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Programme des études sur les innovations techniques

Rapport de recherche

A REPORT ON THE COURSE "ISSUES IN TECHNOLOGICAL CHANGE"

by

Dr. C.C. Bigelow, Dean,
Faculty of Science

Dr. M. Bartell,
Faculty of Administrative Studies

The University of Manitoba

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"ISSUES IN TECHNOLOGICAL CHANGE"

by

Dr. C.C. Bigelow, Dean, Faculty of Science

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The University of Manitoba

PREAMBLE

The course "Issues in Technological Change" was re-designed and re-developed by Dr. Marvin Bartell, Administrative Studies, the University of Manitoba. It was given during the Fall 1980 term as an elective inter-faculty offering by the Department of Public Policy, Faculty of Administrative Studies. The course outline and various memoranda relating to the course are attached.

A note of special thanks goes to Professor J.F. Atwell, Head, Public Policy, under whose administrative auspices the course was given, for providing encouragement and support from the very inception of the project. Thanks also go to Professors J.L. Gray and M.D. Beckman, Head and Acting Head, respectively, Business Administration, for providing release-time from Departmental teaching responsibilities for purposes of teaching this course and to Dean J.D. Mundie and Associate Dean W.S. Good for their interest and co-operation. The helpful support and encouragement of Dean E. Kuffel, Engineering, Professor R.C. Chant, Director, Office of Industrial Research and Professor H.D. Gesser, Department of Chemistry were essential to the success of this venture. Professor Chant, in particular provided

enthusiastic collaboration. We would also like to acknowledge the support of Mr. I.H. Blicq, Assistant Deputy Minister, Manitoba Department of Economic Development and Tourism and Mr. L.H. Tough, General Director, Small Enterprise Development, who co-sponsored the visit of Dr. Donald S. Scott, Associate Dean of Engineering for Graduate Studies, University of Waterloo. This enabled members of the course "Issues in Technological Change" to participate in a joint session with the Enterprise Development Centre to hear an address by Dr. Scott on "Entrepreneurship and Obstacles to Innovation". Finally, the spirited interest and co-operation of Dr. G.S. Trick, Executive Director, Manitoba Research Council, Mr. W. Vernon Bowerman, Director, Industrial Technology Centre and Mr. M.B. Levy, Manager, Enterprise Development Centre were appreciated. A special note of thanks to Ms. J. Head, Head, the University of Manitoba Administrative Studies Library, for her dedicated co-operation in developing the necessary collections to offer the course. We would also like to thank the Curriculum Committee of the Science Faculty Council for approving the course as an available option for Science students.

THE COURSE

"Issues in Technological Change" was offered as a thirteen-week undergraduate course. The course focused on the process of technological innovation including entrepreneurship. The schedule of topics was as follows;

1. Focus on Canada in an International Perspective
2. Creativity, Innovation, Entrepreneurship
3. Applications of Technological Innovation

4. The Organization: Climate, Leadership, Teams, Conflict, Communication and Productivity
5. Fostering Innovation Within the Firm
6. Patent Law and Policy
7. Impact of Governmental Tariff and Science Policies
8. Professional Careers
9. Economic and Financial Aspects of Industrial Innovation
10. Diffusion of Innovations

A bibliography appears for each section in the course outline.

Class meetings were held twice per week and teaching methods were based on lecture-discussions, guest lecturers, short cases for discussions, several films and tapes, and progress reports of individual and small-group student research on innovation and entrepreneurship in relevant Canadian organizations.

Three written assignments were required. First, a four-to-five page critique of a pertinent book, subject to the instructor's approval, was submitted. This was an individual assignment. Second, a ten-page paper on the Creative Process was prepared mainly by individuals but in a few instances by groups of two individuals, each of whom had a clearly defined work role in the assignment. Third, a ten-page empirical paper on Organizational Innovation was required. This latter assignment was done on an individual basis, but again in a few instances by groups of two students and in one instance by a group of three. In this paper as well, a carefully defined and supervised work role for each individual in a group was required. It was felt that assignments prepared by small groups of two or three persons should reflect the quality and quantity of the work expected of a well-co-ordinated and managed effort. Both the second and third

papers were based on interviews and/or library materials but it was a requirement that one of the two papers would be based on interviews.

The objective of the paper on the Creative Process was to attempt to reveal the critical incidents or significant life events of a person who has been involved in technological innovation. The objective of the paper on Organizational Innovation was to attempt to reveal success or failure of an organization's efforts to bring about or increase the level of innovation. Further details concerning these assignments are provided in the course outline. With the assistance of Mr. W. Vernon Bowerman, Director, Industrial Technology Centre, specific names of firms and entrepreneurs, who had already indicated their willingness to co-operate in assisting student supervision, were made available to students during the first week of class. In this way, students perceived a strong sense of direction and an environment that was genuinely concerned with their efforts.

The book critiques prepared by the students were on some aspect of innovation, technology, creativity, or entrepreneurship. Some examples were:

Technology and Man's Future by Albert H. Teich;

Innovation in Big Business by Lowell W. Steel;

Perspectives in Creativity by Taylor and Getzels;

Soviet Science by Zhores Medvedev.

Some of the topics on which students based the library-research paper were as follows:

"The creative process: bureaucratic practices and impact on productivity;"

"Madame Marie Curie;"

"Japan: government-organized innovation;"

"patent procedure and patent policy;"

"Edwin H. Land of Polaroid;"

"the individual innovator."

Empirical studies included:

"a creative process profile of Dr. A. Sehon F.R.S.C., Head, Department of Immunology;"

"organizational innovation at Bristol Aerospace Ltd.;"

"Boeing of Canada Ltd.;"

"Sperry Univac Defense Systems Division;"

"a study of Mr. Edward Speers - Winnipeg inventor and entrepreneur; "

and studies of other technologically-oriented small business concerns.

Guest lecturers were as follows;

1. Mr. Stanley G. Ade, Senior Partner, Ade Kent and Associates Ltd. - Patent and Trademark Agents, Winnipeg - on patent law and procedure.

2. Dr. Riva Bartell, Associate Professor of Educational Psychology, University of Manitoba - on creative person and creative process.

3. Mr. Richard L. Bricker, Senior Vice-President - U.S. Operations, Lakeview Properties Ltd. Winnipeg - on entrepreneurship in Winnipeg: a historical perspective.

4. Mr. Harry T. Ethans, Executive Assistant to the Chairman, CanWest Capital Corporation, Winnipeg - on the entrepreneurial operations of CanWest and the allocation of responsibilities.

5. Dr. H.H. Kristiansen, President, K-cycle Engines Canada, Ltd. Winnipeg - on inventions, development and entrepreneurship.

6. Dr. Donald S. Scott, Associate Dean of Engineering for Graduate Studies, University of Waterloo and co-author of The Technical Entrepreneur - Inventions, Innovations and Business - on entrepreneurship and obstacles to innovation.

7. Dr. A. Sehon F.R.S.C., Professor and Head, Department of Immunology, University of Manitoba - on obstructions to in-

novations in large organizations and, in Canada, more generally.

8. Mr. Edward A. Speers, President, INRAD, Winnipeg - on invention and entrepreneurship.

9. Mr. Alan Sweatman Q.C. of Thompson, Dorfman, Sweatman - Barristers and Solicitors, Winnipeg - on entrepreneurship and technical change in some large western Canadian organizations.

The films, tapes and cases used in the course were the following:

Films:

1. Now the Chips are Down - on the microprocessor including applications and probably effects.

2. This is My Invention - an entertaining history of invention with particular reference to Canadian inventions and patents.

3. Koestler on Creativity - investigates some of the processes underlying the creative act with the main emphasis on the scientist.

4. Small Is Beautiful - exposes the theories of Fritz Schumacher on high technology in relation to economic development and personal identity and meaning in life.

Cassette Tape Recordings: (from American Chemical Society, three-day symposium, Innovation and Research in the United States, held in Washington, D.C., fall 1979.)

1. Dr. J. Herbert Hollomon, Center for Policy Alternatives, Massachusetts Institute of Technology: Appropriate Role of Government in Innovation.

2. Dr. James M. Utterback, Center for Policy Alternatives, Massachusetts Institute of Technology: What Are the Systems for Innovation: Micro/Macro.

3. Dr. Edwin Mansfield, Department of Economics, University of Pennsylvania: Economics of Innovation.

4. Donald W. Banner, Former Commissioner, United States Patent

and Trademark Office: Effect of Patent Policy on Innovation in Industry and Government.

Cases:

1. Excerpt from Ideas in Exile by J.J. Brown, Toronto, McClelland and Stewart, 1967 - provides a historical perspective of Canadian invention and the deficiencies in the innovation process in Canada, used as an orientation exercise to the course.

2. "Innovation at Texas Instruments", Innovation: A Study of Technological Policy by Arthur Gerstenfeld, Washington, D.C., University Press of America, 1979 - illustrating the problems and developmental processes involved in managing a successful, large-scale innovative organization.

3. "Creators in Chains" Canadian Business, October 1980 - discusses the continuing reluctance of Canada to generate a suitable climate for innovation to take place or to remove the obstacles faced by inventors in bringing their inventions to the marketplace.

Texts:

1. Hill, Christopher and James Utterback, (eds.), Technological Innovation for a Dynamic Economy, New York, Pergamon Press, 1979.

2. Mansfield, Edwin, The Production and Application of New Industrial Technology, New York, Norton, 1977.

3. Watson, James D., The Double Helix: A Personal Account of the Discovery of the Structure of DNA, New York, Atheneum, 1969.

There were seventeen students who took the course. One student was working full time as a research and development manager in a technologically-oriented organization and was a non-credit registrant under the auspices of the Continuing Education Division of the University of Manitoba. Four students were enrolled in engineering, two were from education - one graduate and one undergraduate, and the others were enrolled in the final year of the Bachelor of Commerce

program. Students from science were not represented in the course as registration packets in that faculty were sent out to students in March 1980, prior to the approval of the course development proposal by the Department of Industry Trade and Commerce. These mailings, therefore, could not include this course as an available option to science students for the academic year 1980-81.

EVALUATION

At the end of the term, all courses in Administrative Studies at the University of Manitoba were evaluated by students on an anonymous multi-item questionnaire which also included some additional open-ended questions. While the Commerce Students' Association was not able to retrieve the results of the computerized survey, it did forward the written comments which had been provided by some students in the course. The comments indicate that the course was well-received and that the blend of teaching methods used - lecture-discussions, readings, assignments, guest lecturers, films, tapes, and cases - was successful in achieving the course objectives (see course outline). In their comments, students particularly focused on the perceived value (high) of the assignments, the excellent presentation of the course by the professor as well as his enthusiasm, ability to integrate the various facets of the course and the benefits gained from the well-qualified guest speakers. One student stated that "the biggest benefit is that it (the course) has made me aware of the benefits of innovation and technology, which I feel will be invaluable to Canada's future". Another student was pleased "...to find a

course aimed at the individual who thinks in terms of becoming an entrepreneur, rather than an organization man". Still another student commented that "the information presented has given me much to consider and given input into my future career ambitions". One felt that the slot time 5:40 p.m. to 7:00 p.m. was undesirable, another felt there was "slightly too much work" and that "some of the speakers were much too specific at this introductory level". (All the written feedback is on file with the authors of this report.) A further indication of favorable student reaction to the course was the request made to Dr. Bartell by the Commerce Students' Association to organize a seminar as part of the Business Banquet held at the Winnipeg Inn in November 1980 entitled "High Technology in Manitoba: The Will to Succeed" (please see attached).

The required reading assignments, which were discussed in class, were four chapters from the book by Hill and Utterback. The specific chapters were (1) Technological Innovation: Agent of Growth and Change, (2) The Dynamics of Product and Process Innovation in Industry, (8) Policies and Programs Directed Toward Industrial Innovation, and (9) Summary and Policy Implications. These readings, in conjunction with the cassette tape recordings mentioned above, provided a well-focussed, research-based grounding on the topics that were considered. The book by Mansfield et al., while certainly more demanding than the older book Technological Change by the same author, was very helpful in the following chapters: (1) The Production of New Industrial Technology, (4) The Innovation and Development Processes within the Firm, (6) pages 122-125 Public Policy and the Rate of Application of New Technology, and (10) Social Returns from Invest-

ments in New Technology, the Role of Large Firms in the Innovation Process and the Diffusion Process. The book by James D. Watson entitled The Double Helix was recommended but not discussed in class. Many of the bibliographic references in the course outline were available in the library collections at the University of Manitoba owing to the book and periodical orders placed with the library in spring, 1980. The films offered a perspective that integrated well with the various topics and focus of the course and discussion served to clarify and relate points made by the films to the Manitoba and, more generally, the Canadian context. During the last week, students made short presentations on their assignments so that all members of the class would be fully aware of the accomplishments of their fellow classmates.

SUGGESTIONS FOR THE FUTURE

This course should continue to be offered. A question arises, however, as to whether it is best offered at the undergraduate or graduate level. Regardless of the level at which is is offered, if it is a mere course rather than a part of a well-focussed program on technological innovation and entrepreneurship there is some concern as to whether resources are being deployed in order to maximize the benefits that should flow from such an offering. The area is complex and requires detailed coverage so that the learning can be internalized. This can best be accomplished through a program that focuses on science, technology, entrepreneurship and public policy. In no way does this negate the desirability of beginning a developmental

process of curriculum formation and institutionalization by offering a single course. It is just that long run substantive results probably require more than this. The present course at Manitoba was successful and this suggests that other universities could offer a similar course. The following points should be considered by those who may wish to give such a course:

1. Entrepreneurship and the management of innovation are best viewed in relation to the Canadian context. A course like this one needs to have a strong reality orientation. While there needs to be a theoretical and research underpinning to provide a framework for examining issues in this area, live role models in the relevant geographical context are essential to internalize and reinforce the credibility that entrepreneurial and innovative activities can be and are being successfully pursued in the relevant metropolitan or regional area. This is particularly important in Canada as many students do not perceive the Canadian environment as being conducive to entrepreneurship and innovation. Such a perception must be dispelled and an effective approach for accomplishing this is exposure to a wide variety of entrepreneurial and innovative role models.

2. As it is beneficial to use a variety of teaching methods in giving a course of this kind, anyone considering such an offering should feel comfortable in an integrating and synthesizing role. Willingness to tolerate and encourage divergent thinking, openness to bring forward and discuss analytically controversial issues of Canadian public policy as related to entrepreneurship, innovation and science policy, a strong interdisciplinary and pragmatic focus and finally, enthusiastic rapport with a heterogeneous array of guest lecturers - these characteristics of a person offering a course in this area would seem especially helpful.

3. This type of course fosters university-industry cooperation and technology transfer. Students interact, in the classroom and in the field in order to conduct their research assignments, with entrepreneurial role models, inventors and managers of research and development. Both parties gain knowledge and insight into each others perspectives and experience and this may help to facilitate the possible development of joint ventures between the would-be entrepreneur and the "real-world" person of experience.

4. As an inter-faculty offering such a course can productively intermingle, at an advanced level, the outlook and skills of science, engineering and administrative studies students. If the encouragement of technologically - oriented small

business is a desirable objective, then there may be considerable productivity to be gained at this interface. Advanced students from diverse backgrounds working collaboratively, can bring to bear their skills and backgrounds in focussed, collaborative, reality-oriented assignments.

5. Anyone wishing to consider giving this type of course need not offer it in all of the dimensions discussed here. A coherent, unified shorter version can also be given.

6. The authors would be very glad to discuss this course further with anyone wishing to give a similar course. Please feel free to contact us.

APPENDIX A: COURSE OUTLINE

APPENDIX B: COURSE MEMORANDA

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September, 1980

Dr. Marv Bartell, Faculty of Administrative Studies, University of Manitoba
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Phone: office 474-8423
home 489-6103

Introduction

This course focuses on the process of technological innovation. The factors examined include the following: (1) the creative process and the creative personality, (2) facilitators and inhibitors in the creative process, (3) organizational design characteristics to achieve innovative end products, (4) financial, economic and legal aspects, patent law in particular, (5) the social implications and effects of public policy towards research, invenion, and innovation.

Course Objectives

1. To acquire some systematic knowledge and a coherent view of creativity and technological innovation.

2. To examine the context of the organization as a facilitator and inhibitor of innovation.

3. To study innovation as a sequential process involving idea creation, invention and design and requiring entrepreneurship for implementation, production and marketing to become commercially feasible.

4. To understand some basic economic and patent policy issues as related to technological innovation.

5. To gain an understanding of Canada's orientation to innovation and its relative position vis-a-vis other countries in the context of innovation.

Books - to be purchased

Hill, Christopher and James Utterback, (eds.), Technological Innovation for a Dynamic Economy, New York, Pergamon Press, 1979.

Mansfield, Edwin, The Production and Application of New Industrial Technology, 1977.

Watson, James D., The Double Helix: A Personal Account of the Discovery of the Structure of DNA, New York, Atheneum, 1969.

Written Assignments

Three written assignments are required:

1. Book Review. A four-to-five page critique of a relevant book is due at the beginning of October. Many titles are included in this course outline.

2. The Creative Process. A ten-page paper which attempts to reveal the critical incidents or significiant life events of a person who has been involved in technological innovation. This may be done by interviewing such a person or may be based on library research. This paper may be co-authored by up to 3 persons. A one-page outline should be submitted by the middle of October and the paper is due early in November.

3. Organizational Innovation. A ten-page paper which attempts to reveal success or failure of an organization's efforts to bring about innovation. This may be done by interviewing those who are directly involved in managing a project or making strategic decisions concerning innovation. An alternative approach would be based on library resources. This paper may be co-authored by up to 3 persons. A one-page outline should be submitted by the middle of November and the paper is due early in December.

Note. One of the two papers required will be based on interviews.

Suitable topics for The Creative Process paper include: career paths, informal organizations among professionals, communication patterns, "retreats", effects of substantive organizational change on potentially creative persons, bureaucratic practices and impact on individual or group productivity, introspective self-reports of creative persons.

Suitable topics for the Organizational Innovation paper include: comparisons involving differences in climate; leadership style, conflict resolution techniques, communication; ways of fostering innovation; effects of public policy on innovation by organizations; patent policy; decision-making patterns; project management techniques; penetration of foreign markets by Canadian organizations; extent to which information on foreign, potentially innovative technologies is collected and disseminated; new, improved ways of informing industry of inventions in government laboratories, improving industry-university cooperation in R & D, patent and trademark procedures and practices, entrepreneurial counseling for inventors, venture analysis and feasibility-testing support to new firms, federal assistance to provinces to give support to new businesses, federal support of small R & D firms, venture capital availability, examining impact of government anti-pollution, food and drug, occupational safety and health regulations.

Method of Teaching

This course will use lecture-discussions, guest lecturers, short cases for discussion, small groups and several films (Now the Chips Are Down, This Is My Invention, Koestler on Creativity, Small Is Beautiful).

Basis of Grading

Book Review	20%
1st Paper	40%
2nd Paper	40%
	100%

Grading Scale

90 or more	= A+
80 - 89	= A
77 - 79	= B+
70 - 76	= B
67 - 69	= C+
60 - 66	= C
50 - 59	= D
below 50	= F

Schedule of Topics - based on 13 weeks

1. Focus on Canada in an International Perspective
2. Creativity, Innovation, Entrepreneurship
3. Applications of Technological Innovation
4. The Organization: Climate, Leadership, Teams, Conflict, Communication and Productivity
5. Fostering Innovation Within the Firm
6. Patent Law and Policy
7. Impact of Government Tariff and Science Policies
8. Professional Careers and Stress Reactions
9. Economic and Financial Aspects of Industrial Innovation
10. Diffusion of Innovations

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Case Book

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Guest Lecturers

Guest lecturer presentations will be announced in class in advance.

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