAST Communications, Best Division Newsletter, A.I.Ch.E 1990-91.
Fellow, Chemical Institute of Canada 1993
Fellow, Canadian Academy of Engineering 1994
Wickenden Award (with C.M. Crowe, T.W. Hoffman and D.R. Woods) for Best paper in J. Eng. Education 1997
A.I.Ch.E. Award as co-editor of CAST Communications, Best Division Newsletter, two years running, circa 1990.
Keynote Speaker, The Fundamentals of Papermaking Materials: 11th Fundamental Research Symposium, Cambridge University, 1997, *The Future of Paper; plus ça change ...*, also published in Paper Technology, Vol. 38, #10, Dec. 1997, pp 29-41.
President, Canadian Academy of Engineering, 2001
Honorary Doctorate of Science, McMaster University,

Appendix C Chairs of Chemical Engineering

1959-62	J.W. Hodgins
1962-65	A.I. Johnson
1965-71	T.W. Hoffman
1971-74	C.M. Crowe
1974-75	J.W. Hodgins
1975-77	A.E. Hamielec
1977-78	C.M. Crowe
1978-79	A.E. Hamielec
1979-82	D.R. Woods
1982-85	M.H.I. Baird
1985-88	J. Vlachopoulos
1988-91	J.F. MacGregor
1991-97	P.E. Wood
1997-2000	J.L. Brash
2000-10	A.N. Hrymak
2010-	S. Zhu

Index of Names

Addie (now Roberston), Anna, 37,56
Agur, Enno, 31
Aizawa, Mitsuru, 70
Akehata, Takehashi, 58
Anderson, Robert, 10,19,33,34,35,45,51,52,56,62,73,74,80,81,87
Ash, Maureen – *see* Lees, Maureen
Baird, Malcolm, 12,15,20,27,41,51,52,56,76,77,78,79,80,81,87,95
Bancsi, John, 56
Banerjee, Sanjoy, 41,80,82
Behman, Henry, 37,56
Benedek, Andrew, 37,38,52,55,56,74,80,87
Bethune, Brian, 67
Bertrand, Mary-Christine, 17
Bird, R. Byron, 6
Bouchard, C.G.K., 19
Brash, John, 18,28,29,52,56,68,80,83,87,95
Cardenas, Jorge, 50
Cooke, Norman, 9
Costa, Mario, 76
Coverdale, Barbara, 45,46
Corsini, Alfio, 41,80
Courtney, Sheelagh, 47,48,49,51
Cragg, Laurence, 27
Crowe, Cameron, 5,6,9,14,18,19,22,24,25,29,47,48,50,51,52,53,56,
62,63,68,74,76,77,79,80,81,85,88,95
Davidson, Valerie, 63
Dawson, Bob, 39
Deem, Harry, 57
Dickson, Jim, 77
DiClemente, Tony, 60
DiCenzo, Colin, 63,66
Duerksen, John, 28
Dunn, Bob, 56,73,76
Ellis, Ingrid, 51,52
Emmett, Paul, 33
Evans, Sandi, 52
Feuerstein, Irwin, 17,52,83,85
Flory, Paul, 33
Fox, E.Carey, 1
Friis, Nils, 28
Fritze, Klaus, 41

Gallo O'Toole, Sara, 52,53
Gerum, Arnie, 67
Gilmour, George, 1
Gravestock, Sally, 45,47
Groeneweg, Peter, 73
Habgood, Harry, 34
Hamielec, Archie, 9,11,12,14,15,27,28,29,30,51,52,53,54,56,58,80,
81,84,85,88,95
Hanson, Carl, 12
Harling, John, 60
Heikkila, Anita – *see* Weygang, Anita
Heikkila, Bill, 65,67
Heinke, Gary, 38,39
Hester, Kenneth, 41,80
Hill, Peter, 69
Hodgins, John (“Jack”), 2,3,5,7,9,10,11,15,17,22,27,28,37,46,52,57,
58,65,79,80,81,82,89,95
Hoffman, Terrence (“Terry”), 3,5,8,9,10,11,12,13,14,18,19,20,22,29,34,
45,46, 48,51,52,54, 56,58,63,64,68,71,73,76,79,80,81,85,89,95
Honda, Chris, 67
Hrymak, Andy, 19,95
Ives, Brian, 58
Javor, Nick, 67
Johnson, Albin (“Ab”), 7,8,9,11,15,17,23,25,45,48,51,59,70,74,81,89,95
Johnston, Charles, 2
Johnstone, Peggy, 52,55
Jones, Phil, 38
Keller, Douglas, 29,41,81,83
Khosla, Jeet, 73
Kilgour, Leslie – *see* MacLeod, Leslie
Kim, Sang Done, 78
King (now Stevens), Pat, 68
Kiparissides, Costas, 30
Lakshmanan, V., 41
Latto, Brian, 82
LeClair, Brian, 39
Lee, James, 48
Lee, Soo-Il, 48
Lees (now Ash), Maureen, 47,48,49,50,51,52
Levenspiel, Octave, 6
Lightfoot, Edwin, 6
Lo, Cheh Teng, 12

Lozada, Alejandro, 50
Lu, Wei Kao, 11
MacGregor, John, 14,20,28,29,56,76,85,90,95
MacLeod (now Kilgour), Leslie, 64
Majorins, Anna, 17
Mallareddy, Vuyyuru, 7
Marshall, Bob, 19
McCready, Ron, 75
McCreath, Debbie, 52
McLean, Alex, 11
Melnyk, Peter, 39
Meng, Valerie, 17
Millar, David, 66,67
Mitges, David, 66
Mitsoulis, Evan, 31
Mok, Frank, 61
Molgaard, Anne, 41
Monteleone, Mike, 67
Moser, Henry, 8,23
Murphy, Keith, 10,37,38,51,55,56,75,90
Murphy, Ruth, 55
Muthuswami, Sirugamani, 41,81
Netzer, Aharan, 39
Newton, Joe, 56,73,76
Nirdosh, Indirjit, 12,41,78,80,82,83
Nishio, Masatoshi, 24
Nixon, Alan, 41,81
Noh, Soo Hong, 12,75,82
Norman, Jack, 10,37,38,51,52,56,59,91
Nutt, Steve, 39
Orbach, Oded, 24,46,47,72
Orbach, Ora, 45,46,48,49,51,52
Orlickas, Al, 73
Park, Julian, 71
Petryschuk, Walter, 69
Pidruczni, Alice, 41,81
Pruppacher, Hans, 11
Rama Rao, Nadella, 82
Reilly, Park, 20,74
Roberston, Anna – *see* Addie, Anna
Rosenbrock, Howard, 19
Ross, Larry, 7

Seto, Peter, 7
 Shannon, Paul, 8,9,23,70
 Shaw, Ian, 73
 Shemilt, Leslie (“Les”), 1,13,15,41,52,56,80,82,91
 Shen, Zu Jun, 12,82
 Snodgrass, William (“Bill”), 38,52,54,55,56,75
 Stevens, Mark, 68
 Stevens, Pat – *see* King, Pat
 Stewart, Warren, 6, 9
 Stott, Amy, 52,55
 Stover, Harald, 29
 Tan, Patrick, 39
 Taylor, Paul, 19,20,56
 Tebbens, Klaas, 28
 Thibault, Jules, 76
 Thode, Henry (“Harry”), 2
 Torsney, Michael, 3
 Tory, Elmer, 8,23
 Traplin, Charlotte, 47,48,51,52
 Tsezos, Marios, 38,41,74
 Tutleman, Jonathan, 50
 Usenik, Pat 56
 Van Soest, Rudy, 57
 Verstraete, Roy, 59
 Vigers, Gary, 39
 Vijayan, Shiv, 41,80
 Vlachopoulos, John, 12,29,30,52,56,67,68,76,80,92,95
 Wainwright, Mark, 73
 Wairegi, Tom, 79,82
 Walker, Cindy, 41
 Watson, Linda, 45,46
 Weygang (now Heikkila), Anita, 65
 Werezak, George, 7,70
 Wilson, Warren, 38,39
 Wong (now Tse), Stella, 63
 Wood, Phillip (“Phil”), 19,29,95
 Woodhouse, Kim, 19
 Woods, Donald (“Don”), 9,15,18,19,29,34,37,38,41,49,51,52,54,55,56,
 61,65,68,76,79,80,83,85,92,95
 Wright, Joseph, (“Joe”), 10,14,18,19,20,34,51,52,56,93
 Xu, Gu, 29
 Zhu, Shiping , 95