Technological Innovation Studies Program

Research Report

Development of a Course on Innovation

and Entrepreneurship

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On Educating Oneself to Teach "Technological Innovation and Entrepreneurship"

Over the past four years I have been teaching courses (both at undergraduate and graduate levels) variously labelled creative decisionmaking; creativity and innovation; entrepreneurship; and most recently, technological innovation and entrepreneurship. In this paper I propose a number of opinions and ideas which may be of value to a person intending to teach a course on Technological Innovation and Entrepreneurship.

Defining Core Concepts

Let me start by arguing for formal definitions of the concepts of creativity, innovation, technology and entrepreneurship. Applied business courses usually don't require highly formalized definitions. A common strategy for the first time instructor of a new course is to choose a general text and to work with the author's chosen conceptualizations. By staying a few chapters ahead of the students, by rechannelling and relating your existing knowledge and by encouraging heavy student participation you will probably con your way through the first course. From then on it's a building job. But the course books in technological innovation and entrepreneurship are inadequate as texts. Most texts on entrepreneurship and small business are not much more than restatements of fundamental knowledge of the business disciplines. As a result, strongly formalized central

concepts are needed in order to guide the gathering of alternative course materials as well as to aid the meaningful integration of those materials in a classroom setting.

a) Creative ideas are those which possess a notable degree of originality and feasibility (both in a technical and a social sense). It is worth noting that inventions have to be both new and practical to be patentable. One school of thought argues that the original element in creative ideas is produced by imaginitively combining existing ideas (i.e. by producing new combinations).

b) Innovation can simply be defined as the implementation of a creative idea. Technological innovation refers to a particular type of innovation, i.e. the implementation of creative technology.

c) Defining technology is somewhat more problematic. I tend to view technology broadly as being more than mechanical hardware. Organizational procedure is also technique. In a more generic sense "technique is nothing more than means and the ensemble of means... the technical operation includes every operation carried out in accordance with a certain method in order to attain a particular end. It can be as rudimentary as splintering a flint or as complicated as programming an electronic brain: (1., p. 19). However, when the Canadian federal government refers to technological businesses, these enterprises get linked almost immediately with exporting high technology hardware or substituting for such imported hardware. Therefore, as a good citizen, I choose examples and cases which fit public policy thinking rather than the generic definition of technology.

d) My definition of entrepreneurship is built upon the concepts of creativity and innovation. An entrepreneur is a creative individual who for reasons of background, training and values has chosen to

express his creativity through new venture initiation and development. This definition is very similar to that of Joseph Schumpeter. Schumpeter's entrepreneur is fundamentally an innovator - one who "carried out new combinations" (3., p. 132). They are the agents of economic development and as such they introduce new goods and new methods of production; they open new markets; conquest new sources of supply and carry out the new organization of industry (3., p. 66). I do not reference Schumpeter idly as he provides the most comprehensive conception of the entrepreneur of which I am aware. Unfortunately much of what he has written makes difficult reading. However, Schumpeter's view has only a partial applicability to the modern world. By envisaging the entrepreneur as 'the' creative agent of economic development Schumpeter has not paid adequate recognition to others whose contribution is unmistakable in a technological world, in particular, the scientists and the engineers. Furthermore, for the sake of developing formal theory Schumpeter has bifurcated management into entrepreneurs and "mere managers." In the latter decades of the twentieth century, the professional manager has become increasingly more competent to carry out the function of technological innovation. Moreover business creativity is not an either-or aspect of personality. It is important to recognize intermediate levels of creativity in all kinds of business people. Marketing men might develop creative advertising campaigns and financial men creative means of expanding financial resources. Schumpeter argues that the entrepreneur is a sufficient condition for economic development whereas I would maintain that in our increasingly technological world he remains but a necessary condition.

Suggested Preparatory Materials.

The libraries are full of potentially relevant literature on creativity, innovation and to a much lesser degree entrepreneurship. The problem of how to choose good reading material for a class is formidable once one abandons the idea of using an introductory text in entrepreneurship and small business management. My classroom experiences using highly formalized treatises such as those by Schumpeter and Kirzner have been problematic from the students' perspective. Therefore, as a rule of thumb I have attempted to choose less formalized and more readable materials. Below I list a very select number of references, all of which I have found useful either for class readings or for the preparation of classes.

Creativity:

(1) David Campbell, Take the road to creativity and get off your dead end, Argus Communications, Miles, Illinois, 1977.

A highly readable introduction of the many facets of creativity: the creative idea, the creative process, blocks to creativity, the creative manager and the creative organization.

(2) Rollo May, The Courage to Create (Norton, N.Y., 1975).

Despite its psycho-philosophic orientation it is a useful aproach to the dynamics of creativity. Even graduate students may not appreciate this book at the outset of the course but their acceptance grows over the duration of the course. Not recommended for undergraduate consumption.

(3) Edward de Bono, Lateral Thinking, Penguin Middlesex, England, 1970.

Highly readable and intellectually provocative theory of individual creativity.

(4) Harland Manchester, New Trail Blazers of Technology, Scribner, N. Y., 1976.

Descriptions of the technological creativity of a number of pioneering twentieth century inventors. Highly readable. You may wish to choose one or two chapters rather than the entire book for class readings.

(5) H.B.R. Reprints Managing Creativity, (#21292), Harvard Univ. Press, 1977.

Some articles are much better than others but most are relatively readable.

Technological Innovation

(1) Donald Schon Technology and Change, Delacorte Press, N.Y., 1967.

An introduction to the problems inherent in the process of technological innovation.

(2) F. M. Seherer, "Invention and innovation in the Watt-Boulton steam engine venture," M. Kransberg and W. H. Davenport (eds), Technology and Culture, Schockau Books, N.Y., 1972.

A good analysis of the necessary coupling of creative-inventive talent with creative-entrepreneurial talent to produce a successful innovation.

(3) James Bright, Research Development and Technological Innovation, Irwin, Homewood, Illinois, 1964.

Two articles are particularly noteworthy, namely those by W. Rupert MacLaurin and by Elting E. Morison. Both illustrate the different skills required for successful invention than for successful entrepreneurship.

(5) Edwin Mansfield, Technological Change, Norton, N. Y., 1970.

This paperback provides the reader with an overview of research on the economics of innovation by perhaps the best author in the field. More recent works such as The Production and Application of

New Industrial Technology, (1977) by Mansfield et al. is somewhat more demanding reading. You might assign a chapter or two but probably not the book.

(6) Robert G. Cooper, Winning the New Product Game, McGill Publications, McGill Univ., Montreal, 1976.

Good description of the interaction between engineering design and market research needed for successful innovation. Analysis based upon three Canadian case studies. Good for assignment to students.

Entrepreneurship

(1) R. H. Campbell and R. G. Wilson, Entrepreneurship in Britain 1750-1939, Adam and Charles Black, London, 1975.

A fine collection of readings by nineteenth-century notables (i.e. Robert Owen, and John Calvin) upon the topic of entrepreneurship during the rise of industrial revolution.

(2) Alexander Ross, The Risk Takers, FP/MacMillan Publications, Toronto, 1975.

A series of well-written journalistic accounts of Canadian technological entrepreneurs by the current editor of Canadian Business.

(3) Joseph A. Schumpeter, The Theory of Economic Development, Oxford Univ. Press, N. Y., 1974.

The most comprehensive treatment of the entrepreneurial function available. Read chapters II and IV. Not for student reading.

(4) Israel Kirzner, Competition and Entrepreneurship, Univ. of Chicago Press, Chicago, 1973.

Detailed treatment of the economics of entrepreneurship. Provides interesting insight to the entrepreneur who is seen as a market mechanism for adjusting the means of production to ever changing consumer wishes. Heavily influenced by Schumpeter. Not for

student reading.

Entrepreneurial Enterprises and Environments

(1) Robert Buchele, Business Policy in Growing Firms, Chandler, Scranton, Penn., 1967.

Identifies particular problems associated with various stages in the growth of a firm.

(2) Rein Peterson, Small Business: Building a Balanced Economy, Porcepic, Erin, Ont., 1977.

Integrates existing data on the plight of small business in Canada. Makes good reading for undergraduate students.

(3) J. Britton and James Gilmour, The Weakest Link: A Technological Perspective on Canadian Industrial Underdevelopment, Science Council of Canada, Ottawa, 1978.

A critical analysis of Canadian technological development. Background material for the professor.

(4) E. F. Schumacher, Small is Beautiful, Abacus, London, 1975.

A philosophy for the development of a new concept of technology. Schumacher advocates local technology for local needs which is culturally consistent with the people involved. Not for student reading.

(5) Norman Macrae, "The coming entrepreneurial revolution: a survey," The Economist, December, 1975.

A futuristic description of society where the entrepreneur will again play the central role in economic development. Good classroom material.

Other

(1) P. Liles, New Business Venture and the Entrepreneur, Irwin, 1974.

Three cases which I have found to be very good are: American Imports, Ar Tech Packaging, Terry Allen;

(2) Why Man Creates - An International Telefilm on creativity through the ages;

(3) The Journeyman - National Film Board production on a Nova Scotia entrepreneur.

Developing a Course Plan

As a new teacher of Technological Innovation and Entrepreneurship, you will also need to set course objectives, develop a course plan and come to some conclusions regarding the choice of pedagogy. Yet one more book is worth perusing at this point - Karl Vesper's Entrepreneurial Education - A 1978 Update. Vesper's latest manuscript contains relevant course related information from 42 different North American Universities. A review of this book will demonstrate that a number of North American schools utilize an approach fundamentally similar to that advocated here. Let me note that U.C.L.A., Carnegie-Mellon, Dartmouth, North Carolina at Chapel Hill, Pennsylvania, Texas A & M and Waterloo all explicitly reference creativity or innovation as central characterizing elements in the entrepreneurship courses which they offer.

course objectives

The objective which I utilized in last year's class - Technological Innovation and Entrepreneurship - was as follows:

> This course is intended to create an awareness of technological innovation and enhance the entrepreneurial skills of selected students from the Faculties of Engineering, Science and Management.

The course philosophy required that students be pre-selected using much the same logic one might use to choose students in the other creative arts. If you also decide to screen your own students I would suggest that you develop a system of contacts in relevant faculties in order to expedite referrals. Last year I took some steps towards founding an entre-

recruiting students

preneurship club of students who are self-employed in some venture of their own making. Such students should be well suited to such a course as they have already demonstrated some of the skills needed to be successful entrepreneurs.

selecting students

When interviewing each interested student I search for some evidence of entrepreneurial activity in their personal history. I look for a chain of self-initiated ventures stretching back to their preschool years. I also look for the attitudinal attributes common to creative people [2].

class size

Class size is the next variable to consider. Last year's (Winter, 1979) experimental class on Technological Innovation and Entrepreneurship comprised mostly fourth year students from Engineering and Management. Since the course was scheduled much too late for the university calendar and since I provided little promotion, the class started with only eight students. I encouraged a great deal of class participation, individualized student projects and took class field trips to different entrepreneurs' places of business. Towards the end of the course I required that students write detailed course critiques in which they volunteered opinions supporting small classes. I quote from one student:

> "Classes should be limited to eight to ten students at the very most. Small classes do not inhibit participation and discussion. Small classes encourage the latent talent of students to come forward that would otherwise be lost."

Given that entrepreneurs are creative individuals, it is unwise to attempt to process them in mass. Their education requires an individualized response. As a result, I foresee that educating entrepreneurial talent will be a relatively high cost phenomena in a period of tight budgets.

the scheduling of topics

Given a small class allowing for face to face student interaction and an individualized response from the professor, the next issue is that of course plan. My analytical framework is composed of four different parts

focussing upon: (1) the entrepreneur, (2) the technological venture, (3) creative-innovative process and (4) environments for technological entrepreneurship. A typical 13 week program might be set up as follows:

Week 1: The Technological Entrepreneur

A discussion of readings from Alexander Ross' Risk Takers. I have each student prepare one article for presentation to the class. I ask them to analyze and describe the creative aspects of the entrepreneur and his or her venture.

Week 2: Starting a New Venture

I will ask each student to independently search out some heuristic literature on starting new ventures. Each student will be asked to present an analysis and a critique of his chosen material. Hopefully, this section will reduce the student expectation of receiving a simple and effective "how to" package.

Week 3: The Entrepreneur as Creative

With a fourth year class Campbell's book Take the Road to Creativity..., should provide useful background reading. The film "Why Man Creates" and perhaps also "The Journeyman" might provide additional stimuli for discussion. With graduate students you might give them the option of reading The Courage to Create or Lateral Thinking and discuss different perspectives about creativity. Some further discussion of the entrepreneur as a creative person may be desirable (i.e. Schumpeter's ideas).

Week 4: Technological Invention and Innovation

For this week I might assign "The process of technological innovation: the launching of a new scientific industry" by W. Rupert MacLaurin and "A Case Study of Innovation" by Elting Morison from Bright's book, Research Development and Technological Innovation

(Irwin, '64). I would also probably assign F. M. Scherer's article "Invention and Innovation in the Watt-Boulton Steam-Enging Venture" from Technology and Culture.

This is a good place to distinguish invention and innovation. The usual necessity of partnership between inventor and innovator may be prescribed here. Additional material might be taken from Manchester's Trail Blazers of Technology.

Week 5: Case Analysis, e.g. Ar Tech Packaging

Bob D'Amore is an interesting example of an individual who is successful as both a new product designer and an entrepreneur. Analysis might focus upon the character of the entrepreneur, the viability of the venture and the suitability of the entrepreneur to this particular venture. The following analytical framework may prove useful to you.

	The Person	Ar Tech Packaging
1.	Creativity	
	a) Product or service development	high
	b) Production technology	high
	c) General strategy	high
	d) Marketing	low
	e) Financing	high
	f) People/organizational management	medium?
	g) Information collection and analysis	medium
2.	Biography of success/failure	medium
3.	Formal Education (generally relevant)	high
4.	Energy/Time Availability	low
5.	Complementarity/Compatibility of Key participants	medium
	The Venture	
1.	Feasibility of continued cash flow	medium
2.	Market feasibility	high
3.	Potential for profitability	high

4.	Potential for growth	high
5.	Other - positive factors	potential for synergetic development
	negative factors	limitations of partner

The Fit (Between Person(s) and Venture(s))

1.	Specific relevance of education	high
2.	Industry knowledge and experience	low-medium
3.	Contact established	low-medium
4.	Interest/value compatibility	high

Week 6: Visiting Technological Entrepreneur

In one instance we had Keith Banks who is the founder and president of Rolee Oil - an electronic logging company. One of my graduate students has written a case analysis of Keith's background which was passed out the week before he came to class.

Week 7: New Product Development

Cooper's book Winning the New Product Game makes good reading for this session.

Week 8: Second Case - Terry Allen

Terry Allen is a natural entrepreneur but not a technological innovator. He comes across as a promoter to some who read the case. Careful analysis is required to illustrate how effective he has really been. Even students who have substantial background in accounting and/or finance are liable to misinterpret the case. The type of analysis which is required for small start-up situations is substantially different than for large on-going corporations.

Week 9: Visiting a Second Local Entrepreneur

Last year the class spent an afternoon at Dr. Allan Vrooms' pilot

plant in South Calgary. Dr. Vrooms' research led him to develop a substitute for concrete which uses a sulpher base. Financing the innovation has been one of his continuous struggles.

Week 10: Financing Technological Innovation

The Lawrence Kryzanowski and R. Giraldeau article "Venture Capital Management: a Survey of Attitudes Towards Selection Criteria." American Journal of Small Business, 1977 presents data collected on Canadian venture capitalists.

Robert Grasley's Ministry of State for Science and Technology publication, The Availability of Risk Capital for Technological Innovation and Invention in Canada, 1976 provides more useful background information.

I have usually invited venture capitalists or bankers to speak to the class. Last year I invited Dave Crowe of the Calgary Office of the Federal Business Development Bank.

Week 11: Alberta and Canada as Environments for Technological Innovation

The Weakest Link and Small Business: Building a Balanced Economy are good background material for this class. For the duration of the course I clip out relevant articles from sources such as the Financial Post in preparation for this session.

Weeks 12-13: Student Presentations

The students were given too much latitude last year in their choice of a project which resulted in unnecessary high levels of frustration. The next time I give this course I will ask them to profile a local technological entrepreneur and his venture. The one stipulation which I will place on their choice of subject is that he currently have a minimum of three full-time employees.

evaluation and grading

The evaluation and grading of course performance is difficult. Last year I negotiated a grading scheme with the class similar to the following:

A. Participation

Self-evaluated effort to contribute	- 10%
Peer-evaluated contribution	- 10%
Professor-evaluated contribution to class learning	- 10%

B. Project: Profile of a Local Technological Entrepreneur

Written material	- 30%
Oral presentation	- 10%

C. Case Analysis: Written Prior to Class Discussion (10% each) - 20%

D. Quizzes (2 @ 5% each on reading material) - 10%

Such a grading strategy places a heavy emphasis both directly and indirectly on classroom preparation and contribution. I am generally amenable to adjustments that the students consider desirable. If one or two individuals have substantially different objectives than the rest I will contract the grading with them on an individual basis.

pedagogy in general

As should probably be quite evident at this point I favour a pedagogy which places substantial responsibility upon the student for indidivual initiative and followthrough. Formal student course evaluations and some specific student comment demonstrated support for this general strategy,* for example:

> "I really liked the idea of being treated like an adult for a change."

I believe that effectiveness in recruiting the high potential students will

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* The Winter, 1979 course on Technological Innovation and Entrepreneurship was rated approximately 4 on a 5 point scale.

result in good student response to more ambitious student-based pedagogies.

In summary, I have developed a strategy to follow in preparing oneself to teach Technological Innovation and Entrepreneurship. Firstly, I have suggested that one start by clarifying their conception of entrepreneurship - in particular by choosing a conceptualization based upon the Schumpeterian notion of the creative entrepreneur. Secondly, I have suggested articles and books for pre-course reading. Thirdly, I have provided a sample outline for one's first trial with this subject. I hope that what I have offered will be of value to you.

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TECHNOLOGICAL INNOVATION STUDIES PROGRAM

PROGRAMME DES ÉTUDES SUR LES INNOVATIONS TECHNIQUES

REPORTS/RAPPORTS

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8.	Gérard Garnier	Faculty of Management University of Sherbrooke.	Characteristics and Problems of Small and Medium Exporting Firms in the Quebec Manufacturing Sector with Special Emphasis on Those Using Advanced Production Techniques. (August 1974)
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