A STUDY OF INTERDISCIPLINARY EDUCATION AT M.I.T.:

THE CONCOURSE PROGRAM

by

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by Martin Horowitz, submitted to the Sloan School of Management on May 2, 1975, in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Management and Technical Education

Abstract

The study provides a descriptive analysis and evaluation of the Concourse Program, an educational innovation for freshmen at M.I.T. The Concourse Program was, and is, collaboratively planned and taught by an interdisciplinary interdepartmental faculty group utilizing thematically organized subject matter and interactive class sytles to create interdisciplinary learning situations. The goals of the program were to present the core requirements for freshmen within an interdisciplinary context and to supply a model experience for interdisciplinary concept learning and participation in an interdisciplinary working environment.

The study sought to determine the extent to which the Concourse Program met its objectives and to interpret these findings both as a test of an educational innovation within M.I.T. and, in a broader sense, as a test of the validity of a trend toward interdisciplinary approaches to complex issues in our society at large. The primary data sources were the results of surveys of the Concourse students and a control group of students in the M.I.T. regular curriculum, and autor's interviews with faculty and students in the two programs and his personal experience as a member of the Concourse staff.

The findings of the study included the following: the Concourse Program did create an interdisciplinary learning environment; the Concourse and regular curriculum students did not differ in terms of academic achievement; as predicted, Concourse students did differ from regular curriculum students in terms of attitudes, behavior, learning style, and creativity. It was concluded that the Concourse Program met its objectives in terms of short term outcomes in its students and in providing a supportive environment for interdisciplinary, interdepartmental faculty collaboration. These results also lend general support to the trend toward interdisciplinary approaches to the resolution of complex issues and to the propriety of interdisciplinary education as preparation for participation in interdisciplinary processes.

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Finally, I dedicate this thesis to my wife, Linda, whose love, faith and typing sustained me through the last few months.

A Study of Interdisciplinary Education at MIT: The Concourse Program

Table of Contents

	Page
ABSTRACT	2
ACKNOWLEDGEMENTS	3
TABLE OF CONTENTS	4
TABLE OF FIGURES	7
I. What is the Concourse Program and Why Study It?	8
A. Introduction	
1. Purposes of the Study	9
2. A Narrative Outline	11
B. The Concourse Program	
1. History	12
2. Objectives	21
3. Subject Matter	26
4. Class Style	28
5. Faculty Interaction	34
6. Similarities and Differences of the Concourse Program and Regular Curriculum	36
C. Theoretical Bases for Interdisciplinary Education	
1. What is an Interdisciplinary Learning Situation?	38
2. The Potential Results of Interdisciplinary Learning in the Students	44
II. Methodological Approach	48
A. How is an Educational Innovation Evaluated?	48
B. Data Sources	
1. Observations--Participation and Interviews	51
2. Archives	53

3. Statistics 55
4. Timeframe for Data Acquisition 64

C. Experimental Design 67

D. Analytical Techniques . . . . . .

1. Matched Group Selection. 70
2. Comparisons 72

E. Hypotheses 74

III. Initial Measures of the Students 77

A. Initial Condition Hypotheses. 77

B. Quantitative Data

1. Attitude Measures 84
2. Behavior Measures. 85
3. Learning Styles. 86

C. Discussions and Conclusions 88

IV. Program Characteristics. 95

A. Program Characteristic Hypothesis 95

B. Quantitative Data

1. Instructor Quality 98
2. Subject Matter 98
3. Class Style. 99
4. Student Faculty Interaction. 100

C. Discussions and Conclusions 101

V. Subsequent Measures of the Students. 108

A. Post-Test Hypotheses. 108

B. Quantitative Data

1. Attitude Measures. 115
2. Behavior Measures. 116
3. Learning Styles. 117
4. Other Post-Test Data 118

C. Discussion and Conclusions. 120

VI. General Conclusions 128

A. Conclusions

1. Evaluation in the Context of an M.I.T. Innovation 128
2. Support for Interdisciplinary Approaches to Complex Issues 132
3. General Conclusions 134

B. Suggestions for Further Research 136

Bibliography 139

APPENDIX I: Questionnaire I 143

APPENDIX II: Questionnaire II 149

APPENDIX III: The Regular Curriculum 155

A. Institute Requirements. 155

B. Class Styles. 159

C. Faculty Interaction 161

APPENDIX IV: Faculty Interaction in the Concourse Program 164

BIOGRAPHY. 168

Table of Figures

		Page
1.	Characteristics of the Concourse Program and Regular Curriculum for M.I.T. Freshmen.	37
2.	Contextual-Conceptual Systems	41
3.	Response Rates to the Questionnaires.	57
4.	a. The Experiential Learning Model.	60
	b. The Derivation of Learning Styles.	60
5.	Time Frame for Data Acquisition.	65
6.	Experimental Design.	68
7.	Scholastic Aptitude Scores	79
8.	Initial Attitude Measures.	80
9.	Initial Behavioral Measures.	81
10.	a. Initial Learning Style Inventory.	83
	b. The Initial L.S.I. Plotted.	83
11.	Program Characteristic	96
12.	Longitudinal Attitude Measure.	110
13.	Post-Test Attitudes.	111
14.	Longitudinal Behavioral Measures	112
15.	a. Longitudinal Responses to the L.S.I..	113
	b. Longitudinal L.S.I. Plot.	113
16.	Other Post-Test Data	114

CHAPTER I

What is the Concourse Program and Why Study It?

A. INTRODUCTION

By what means can the complex problems of our times be solved? How can they even be adequately defined? One approach to these issues revolves around the concept of interdisciplinarity. We must develop the ability to creatively negotiate the intersections of the disciplines. To do this, the isolation of the disciplines from one another, a by-product of the intensification of professional specialization, must be overcome. The issue has become much more pervasive than the "two culture" problem, the confrontation of the technological and humanistic perspectives. It extends to the isolation of once closely related disciplines in science and engineering; it has become the "every culture" problem.

The natural place to begin the process of change is within the domain of professional education. The Concourse Program is such an atempt within a technological university, M.I.T. Concourse is planned and taught by an interdepartmental faculty representing the major schools at M.I.T. The program has sought to foster interprofessional collaboration among its faculty members and provide a truly interdisciplinary education experience for M.I.T. freshman. The primary inno-

vations attempted in the program have included team-teaching, thematic organization of subject matter, and interactive class formats. Thus, the Concourse Program has tried to create, within the interdisciplinary learning situation, a realistic model and a way for the student to begin preparing to meet the demand for interprofessional interdisciplinary collaboration in the working environment.

1. Purposes of the Study. The goals of this study may be considered at two levels. In the most basic sense, the purpose of this study is to provide a comprehensive evaluation of the Concourse Program and an answer to the question: Is the program a successful interdisciplinary education innovation at M.I.T? In a large sense, however, the purpose of this study is to supply additional evidence that justifies (or contra-indicates) the current trend toward an interdisciplinary approach to societal and technological issues.

There are several objectives to be met in the evaluation of the Concourse Program. The first is to supply an observational and quantitative description of the program. This includes an enumeration of the initial operational objectives of the program and an assessment as to whether or not they have been realized. To what extent was the implemented Concourse Program congruent with the planned program? To what extent was the implemented program actually an interdisciplinary experience? A second purpose is to discover what learning outcomes were originally projected and how they compared to the actual results in the students.

Another important aspect of the evaluation of the Concourse Program is comparing it with the standard programs at M.I.T. Here the important questions are: In what ways was the Concourse Program different from (and similar to) the regular curricular options for M.I.T. freshmen? What were the differences between Concourse students and students who experienced the regular curriculum?

The larger purpose of this study, to lend support to the general concept of interdisciplinarity, will be achieved by extrapolating from the specific outcomes of evaluating the Concourse Program. One key factor will be to observe the degree to which an interdepartmental faculty can cooperatively interact in their planning and teaching roles. Another will be the extent to which students shift toward more cooperative rather than competitive modes of interaction among themselves. A third critical measure will be the student's attitudes toward the humanities and integration of the humanistic and technical perspectives. The results of the above measures will point to the efficacy of interdisciplinary education as preparation for technologically-oriented participation in interdisciplinary research and applications.

Thus the purpose of this study is to test the outcomes of a pilot experiment in interdisciplinary education. If judged successful, Concourse may serve as a model for modified or expanded interdisciplinary programs. At worst, the program should point out pitfalls to avoid in the pursuit of solutions to the problems of disciplinary isolation.

2. A Narrative Outline. There are two primary structural elements in this study. The first is a descriptive analysis of the Concourse Program and its theoretical bases. The second element is statistical analysis in which the program is described in quantitative terms and compared with the regular M.I.T. freshman curriculum in terms of educational structure and resultant effects on students.

The descriptive analysis and theoretical bases of the Concourse Program are presented in the balance of the first chapter. The quantitatively based analysis of the program is contained in the second through sixth chapters. The second chapter addresses the methodological issues germane to this study, including the general question of how to evaluate an educational innovation. In addition, the sources of data for this study -- observational, archival, and statistical -- are described. A description of the structure of the quantitative aspect of the study and the hypotheses round out the second chapter. In the third, fourth and fifth chapters the quantitative data is presented with specific discussions and conclusions based on the data and supporting observations. Chapter III presents data pertaining to the initial measures of the students in this study. Chapter IV presents data which describes the program characteristics of Concourse and the regular curriculum. Chapter V presents data pertaining to measures of the students subsequent to the test period. And in the final chapter, general conclusions are drawn and suggestions for further research are offered.

B. THE CONCOURSE PROGRAM

This section provides a qualitative description of the Concourse Program drawn from my own observations (as a participant) in the progam from its beginnings) and augmented by written sources generated by the program's faculty. The program is reviewed in terms of the subject matter, class styles and faculty interactions that characterized the test period of this study, the academic year 1972-1973. In order to supply a contextual framework for this description, a brief history of the program, and a summary of the objectives set by its faculty, is first presented.

1. History. The roots of the Concourse Program may be traced back to the academic year 1969-1970. At that time many activities at M.I.T. were focused on the issue of the relevance of technical education. The rising anti-war sentiment on the nation's campuses, which would culminate that spring in the Kent State shootings and the student strike, was certainly a primary contributor to these concerns. During that year the Commission on M.I.T. Education was addressing issues pertaining to the undergraduate programs as well as questions concerning the propriety of conducting War-related research at M.I.T. facilities.

The above situation proved to be a fertile environment for those members of the M.I.T. faculty concerned with educational innovation. Two experimental undergraduate programs, Unified Science Study Program and Experimental Study Group, had already begun at M.I.T. At this time, Professor Larry Bucciarelli and Dave Oliver, both members of the Depart-

ment of Aeronautics and Astronautics, began discussions around the issues of the quality of undergraduate teaching and student-teacher relationships. They focused their ideas in a paper entitled Education Beyond the Two Cultures: Some Thoughts on the Community Teaching Experiment for Cultural Wholeness (Bucciarelli and Oliver, 1970).

At the same time I was involved in an independent study course, the purpose of which was to explore the possibilities of increasing the relevance of the undergraduate engineering curriculum at M.I.T. This study primarily consisted of a series of interviews with heads of departments and other prominent faculty in the School of Engineering. The interviews centered on proposals for changes in the structure of undergraduate courses and interviewees' reactions and counter-proposals. Professor Bucciarelli, as my undergraduate advisor, was kept informed on the progress of this independent study.

In May, 1970 I suggested to Professors Bucciarelli and Oliver that the interests we shared might be further pursued under the sponsorship of the Commission on M.I.T. Education. The Commission agreed to support a preliminary investigation into the ideas of improving undergraduate education and the concept of the teaching community.

Other members of the M.I.T. faculty who also wished to explore these issues joined us during the summer of 1970. The members of the resulting group (later known as the Clock Group) are listed below (along with their departmental affiliations and rank at the time):

Ron Bruno, Graduate Research Assistant, Physics

Larry Bucciarelli, Associate Professor, Aeronautics and Astronautics

Nancy Dworsky, Assistant Professor, Humanities

Duncan Foley, Associate Professor, Economics

Martin Horowitz, Educational Researcher, Division of Sponsored Reseach

Travis Merritt, Associate Professor, Humanities

Dave Oliver, Assistant Professor, Aeronautics and Astronautics

Brian Schwartz, Associate Professor, Physics

The major schools at MIT -- Science, Engineering, and Humanities and Social Science -- were all represented in this group. It should be noted that each of the faculty members who joined the group had great expectations of the positive outcomes of interdepartmental, interdisciplinary collaboration. This fact certainly improved the probability for their successful collaboration as compared with a randomly selected group. The first task of the newly formed group was to collectively plan and execute a joint project, the building of a clock, as a test of the ability of such a diverse faculty group to collaborate productively (Horowitz, et al., 1970). The clock building project served two important functions: 1) It enabled the faculty group to explore, in a non-threatening environment, the problems and rewards of working together. 2) It supplied insights into the appropriateness of an interdisciplinary theme, such as "time," as the focus of an interdepartmental teaching

program. Another important feature of the clock building project was the opportunity for each group member to lecture, in his or her own professional specialty, to the rest of the group. This provided everyone with an opportunity to experience learning outside of their specialty as well as to be exposed to helpful criticism of each group member's teaching style. At the conclusion of the clock building project it was the consensus of the faculty group that interdisciplinary collaboration had been a rewarding, motivating experience (Horowitz et al., 1970).

We felt encouraged to the extent that we decided to continue our investigation of the potentials for interdisciplinary collaboration. The next step naturally, was to initiate an experiment with students in the context of an undergraduate seminar at MIT. In the fall term of the academic year 1970-71, the Clock Group ran a seminar entitled "From Earth to Moon: Fact, Fiction, and Fantasy" (Horowitz et al., 1971). The seminar was the testing ground for many ideas conceived during the clock building project, especially theme-centered learning. It began with two readings on travel between the Earth and Moon (Jules Verne, From the Earth to the Moon, and a factual account of the Apollo program). The majority of the semester was then spent on four projects -- a study on the feasibility of lunar colonization, a group authored science fiction novel, Getting the Hell Out, (Mersteinwold, 1971), a correlational analysis of moon phases and the incidence of violent crime, and the examination of extraterrestrial images produced with the naked eye, prephotographic telescopes, cameras, and sheer imagination. Each pro-

ject was formulated and completed by a subgroup of the seminar consisting of two faculty members from different schools and four or five students. For example, Duncan Foley (Economics) and Dave Oliver (Aeronautics) combined on the lunar colonization study while Larry Bucciarelli (Aeronautics) and Nancy Dworsky (Humanities) participated together in the lunar phase-violent crime correlational analysis. At the end of the semester each group gave a presentation of their project to the rest of the class.

The Clock Group considered the "Moon" seminar to be a successful, encouraging (and enjoyable) test of the concepts of theme-centered learning and collaborative teaching. In the Spring of 1971, they proceeded to draft a proposal for a full-scale undergraduate program based on these concepts (Horowitz et al., 1971). The proposal outlined the projected form and substance of the first year of the Concourse Program, the academic year 1971-72. The proposal also suggested mechanisms for evaluation of the student's performance within the program and the program's performance within MIT. The proposed program evaluation would consist of analyses by students in the program, the program faculty, and review board composed of non-participants from MIT and outside of the Institute.

It should be noted here that the proposal was suggesting an education innovation that differed significantly from the two on-going experiments at M.I.T. The central orientation of the Unified Science Study Program (U.S.S.P.) encouraged project-centered learning.

The U.S.S.P. student would design and execute a project, learning concepts and skills relevant to the completion of the project. As needed, the student would draw on the teaching resources available in the faculty affiliated with the program. The U.S.S.P. faculty also offered courses in some of the core subjects utilizing innovative teaching techniques. Primary examples of such courses were programmed instruction in the calculus and project-centered physics (classical mechanics).

The Experimental Study Group (E.S.G.) was designed toward the highly self-motivated student. E.S.G. students designed their own individually tailored academic programs, determining both the subject matter and learning style they wished to emphasize. The faculty affiliated with E.S.G. were resources available to the students if and when they desired them. Accreditation of work completed was usually a process mutually agreed upon by the student and faculty member. The learning community, stressing both academic and social interaction among the staff and students, was an important element of the E.S.G. program.

As can be seen from the above descriptions, the main innovative thrust of the proposal for the Concourse Program -- the interdisciplinary interaction of subject matter, students, and faculty -- was unique among the experimental programs at MIT in 1971. The primary stress on interdepartmental faculty collaboration in the Concourse Program was missing in both E.S.G. and U.S.S.P. The Concourse Program certainly integrated into its structure some of the innovations that were central

to the other programs, but its primary focus, the interdisciplinary learning situation, set is apart.

The actual history of the first year of the Concourse Program is described in Concourse: Report to the Committee on Educational Policy (Horowitz et al., 1972a). The proposal received academic approval from the Committee on Educational Policy and budgetary approval from the MIT administration in the Spring of 1971. Faculty members were typically committed to the program for one-half of their teaching time during the academic year. During the summer of 1971, the Concourse faculty met once or twice a week to plan a detailed curriculum for the academic year 1971-72. Two additional faculty members had joined the group since the completion of the "Moon Seminar." Thus, the faculty that participated in the first year of the Concourse Program included the previous named members and the following additions:

Adrian Houtsma, Lecturer, Electrical Engineering and Humanities

Karl Linn, Associate Professor, Urban Planning

The enrollment for the first year was 14 students, significantly less than the 35 students anticipated in the proposal. Nevertheless, the academic year began with the major emphasis on getting the bugs out of the program and running smoothly rather than immediately dealing with the problem of low enrollment. The interdisciplinary theme for the academic year was "Prediction and Prophecy." Successive subunits of the theme investigated celestial mechanics; population; perception; and prophets, oracles and seers.

The theme was developed in a series of General Meetings, formal classes that met two times a week for three hours at each meeting. The format of the General Meetings varied from meeting to meeting and also within a given three-hour session; lectures, recitations, laboratories, demonstrations, seminars, etc. were engaged in, depending on the specific topic and faculty members involved. It should be noted that the program was accrediting students in the freshman requirement courses (calculus, physics, chemistry and humanities), so that a primary concern was integrating prerequisite skill learning into the varying class format. During the second semester (Spring, 1972) the faculty added a weekly three hour session, entitled "Techniques of Disciplines," in which disciplinary skill -- learning and problem-solving were emphasized. This removed a good deal of the pressure on the thematic nature of the General Meetings to continuously fulfill all of the learning needs of the core subjects.

A second, complementary educational component, the Working Groups, was also a part of the first year of the Concourse Program. Working Groups were a much less structured and formalized activity than the General Meetings. The Working Groups were intended to be projects initiated and completed by small groups of students under faculty supervision, similar to the project in the "Moon Seminar" the previous year. A wide array of Working Groups completed semester-long projects during the academic year; however, persistent problems relating to motivation and the rigor of work done led to the tightening up of fac-

ulty supervision in what was initially intended to be a primarily student-run activity with minimal faculty involvement. While the Working Groups were a primary, compulsory component of the first year of the program, the Concourse faculty decided to eliminate them as a formal requirement during the program's second year of operation, though students were still encouraged to participate in similar projects on an optional basis. This and other changes in the second year of operation of the Concourse Program, the academic year 1972-73, are described in subsequent sections which deal with the educational objectives, subject matter, class style, and faculty interaction relevant to that year.

There were some changes in the make-up of the Concourse faculty between the first and second year of the program's life. The faculty group that planned and taught the Concourse Program during the test year of this study, 1972-73, was comprised of the following members:

Larry Bucciarelli, Associate Professor, Aeronautics and Astronautics

Nancy Dworsky, Assistant Professor, Humanities

Duncan Foley, Asssociate Professor, Economics

Martin Horowitz, Graduate Research Assistant, Management

Irving Kaplan, Professor, Nuclear Engineering

Karl Linn, Associate Professor, Urban Planning

Travis Merritt, Associate Professor, Humanities

Dave Oliver, Assistant Professor, Aeronautics and Astronautics

Brian Schwartz, Associate Professor, Physics

Bob Silbey, Associate Professor, Chemistry

The above group spanned a wider array of disciplines and interests than the original Clock Group. It was hoped that the new staff members, part of a planned gradual turnover of faculty in the program, would prove to be a continuing source of new perspectives and insights contributing to the interdisciplinary learning situation.

2. Objectives. A careful reading of the various documents generated by the Concourse faculty reveals several detailed statements of the goals for the program. This section will include a representative sample of these statements in an effort to recreate the sharply defined expectations shared by the Concourse faculty for the focal year of this study. Immediately following the clock building project, the initial objectives of the faculty groups were summarized in The Making of a Clock (Horowitz et al., 1970):

> There is general agreement that the group wants to guide the student experience along pathways which are more fully interactive amongst the humanities, engineering, the sciences and social sciences (p. 36).
>
> The student's relation to other students and of groups of students to subjects of study has been left largely to informal extracurricular activities. .... the group wants to use student groups as a basic feature of an undergraduate program. (p. 37)
>
> A beginning has been made in drawing distinctions between the experience of quantitative and non-quantitative modes of thought (p. 37).

The objectives of the faculty group became less generalized and more pointed as the "Moon" Seminar was completed and the decision was made to put together a full-scale program for freshmen. The faculty's goals are more directly linked to the realities of a teaching program in the original Concourse Proposal (Horowitz, et al., 1971):

> We seek collaborative teaching, not "turn" teaching, and a natural synthesis and contrast of humane and technical disciplines. In pursuing these goals, we as faculty are often put in the role of students; a circumstance we find healthy. We want to foster students' abilities to set problems for themselves as well as solve them, and to choose problems intelligently, rather than accepting passively what they have been told to do (P. 1).
>
> Our priorities have more to do with attitude and intellectual style than with irreducible minima of substance (p. 7).
>
> Students will have a chance to be part of serious conversation involving several teachers ... Each faculty member will have the experience of rediscovering what it is like to be a student; and he will be known to the students as a man with certain important limitations and ignorances, rather than just the infallible champion of his own arena (p. 8).
>
> ... we will use comparative and contrastive means to achieve a critical consciousness of the present. We will encourage students

> to see that there are many ways to approach a problem or judge an argument, and to become capable of understanding reality with a variety of intellectual techniques (p. 9).
>
> Groups should promote a richer student culture than now exisits here. ... and form a context for the development of a social identity prior to the choice of an academic specialty (p. 14).

The faculty group did not change its objectives for the program in any significant way after its first year of operation. The goals stated in the first year evaluation are essentially identical to those listed above. Some minor changes in subject matter and class style were indicated for the academic year 1972-73 as will be reported below. However, these changes were made so that the program could more effectively pursue its original objectives in subsequent years. Further refinement of the faculty's goals in light of a year of actual experimentation are reflected in the following statements from Concourse: Report of the Committee on Educational Policy (Horowitz et al., 1972a):

> (the faculty) conceived the educational experience of Concourse as establishing the complementarity between two central modes of learning (the General Meetings and Working Groups), each significantly different from the regular MIT program ... in the General Meetings, the faculty would not be treated merely as an available consultive resource; in the Working Groups the students would not

be placed in a wholly passive relation to a pre-structured curriculum (p. 30).

> The chief innovation springs from the curriculum itself which emphasizes the relations among disciplines and differences between the scientific and humanistic approach to the same problem ... but it is important to point out that we have not perceived our task as one of universal and unintermittent synthesis. Much of our teaching follows the seperate strands of particular disciplines as they related to the central theme, and we have found it more useful to coordinate or interweave these strands than to attempt an obliteration of distinctions between them (p. 6).

The Concourse Program entered its second year with the faculty sharing a strong sense of where it had been, where it was going, and how to go about achieving its educational objectives. It should be noted that the objectives stated in the program's documentation suggest several additional implicit goals. Not by accident, these implicit goals coincide with the formally stated objectives of the pass/fail policy for freshmen.

Since 1968, all courses, even sophomore level subjects, taken by MIT students during their freshman year, have been graded on a pass/fail basis. The Freshman Handbook (1972) cites six objectives of this policy:

1) to promote more active, expressive, and independent intellectual attitudes

2) to reduce non-functional stresses such as anxieties about time, class rank, doing "A" work, etc.

3) to diminish competitiveness among students

4) to reduce the significance of grades and focus more strongly on real learning achievements

5) to improve communication between students and faculty through the use of more detailed and complex student evaluations

6) to make the evaluation system more responsive to students needs and learning styles.

These objectives seem to be widely shared by MIT faculty and students alike. It is, however, difficult to determine the extent to which the pass/fail policy has contributed toward the realization of these objectives. Other factors, such as class style and the availability of faculty to students, may exert a more critical influence on progress toward these objectives. The quantitative analysis presented later in this study explores the effects of such factors on some of the above objectives and compares the two programs on this basis.

A key observation pertaining to the pass/fail policy should be stressed here. The implementation of the policy, and the statement of the above objectives, stressed the fact that it was a generally accepted view in the MIT academic community that there were serious difficulties in the undergraduate educational environment, especially for freshmen.

A further indication of the pervasiveness of these issues relates to the freshman's average course load. In the past, freshmen usually took four or five courses (45-57 units) each semester. Since the pass/fail policy was instituted, many students have taken extra courses (sometimes as many as 8-10 courses) in an effort to "get the requirements out of the way" as quickly and easily as possible. This may be a symptom of a deficiency in the freshman year that was exacerbated, rather than alleviated, by the pass/fail policy.

The consensus of opinion among the members of the Concourse faculty was that the freshman pass/fail policy had not (and could not) entirely fulfill its promise and, further, that the Concourse Program could implement changes which would more directly address these issues. In particular, the Concourse faculty sought to work specifically to diminish competition and foster cooperation among students, to improve student-faculty communication, to make the evaluation system more responsive to the array of student needs and learning styles, and to promote more active, expressive, and independent intellectual attitudes.

3. Subject Matter. During the academic year 1972-73, the Concourse Progam offered course credit that fulfilled the Institute requirements for physics, calculus, chemistry, and freshman humanities. The specific subject matter contained in these core subjects is presented in Appendix IIIA, Institute Requirements. The program did not alter the content in the core subject matter. Rather, Concourse provided a context, an interdisciplinary organizing principle which could

serve to juxtapose the disciplinary concepts basic to the core courses. It was then the faculty's job to point out when and how these concepts form complementary perspectives for understanding a particular subject or problem.

The interdisciplinary theme for the fall semester was entitled "Sources and Contexts of Modern Scientific Thought," a study designed to explore the historical, social and cultural dimensions of science as an intellectual and practical activity. The scope of the theme ranged from the Seventeenth Century to the contemporary period. It began with the study of contributions by Galileo, Descartes, Newton, etc., in the fields of physics and calculus and expanded into the political, religious, and literary environments in which they worked. It was then possible to compare and contrast the past and present, "the Newtonian revolution and Einsteinian, the pyscho-political schematics of Hobbes and the current world-systems computer analysis of Forrester" (Horowitz et al., 1972b).

In contrast to the quasi-historical orientation of the first semester theme, the faculty selected a topically-oriented theme "Theories and Knowledge" for second semester. Three sub-topics were developed during the course of the semester: the wave-particle duality, details of population growth, and a broad-based study of Sophocles' Oedipus Rex. The behavior of light and electrons was studied from historical, physical, and philosophical perspectives and culminated in the application of quantum mechanical theory to explain physical observations. At the same time, the mathematical skills needed to manipulate the physical

concepts were being developed. These skills included the handling of harmonic oscillators, the wave equation for electromagnetic radiation, and the Schroedinger Equation. The section on population growth began with the intensive study of linear algebra and demographic transition matrices concurrent with the reading of several anthropological studies. The mathematical and anthropological view-points were then used to address questions such as whether there is a population crisis and how either or both perspectives might be applied to alleviate existing problems. The third subtopic involved the reading, analyzing and staging of the play Oedipus Rex. Issues raised during this section of the semester included ways of knowing and being, and methods for obtaining self-knowledge.

Core subject matter in physics, calculus, and the humanities seemed to fit naturally into the interdisciplinary themes chosen. Chemistry requirements, however, simply could not be integrated into the general thematic development. Core subject matter in chemistry was presented exclusively in the more disciplinary format of the Techniques of Disciplines classes (which will be further described below) rather than forced into an interdisciplinary mold into which it did not easily fit.

4. Class Style. The Concourse faculty built four educational formats into the program for the academic year, 1972-73. In the General Meetings several interdisciplinary themes were introduced and developed. The Techniques of Disciplines addressed specific disciplinary skill learning. In the Concourse Forum, a lecture series open to the whole MIT

community, guest speakers traced the history of the atomic bomb from World War II to the SALT talks. The fourth component of the program consisted of optional workshops and projects engaged in by groups of students and faculty in the program. This section will outline the class styles employed in each of the above aspects of the program. In addition, the mechanics of the grading procedure for the program and the philosophy underlying it will be described. A key fact that should be noted at this point is that the enrollment for the first semester of the academic year 1972-1973 was 48 students, up from 14 the previous year.

A broad array of class styles were tried during the General Meetings, including lectures, recitations, seminars, debates, and dramatizations. Class style was varied not only from day to day, but also during a single General Meeting. A typical General Meeting was divided into two, one-and-one-half hour segments, each presented in a different style and focusing on a different aspect of the interdisciplinary theme. The basic intention was to strive for the most effective links between particular topics and the students' learning styles.

Although traditional class styles were used in the General Meetings, the actual classes seemed qualitatively different from the usual for two reasons. The first reason was the presence of more than one faculty member at each General Meeting. The participation of additional faculty helped to shift the focus of active involvement from the faculty-in-charge to the students. This was especially true in recitations and seminars, class styles designed to, but not always successful in, fos-

tering two-way interaction between faculty and students. The extra faculty members were frequently able to supply an alternative disciplinary perspective in a class discussion. The second contributor to the qualitative differences in Concourse classes was the limited enrollment of the program and the fact that these students were taking the majority of their classes together. Lectures were never attended by more than 50 persons -- students and faculty were frequently able to address questions to the lecturer or add parenthetical information to the topic. Class discussions were often carried on in three or four groups consisting of from 10-15 students and a faculty monitor, thus affording students many opportunities to interact with the faculty and other students in the formal class setting. The fact that the Concourse students attended a majority of their classes together, also seemed to heighten the sense of friendship and comaraderie among them, which may have facilitated in-class communication between them and with the faculty during the General Meetings.

The Techniques of Disciplines, which met once a week for three hours, were more limited in scope than the General Meetings, and a narrower range of class styles were utilized in them as well. Techniques classes were usually divided into two one-and-one-half-hour segments, each with different disciplinary skill-learning objectives such as central field motion, partial differentiation, or prose writing. The class styles for Techniques were typically lectures, recitations or problem-solving sessions (in which home work or in-class quiz problems

were solved and explained). The advantages of small scale and student community were present in the Techniques as well as in the General Meetings, though participation by more than one faculty member was not a regular feature in these classes. The sequence of skills taught and the style of problems posed in the Techniques classes were coordinated with the development of topics in the General Meetings so as to provide the basic tools prerequisite for meaningful involvement in the interdisciplinary context. Occasionally, a whole day (10 A.M. to 5 P.M.) was set aside as a mini-concentrated study into a particular relevant skill or concept such as the derivative or second-order differential equations. On these days a sequence of lectures, problem-solving sessions, demonstrations and in-class quizzes would be offered, all based on the same skill or concept. Several faculty would participate in the various elements of concentrated study, each involved in a particular class style or application that used their specialization to best advantage.

Concourse Forums were an optional component of the program. They were weekly lectures by eminent scientists and adminstrators such as Jerome Wiesner, Philip Morrison, and Jerrold Zaccharias. The Forums were given in the traditional style of the lecture, followed by questions and answers, then refreshments and a chance to meet the speaker. The topics did not necessarily relate to those in the General Meetings. Rather the Forum was conceived as an opportunity for students to interact with subject matter and personalities beyond the scope of Concourse faculty yet available in the larger MIT community. (The Forum also served a

definite promotional function for the Concourse Program within MIT).

The last educational format sponsored by the program was optional workshops and projects, offshoots of the required Working Groups of the previous year. The workshops and projects involved individual students or small groups of students with faculty supervision. They spanned subjects ranging from advanced physics and computer programming to writing, photography, and yoga. Most groups met at least once a week for presentations or progress reports; individual students reported to faculty advisors on a regular basis. About half the students remained active in at least one workshop or project for the entire academic year.

A key element interacting with the various class styles is the grading system; the grading system for the Concourse Porgram is unique among core programs at MIT. It is intended to supply a mechanism that helps to integrate, where possible, the array of class styles and disciplinary emphases presented in the program. A formal statement of the grading policy is included in the "Letter to Prospective Concourse Students" (Horowitz et al., 1972b):

> Assignments are generated with the Techniques of Disciplines and the General Meetings, in the form of quizzes, problem sets, papers, and exams. Each assignment carries a certain number of points for stated Institute requirements. Assignments can be completed at any time after they have been made and will be graded pass/no credit. A student may resubmit an assignment on which he has received no credit. Passing an assignment will credit the

> student with the stated number of points. One hundred points are required for credit in each Institute Requirement subject. During the semester 150-200 points worth of assignments in each subject will be made (p. 3).

An important feature of the above policy is the student's option to resubmit assignments that originally receive no credit. Assignments were graded on a mastery level: 80-100 percent constituted a passing grade. Thus it was quite normal for students to have to resubmit assignments to bring them to a mastery level (about one-third of all assignments received no credit on first submission). This process provided a built-in feedback system which most students found very useful in quickly identifying and remedying difficulties in learning particular skills or concepts. However, some did not turn in a majority of their assignments until the last third of each semester, thus failing to take advantage of this aspect of the grading system. (The Concourse Program in subsequent years has remedied this situation by placing due dates on the initial submission of an assignment).

A final observation of the grading system involves assignments which offered points in more than one discipline. Where possible, the faculty generated assignments which would pose problems that combined aspects of mathematics and physics, or physics and the humanities, for example. Passing the assignment, such as an application-oriented problem set or history of science paper, then gave the student points in both core subjects involved in the assignment.

5. Faculty Interaction. A striking difference between the Concourse Program and the regular curriculum is that a high level of faculty interaction has been designed into the Concourse Program. Summer planning meetings, staff meetings, and the classroom provide structured situations that require interdepartmental and intradepartmental communication among the faculty.

Each summer the Concourse faculty meets approximately one morning per week for the purpose of planning the curriculum for the subsequent academic year. The process of choosing and developing an interdisciplinary theme necessitates a high degree of collaboration in order to interweave the abilities and preferences represented by the faculty. These meetings also serve the function of integrating new faculty members into the program while discovering how their capabilites complement those of the continuing staff. This function is particularly important since the program has averaged an annual turnover of 3 out of its 7-8 faculty.

The Concourse faculty meets once a week for an hour during the academic year. These meetings serve several purposes. One business function is to finalize an agenda of class styles and topics in the General Meetings and Techniques of Disciplines for the coming week. A second function of the weekly staff meeting is for the faculty to exchange information about difficulties any student(s) might be encountering and then decide what resources of the whole staff might be mobilized to help the student(s). Staff members may suggest to one another

the most appropriate source and type of aid, such as tutoring or special assignments. Staff meetings are also the setting in which faculty members critique each others techniques and effectiveness in the classroom. Such interactions seemed to foster increasing trust and interdependence among the faculty in the program.

The classroom also was frequently the scene of faculty interaction. All of the General Meetings and many of the Techniques of Disciplines were attended by more than one member of the staff. While multiple faculty participation was intentionally a part of specific discussions, spontaneous interaction often occurrred in lectures, recitations or demonstrations where faculty members (not in charge) offered supplementary or contradictory perspectives.

The quality of faculty interaction in the Concourse Program is perhaps best summarized by the faculty members themselves, in a statement jointly drafted by the staff after the first year of the program in Concourse: Report to the C.E.P (Horowitz et al., 1972a). The statement appears in Appendix IV.

Formalized faculty interaction and the expectations generated by planning for it, had a great positive effect on the Concourse faculty. Initial successes seemed to reinforce the group's affection for interdisciplinary collaboration, while initial difficulties tempered their enthusiasm with the knowledge of the high premium in energy and personal commitment needed to sustain such interaction.

6. Similarities and Differences of the Concourse Program and Regular Curriculum. Figure 1 provides a summary of the descriptive characteristics of each program as they are presented in Chapter I and Appendix III. Note that the Concourse Program offers a greater array of subject matter and class styles, but does so by adding to those characteristics basic to the regular curriculum rather than substituting for them.

Figure 1 Characteristics of the Concourse Program and Regular Curriculum for M.I.T. Freshman

Characteristic	Concourse	Regular Curriculum
Grading System	-Pass/fail -individual	Pass/fail -competitive (Humanities -individual)
Teaching Styles	-Co-operative -Individual	Individual
Class Styles	-Lecture -Recitation -Discussion Group -Seminar -Workshop -Problem solving session -Tutorial	Lecture Recitation
Subject Matter	•Disciplinary Core Subjects -Calculus -Physics -Chemistry -Humanities •Interdisciplinary Thematically Organized Topics and Issues	•Disciplinary Core Subjects -Calculus -Physics -Chemistry -Humanities
Student-Faculty Interaction	-Actively encouraged in interactive format	-Neutral
Student-Student Interaction	-Actively encouraged in interactive format & cooperative assignment	-Neutral

C. THEORETICAL BASES FOR INTERDISCIPLINARY EDUCATION

1. What is an Interdisciplinary Learning Situation? This section presents the rationale for the substance and structure of the Concourse Program. The central issues that are addressed include the arguments for thematic organization of the subject matter taught in the program and support for the particular mix of classroom situations utilized by the faculty.

Probably one of the chief reasons for developing an interdisciplinary program is to provide a model for the student, a model that may better indicate the kinds of situations the faculty feels the student will probably face in subsequent years. The assumption is that future scientists and engineers will be confronted with problems that can best be defined and solved from an interdisciplinary approach. This does not mean that the program seeks to graduate Renaissance men; discipinary specialization will still be necessary in order to master any particular area on the expanding sphere of knowledge. Rather, the emerging prerequisite is the ability to integrate diverse disciplinary persectives through collaboration among specialists from each of the disciplines which are relevant to the problems at hand.

The question is then: how and to what extent can thematically organized subject matter, in an educational environment, model real world interdisciplinary problems? Some definitional ground work must first be laid. Disciplines may be defined in terms of content. The

contents of a discipline are the specific attitudes, facts and skills that comprise it. Context refers to the environments in which disciplinary contents are encountered. Contexts may be disciplinary in nature. The traditional classroom, in which the contents of a single subject such as calculus or literature are taught, is a disciplinary context. Most real world work tasks created disciplinary contexts such as stress analyzing an aircraft wing (aeronautical engineering) or stress analyzing a building (architectural engineering). In both the educational and working context, as illustrated above, the problem (either to learn, or complete a work task) is defined in terms of the contents of a single discipline. An interdiscplinary context sets a problem that must be defined in terms of several disciplines. In the classroom, thematically organized subject matter can provide an interdisciplinary context. For example, a current issue (population control), a topic (the medical-industrial complex), or an historical period or event (the Industrial Revolution) may stand at the intersection of several disciplines. Similarly, certain work tasks, such as designing a jet engine in light of noise and air pollution standards or routing a highway while observing zoning and environmental constraints, require that the problem be defined in terms of the contents of several disciplines simultaneously. The final element of this scheme is the concept. The concept is the learning outcome in the classroom or the problem solution to the work task. A disciplinary concept is the learning outcome or solution to a problem defined in terms of a single discipline

and one to which the answer is forumulated in terms of the contents of a single discipline. Interdisciplinary concepts are then, learning outcomes or problem solutions arising out of a context defined by several disciplines and applying the contents of several disciplines in the formulation of each concept.

The interdisciplinary context and interdisciplinary concept find their roots in theories of Gestalt psychology. Wertheimer (1967), originally working in the perceptual domain, found that groups of objects exhibited properties of organization, pattern, or configuration which transcend the characteristics of the individual objects. The application of this Gestalt principle to describe learning and behavior was experimentally demonstrated by Kohler (1949, 1969) and Koffka (1935). Neurological phenomena, supporting Gestalt principles such as pattern recognition, were observed by Lashley (1960). The Gestalt theories describe concept formation as occurring when a cognitive jump or insight signals the discovery of organizational and structural relationships among formerly disparate elements. The interdisciplinary context is, then, the juxtaposition of formerly disparate, disciplinary elements. The interdisciplinary concept is the organizational or structural relationship recognized among the elements of the interdisciplinary context.

Both disciplinary and interdisciplinary concepts may be formed in an interdisciplinary context; the disciplinary context limits learning outcomes or problems solutions to disciplinary concepts. These assumptions permit the definition of three contextual conceptual system (see

Figure 2 Contextual-Conceptual Systems

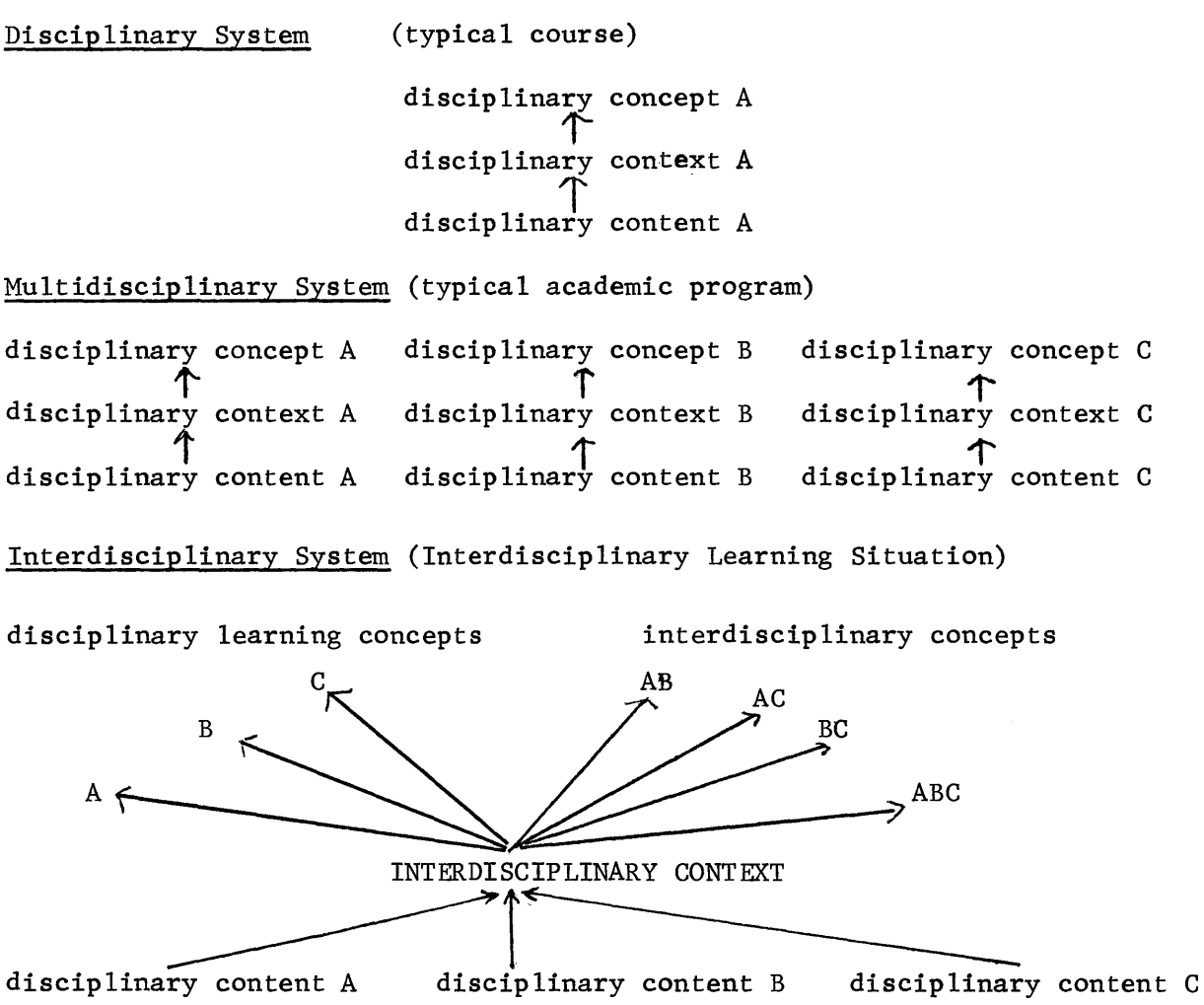


Figure 2) The disciplinary system models the normal academic course in calculus, physics, literature, etc. The multidisciplinary system represents the normal academic program. Several courses are taken simultaneously with no structured interaction between the disciplinary contents of each subject. Thus the learning outcomes are limited to disciplinary concepts only. In the interdisciplinary system, prepre-quisite disciplinary concept learning may be accompanied by interdisci-plinary concept learning as well.

Thematically organized subject matter and certain complex work problems are both examples of interdisciplinary contexts. Viable learning outcomes or solutions in these contexts are interdisciplinary concepts. The distinguishing characteristic of both academic and real world interdisciplinary systems is the necessity to include the elements or contents of more than one discipline in defining and solving pro-blems. Thus the interdisciplinary academic system is a structual analog for the interdisciplinary real-world system.

Schein (1972) describes two meanings of interdisciplinarity which correspond to multidisciplinary systems. These are: 1) an academic program in which several disciplines are studied, each in a separate course offered by a different school or department. 2) an academic program, within a school or department, in which several disciplines are studied concurrently, each still in a separate course. Schein's third meaning for inter-disciplinary education corresponds with that used here and by the Concourse faculty in putting together their program:

interdisciplinary education occurs when the subject matter of several disciplines is combined within a single course and when faculty from several disciplinary specialites collaborate in the planning and teaching of such courses.

Different types of learning situations, and different combinations of learning situations, may contribute to the learning of interdisciciplinary concepts. There are two critical factors in defining a learning situation. The first is whether the breadth and arrangement of subject matter constitutes an interdisciplinary or disciplinary context. The second factor is the class format or style, the kinds of interactions between students and faculty and between students and students, which are employed to facilitate concept formation. The distinction between disciplinary and interdisciplinary context has been outlined above. There are two classifications of class style that will be defined for the purpose of this discussion. The first is the individual class style. Traditional class formats, especially the lecture, place the learner in a passive role. Communication is essentially one way, a still prevalent manifestation of Herbartian apperception (Bigge, 1964). The second class style is interactive. The student and teacher exchange information; feedback is an important element in an interactive class style. Recitations, seminars and discussion groups are examples of interactive class styles. In addition, the interactive format may be designed to take advantage of communication between students. Problem-solving sessions, seminars and discussion groups can be structured to

encourage constructive interaction between students.

At this point, it should be apparent that the optimal interdisciplinary learning situation is one in which an interactive class style is used to present subject matter constituting an interdisciplinary context. The learning outcomes in this case include an improvement in interpersonal competence as well as the desired disciplinary and interdisciplinary concepts. Thus the interdisciplinary learning situation can prepare the student for the interdisciplinary working situation by providing a model for both interdisciplinary concept formation and interdisciplinary collaboration.

2. The Potential Results of Interdisciplinary Learning in the Students. The preceding discussion was based on certain assumptions about learning outcomes concerning cognitive structure, learning style, and interpersonal competence. In this section, these assumptions are outlined and evidence is presented to support their validity.

The first assumption is that learning outcomes may be systemized in a cognitive structure and that this structure is hierarchical. This enables one to conceive of interdisciplinary concepts as essentially more complex (or at a higher level) than disciplinary concepts, because they subsume disciplinary concepts. Harvey, et al. (1961) schematize learning according to the level of abstraction of the conceptual structure. Also in Piaget's (1947) scheme, learning is represented in ascending levels of groups of concepts or cognitive structures. Bruner (1960, 1966) structures "taught knowledge" as it proceeds from enactive, through

iconic, to symbolic conceptual structures. All of the above are variations of the cognitive-field theory view of learning: relationships between concepts are learned and combined to form generalizations on which still higher level concepts are built (Lewin, 1935; Deutsch, 1964). This is the theory on which the differentiation of disciplinary and interdisciplinary concepts is based.

The second general assumption about learning outcomes in the students focuses on the interrelationship among learning, creativity, and learning style. The first component of this assumption is that higher level learning outcomes (interdisciplinary concepts) are related to an increase in creativity. If creativity is related to associative ability, then the juxtaposition and synthesis of concepts and perspectives in the interdisciplinary learning situation should model and improve the creative process in the student (Mednick, 1962). The stress on an intuitive perceptual orientation in the interdisciplinary learning situation also fosters creativity (Machinnon, 1967). In addition, the motivational stimulus of the interactive (group) class style may favor creativity in the student (Abelson, 1967).

The other aspect of the above assumption is the role of learning styles. The interdisciplinary contextual-conceptual system should encourage a divergent learning style (as opposed to a convergent learning style) because it presents a multiplicity of disciplinary perspectives as well as placing the humanities on an equal footing with the sciences (Hudson, 1966). According to Kolb's (1971) learning style

scheme, also, the reflective and concrete emphasis of the interdisciplinary learning situation should favor the divergent learning style in the student. Both divergent learning style and increased creativity should characterize the student who has participated in the interdisciplinary learning situation.

The last major assumption of the interdisciplinary learning theory concerns interpersonal competence. Just as important as the ability to formulate interdisciplinary concepts is the ability to interact constructively around these concepts with professionals from disciplines other than one's own. There is a wealth of evidence confirming the fact that interprofessional collaboration has recently been quite unusual. Zaleznik et al. (1970) point out that professionals tend to focus on the individual nature of their work, minimizing contact with associates. Super (1957) asserts that the professional has achieved a stable career pattern and is concerned with establishment or maintainance functions which weigh against the role-innovativeness prerequisite to interdisciplinary collaboration.

The interdisciplinary learning situation supplies a strong antidote to professional isolation by emphasizing interactive class styles. Class styles utilizing group interaction among students and between students and faculty have several advantages. The ambiguity inherent in the start-up of such groups opens new communication channels in order to clarify norms for the new situations (Festinger, 1954). Deutsch (1960) finds that participants in cooperative group situations (as compared to

competitive situations) exhibit greater coordination of effort, attentiveness to fellow members, mutual comprehension, friendliness, and a higher degree of shared attitudes -- all manifestations of interpersonal competence. General improvement of interpersonal competence is motivated by needs for belongingness and self-actualization which are best fulfilled in group situations (Maslow, 1954; Rogers, 1961).

In summary, the above discussion supports the following assumptions:

1) Given the hierarchical nature of cognitive structure, the interdisciplinary learning situation is an optimal stimulant for interdisciplinary concept learning.

2) Higher creativity and a divergent learning style are characteristic outcomes of the interdisciplinary learning situation.

3) Participation in interdisciplinary learning situations helps to improve interpersonal competence.

CHAPTER II

METHODOLOGICAL APPROACH

The first section of this chapter will discuss some of the issues involved in the selection of an evaluative strategy for investigating the Concourse Program. The second section will review the primary sources of data on the Concourse Program and regular curriculum at MIT. The remainder of the chapter will describe the structure of the statistical aspect of this study including the experimental design, the analytical techniques that will be applied to the quantitative data, and the hypotheses which the data will test.

A. How is an Educational Innovation Evaluated?

The evaluative strategy I have adopted for this study, and in general for my interaction with the Concourse Program, perhaps lies closest in intent to "illuminative" evaluation as described by Parlett and Hamilton (1972). Illuminative evaluation is an attempt to integrate the rigorous demands of classical research design with educational evaluation for the purpose of decision-making. The research strategy and methods are defined by the problem, not the reverse. In the case of the Concourse Program, this has meant a two-fold approach. Observational and interview data have been focused on the issue of comprehensively describing the program in the context of an innovation in the undergraduate curriculum at MIT. Quantitative data will be presented in order to test hypotheses which grow out of the theoretical rationalization for interdisciplinary learning situations presented in Chapter I.

The issue of whether the problem defines the methodology, rather than the reverse, is particularly relevant to this study in terms of both the descriptive and quantitative analyses. My relationship to the Concourse Program as a participant was well established before my role as an evaluator emerged (see the next section, Data Sources). Also, the statistical instruments were assembled and administered before this study was conceived in its entirety, resulting in a during-after design, rather than the preferred before-during-after design (see Experimental Design later in this chapter).

Another important issue which is addressed uniquely in illuminative evaluation is that of subjective bias. It is my intent to deal with it as openly as possible and take advantage of it whenever possible: the fact that my participation in Concourse predates my role as evaluator has provided me with a source of insights and interpretations that would normally be unavailable to an evaluator initially entering the situation as an "outsider." I have found it more constructive to defend and exploit this subjectivity than to cover it up.

The evaluative criteria of this study center on the participants. These criteria include behavior in the students and faculty and attitudes and attitude changes in the students. Both the descriptive and quantitative aspects of this study assess these evaluative criteria in terms of the explicitly stated goals of the program, a strategy most favored by Van Maanen (1973). Thus the resultant conclusions will focus on the primary evaluative issues including the success of the program in

fulfilling its operational mandates and contributing to desirable learning outcomes in its students and faculty. Before concluding this section it should again be emphasized that the nature of my involvement with the Concourse Program may indeed be a biasing influence on my observations. I believe that this potential problem is more than amply compensated by the greater depth of information and insight available to me because of my role in the program. In addition, the quantitative analysis in this study has been structured so as to corroborate many of the conclusions initially based on my observations.

B. DATA SOURCES

In this section, the various sources of available information about the Concourse Program and regular curriculum are described. The data sources are differentiated by their specific types and are placed in a time frame spanning the entire period of the study. The observational and archival sources served as the basis of the description of the Concourse Program in Chapter I; these sources will again be drawn upon to augment the discussion of the quantitative data in subsequent sections.

1. Observation -- Participation and Interviews. Extensive observational data on the Concourse Program was available through my direct involvement with the program from the time of its conception. Throughout the four year period this study encompasses, I was a staff member of the program with responsibility for tutoring and faculty group coordination. During the last two years, my role has expanded to include program evaluation. Thus, I was a participant in all of the planning meetings (during the summers) and regular staff meetings (during the academic year). I observed and/or participated in a majority of the class sessions as well. Data from these experiences exists in the form of notes taken at the time and, of course, later recollections and impressions. In addition, continuing dialogues between other Concourse staff members and myself have provided me with insights into their perspectives on past experiences we shared in the program.

In the course of daily interaction with the Concourse faculty, I was able to learn about each staff member's academic and career back-

ground prior to joining the program. We also discussed how and why each faculty member became involved in the program and where the program fit into their plans for career development. Such discussions were often a more or less formal, shared aspect of the yearly planning meetings. Other important issues raised in these sessions were the attitudes each staff member's home department held concerning their particpation in the Concourse Program and the effect that participation in the program had on their departmentally-based research.

My interaction with students in the Concourse Program took several forms. I often met with them in tutorial situations. In addition, I served in an informal capacity as advisor to several students each semester during which they were enrolled in the program. I also interviewed a majority of the students at three points in time: at the ends of the first and second semesters of their freshman year (in the program) and at the end of their sophomore year (in the regular curriculum). The interviews focused primarily on subjects including the student's individual progress in the academic program, their general impressions of the class style, instruction, and subject matter, their criticisms and suggestions, and their future academic and career goals.

My direct contact with the regular curriculum during this study was limited. I did draw on my own experience as an undergraduate at MIT during the four years prior to the study. I also queried the Concourse staff about courses they were teaching in the regular curriculum at the same time they were participating in the Concourse Program. The regular

curriculum for freshmen had not changed significantly in terms of class style and subject matter since I was an undergraduate.

Concourse students who took regular curriculum courses in addition to the Concourse Program were a good source of information. I also obtained second-hand observational impressions from regular curriculum students and faculty and from members of the Freshman Advisory Council and Committee on Educational Policy. There is, in addition, an extensive literature about the regular curriculum, though for the most part I drew my descriptive data from a single primary source, the Freshman Handbook, which will be discussed in the following section.

2. Archives. There are several written sources of data available on both the Concourse Program and the regular curriculum for freshman. These documents are all primarily descriptive in intent and do not contain quantitative data or analysis.

The primary sources for the regular curriculum for MIT freshman is the Freshman Handbook (Freshman Advisory Council, 1972, 1973) assembled each year by the Freshman Advisory Council. The Freshman Handbook contains a description of the core course requirements and the various options the student has in fulfilling them. The Handbook also contains detailed descriptions of the subject matter and class style of each course option, supplied by the instructor of each course. (Capsule descriptions of alternative freshman programs, including the Concourse Program, are also contained in the Handbook). In addition, there are discussions of the grading or evaluation policy in each course option

and the rationalization for the homework and testing strategy in each course as well. The Handbooks for the academic years 1972-73 and 1973-74 are used in this study.

There are a number of sources that focus exclusively on the Concourse Program. The majority of these sources were generated collaboratively by the staff of the Concourse Program.

The Making of a Clock (Horowitz, et al, 1970) written in the fall of 1970, describes and analyzes the process by which the Concourse faculty was assembled. It follows the faculty as they became a close-working team formed around the design of and execution of the group project.

A Proposal for a New Mode of Undergraduate Education for the First Two Years At MIT (Horowitz et al., 1971) written during the spring of 1971, outlines the faculty group's proposal for the structure of the first year of the Concourse Program. It includes tentative interdisciplinary themes, class formats, teaching styles and methods for evaluating both the students and the program as a whole. Also contained in the proposal is a description of the faculty group's planning process including the running of a collaboratively taught seminar the previous fall semester (1970) as a testing ground for the full scale Concourse Program.

Concourse: Report to the Committee on Educational Policy, (Horowitz et al., 1972a) was completed in the Spring of 1972. It encompasses the first year of full scale operation of the Concourse Program. It provides

two kinds of information about the program. First, the report contains a subjective, descriptive self-evaluation by the Concourse faculty. The effectiveness of the interdisciplinary theme and the various class formats and the quality of the interaction among the faculty group are all discussed. Second, the report contains the weekly class schedules ("agenda") containing daily class discussion topics and, also, a representative sample of the actual problem sets and reading assignments used during the first year of the Concouse Program.

A "Letter to Prospective Concourse Students," (Horowitz et al, 1972b), a promotional document composed by the staff each year, is the source of detailed information about the theme, class style, and grading structure of the Concourse Program. The initial "letter" was written in December, 1972 and contains a detailed description of the Concourse Program for the academic year 1972-73, the year on which this study is based.

Interdisciplinary Collaboration in the University: An Exploratory Study (Demb, 1973) is the lone paper about the program written by a non-Concourse researcher. Completed in the Spring of 1973, it is an analysis of the quality of interrelationships among the Concourse faculty during the focal year of this study and a compilation of their career paths to that point in time. It is based on interviews with the Concourse faculty which Ms. Ada Demb conducted during April 1973.

3. Statistics. The statistical evidence was gathered exclusively from the Concourse and regular curriculum students who were freshmen

during the academic year 1972-73. This was the second year of full-scale operation of the Concourse Program.

Questionnaires. A Questionnaire (Questionnaire I) was mailed to the Concourse and regular curriculum students of the class of 1976 between the first and second semester of their freshman year (February, 1973). A second questionnaire (Questionnaire II) a modified version of Questionnaire I, was administered at the end of these same students' sophomore year (May, 1974).

The data presented in this study is based on the replies of 23 Concourse students and 190 regular curriculum students who responded to both Questionnaires I and II. Figure 3 summarizes how the test subjects were derived from the total population of Concourse and regular curriculum students initially sent Questionnaire I. The fact that the response rates to Questionnaires I and II are essentially the same seems to support the assumption that there was no persistent selection bias and that the decision to respond was a random process.

Questionnaire I (see Appendix A) contains two sections. The first section consists of questions with response choices along a seven-point scale between opposed answers to each question. The questions explore three different issues of interest to this study. One group of questions investigates program variables, measures of characteristics of the academic program (Concourse or regular curriculum) in which the student was enrolled. Program variables include such measures as the quality of instruction, the amount of integration of technical and

humanistic perspective, the availability of faculty feedback, etc. The program variables were included with the intent of establishing the differences between the two programs as percieved by the students of each program. The program variables also serve as potential correlates of an attitude change.

Another type of question investigates various attitude measures. Attitudes which the Concourse Program would be expected to enhance were probed. These include for example, the attitude toward the importance of the humanities in a technical education, the dedesirability of integrating disciplines, and the desirability of studying current issues and topics in science. These and other attitude measures establish one basis for comparing the Concourse and regular curriculum students both during and after their freshman year. In addition the attitude measures are an important element of the test of whether the Concourse Program met its stated objectives.

Figure 3 Response Rates to Questionnaire

	number of questionnaires sent	number of responses	%response rate
Questionnaire I			
regular curriculum	948	419	45%
Concourse	48	33	69%
Questionnaire II			
regular curriculum	419	190*, **	45%
Concourse	33	23*	70%

*The responses of these students to both questionnaires form the basis for all subsequent statistics in this study.
**The matched group of regular curriculum students was drawn from this group.

The third area investigated focuses on behavioral measures. Again, students were asked to self-report on behaviors that would possibly distinguish between their participation in the two programs. Behaviors which were which were measured include how often students studied with their peers, how often they sought help from the faculty, and how they balanced their study time between technical and humanistic subjects. Behavioral measures are potential correlates of both program variables and attitude measures. In addition they are another means of testing the extent to which the Concourse Program met its objectives.

Questionnaire I also elicits data concerning the prospective discipline the student would designate as a major and the type of career he or she would pursue. This information forms another basis for comparing students of the two programs as well as providing a baseline against which changes in career preference, possibly attributable to the programs, may be measured.

Questionnaire I also contains a second section, the Learning Style Inventory, which is discussed below.

Questionnaire II (see Appendix II) contains questions pertaining to all of the areas which Questionnaire I covered; these questions are repeated in the identical format. In addition, Questionnaire II delves into the areas of satisfaction (with M.I.T. in general), the quality of the students' interaction with each other, and the subject matter of the sophomore year. The questionnaire was given only to those students who had responded to Questionnaire I. Those students who then responded to both questionnaires form the statistical basis for this study. Question-

naire II was administered at the end of these students sophomore year (May 1974), after the Concourse students had spent a year in the regular curriculum following their freshman year in the Concourse Program. Questionnaire II provides a means for looking at longitudinal effects of the Concourse Program as well as post-test comparisons between the two programs. Thus, the Learning Style Inventory appears in Questionnaire II as well as in Questionnaire I. In addition, Questionnaire II alone contains the Remote Associates Test. Both instruments are described below.

Learning Style Inventory. The Learning Style Inventory (LSI) is the second section of Questionnaires I and II (see Appendices I and II). Kolb (1971) provides a detailed analysis of the theoretical basis and design considerations for the LSI. A brief summarization of that analysis is offered here. The LSI consists of nine items. In each item the student rank orders four words according to how well each word describes his or her learning style relative to the other words in the item. One word in each item corresponds to each of four learning modes -- Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation. A score for each learning mode is generated by summing the ranking of six of the nine words corresponding to each mode. Two additional scores are then derived: an Abstract/Concrete score is the difference resulting when the Concrete Experience score is subtracted from the Abstract Conceptualization score, an Active/Reflective score is the difference resulting when the Reflective Observation score

Figure 4a The Experiential Learning Model
(Kolb, 1971, p.2)

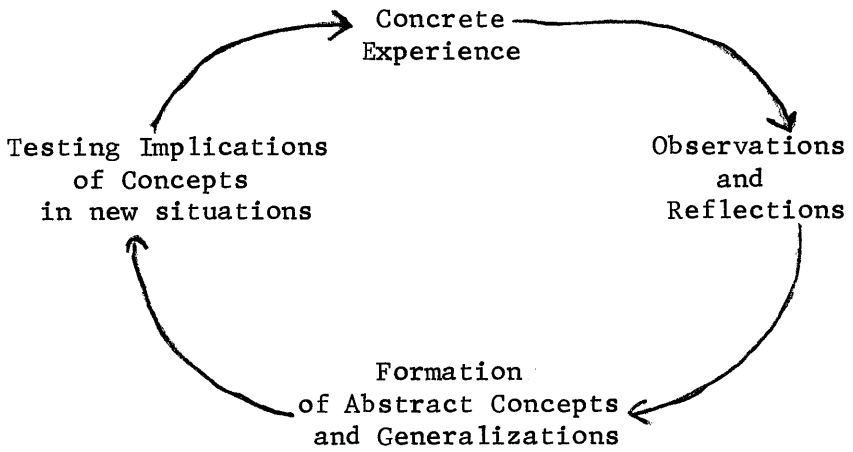
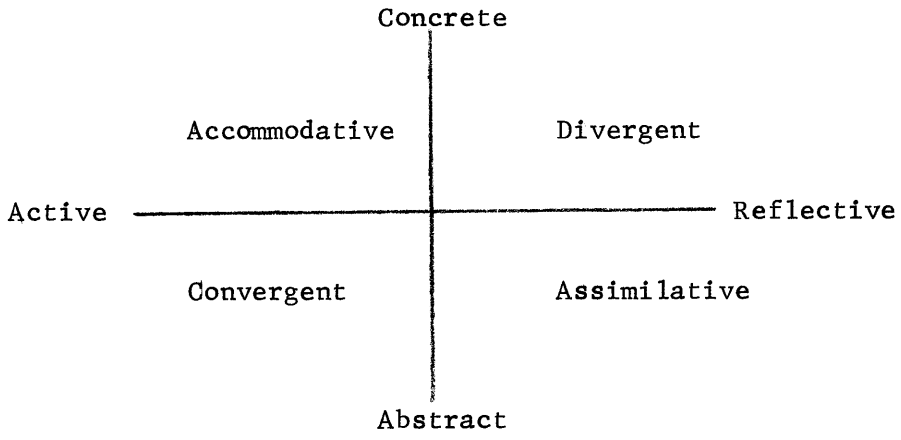


Figure 4b The Derivation of Learning Styles
(Kolb, 1971, p.11)



is subtracted from the Active Experimentation score (Kolb, 1971).

The four learning modes correspond to the four stages in a cyclical representation of learning, the Experiential Learning Model. In the model, concrete experience is observed and reflected on; these observations are processed into abstractons and generalizations; abstract concepts form the basis of implications that are tested in new situations, thereby generating new concrete experience (see Figure 4a).

The abstract/concrete and active/reflective scores represent two dimensions of the learning process. Learning style is identified by determining the dominant modes in the individual's learning processes; the positions of these modes on a plane defined by the two dimensions of the learning process determines the learning style. The quadrants formed by the combination of these two dimensions represent the following learning styles: accommodative (active and concrete); divergent (concrete and reflective); assimilative (reflective and abstract); divergent (concrete and reflective); assimilative (reflective and abstract) and convergent (abstract and active). The relationships between dimensions of the learning process and learning styles are shown in Figure 4b.

The LSI thus provides a useful tool for defining the learning styles of students in both programs. The initial learning style scores are an important point of comparison between students that would participate in the Concourse Program and those in the regular curriculum. The second LSI scores then allow comparison of the longitudinal effects

of each program on the students. The LSI scores are, then, potential indicators of: 1) a tendency to be attracted to interdisciplinary learning situations (or situations perceived as such, and 2) an interdisciplinary (vs. a disciplinary) learning style resulting from participation in an interdisciplinary learning environment. Learning style may also be a correlate of the attitudes, behaviors and/or program variables investigated by the questionnaires.

Remote Associates Test. The Remote Associates Test (RAT) was designed as a measure of creative thinking ability (Mednick and Mednick, 1966). From the test manual: "it (the RAT) is an instrument designed to measure individual differences in an ability considered to be fundamental to the creative thinking process." The RAT was the third section on Questionnaire II only; the students were not given the RAT on Questionnaire I. The RAT normally contains thirty items. Because of time and space limitations due to the inclusion of the RAT on Questionnaire II, only the first fifteen items of the RAT were administered. Each item contains three mutually associated words. The subject must supply a fourth word which provides a specific associative linkage between it and the first three words. The test score is equal to the number of correct responses.

The RAT is based on the premise that the creative thinking process is identical with the ability to form associations between initially remote conceptual elements. The creative associative act is contingent on the presentation of formerly distant elements in juxtaposition. Thus

the RAT may measure the extent of an analogous process: the juxtaposition of disciplinary concepts in an interdisciplinary learning environment such as the Concourse Program. Unfortunately, the RAT was not included in Questionnaire I; thus, there is no baseline data for the freshman year of subjects in this study. However, the Concourse and regular curriculum student's scores on the RAT at the end of the sophomore year may be compared to various measures, such as the LSI and CUM, included on Questionnaire II.

Other Statistics. Two other relevant statistics about the Concourse and regular curriculum students were available. The first is the Scholastic Aptitude Test (SAT), Math and Verbal scores. These tests were generally administered during the student's junior or senior year in high school. The SAT data was made available by M.I.T. Admissions Office. However, the data was supplied only in aggregate form (due to issues of confidentiality) so that no correlational analysis was possible, only comparisons.

The Cumulative Grade Average (CUM) for each student at the end of his or her sophmore year was made available by the M.I.T. Registrar. Because all freshman courses are graded pass/fail the CUM reflects academic performance for the sophomore year exclusively. CUM is thus an interesting factor in the post-test comparison of former Concourse and regular curriculum students.

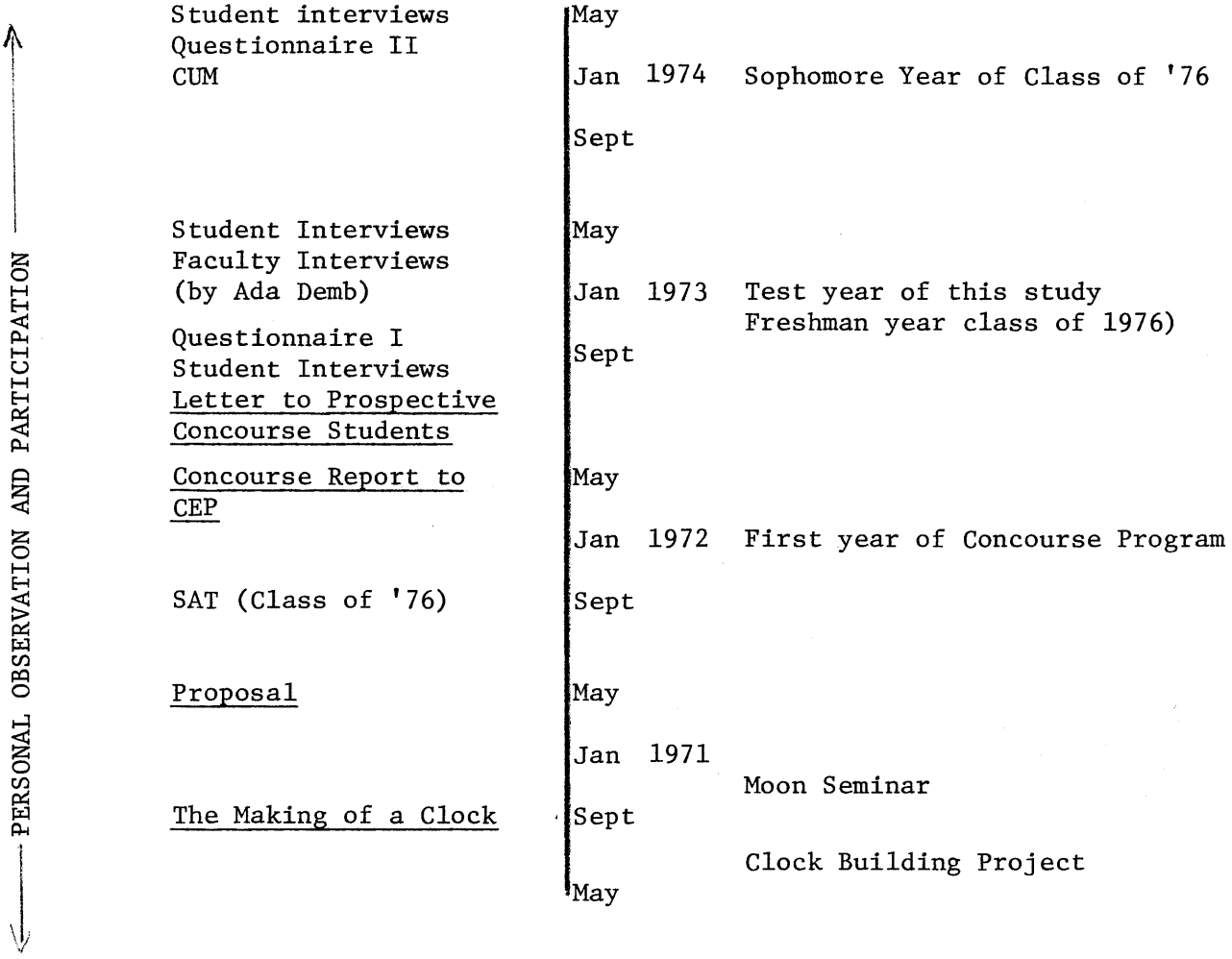
4. Timeframe for Data Acquisition. Figure 5 summarizes the various data collected for this study and the chronological sequence of its acquisition. Observational data was gathered during the course of the entire study, from May, 1970 through May, 1974. The primary subjects of this study, the Concourse and regular curriculum students of the class of 1976, were followed during the period from September, 1972 through May, 1974, their freshman and sophomore years. The Concourse students participated in the Concourse Program only during their freshman year, September, 1972 through May, 1973. Both groups of students participated in the regular curriculum during their sophomore year, from September 1973 through May, 1974.

Formal interviews with the Concourse students were conducted at three points in time: 1) after first semester, freshman year (February, 1973); 2) after freshman year (May, 1973); 3) after sophomore year (May, 1974). Interviews with the Concourse faculty conducted by Ada Demb took place during April, 1973.

Documentation of the Concourse Program covers the following time spans: from May, 1970 through August 1970 -- The Making of a Clock; from September, 1970 through March, 1971 -- Proposal; from May 1971 through March, 1972 -- Report to the C.E.P. Documentation of the regular curriculum is contained in the Freshman Handbook's for the academic year 1972-73 and 1973-74.

The questionnaires were administered at two points in time. Questionnaire I, with the LSI as a second section, was given after the

Figure 5 Timeframe for Data Acquisition



students' first semester, freshman year (February, 1973). Questionnaire II, with the LSI as a second section and the RAT as a third section, was given after the students' sophomore year (May 1974). Both Concourse and regular curriculum students took Questionnaires I and II at the same times.

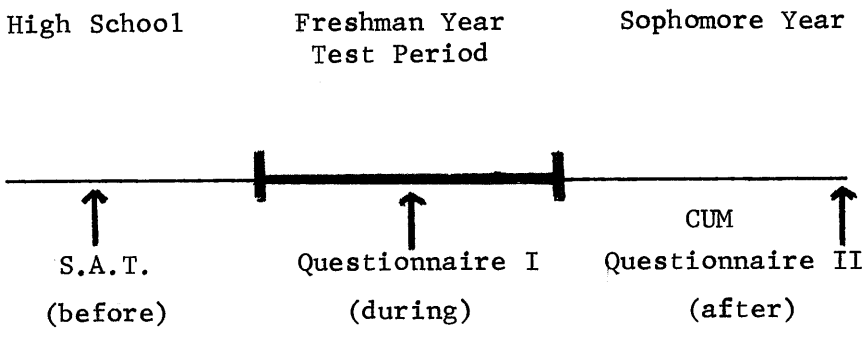
The SAT Math and Verbal tests were taken by the students during their junior and senior years in high school, September, 1970 through January, 1972. The student's CUM was calculated at the end of their sophomore year at M.I.T. (May, 1974). The SAT and CUM data were gathered at the same times for both the Concourse and regular curriculum students.

C. EXPERIMENTAL DESIGN

The statistical aspect of this study will employ an experimental design that might be designated as a "during-after" design. The test period was the academic year 1972-73, the freshman year of the class of 1976 at M.I.T. Questionnaire I, the initial data source, was administered between the first and second semester of that year, during the freshman year of the student subjects. Questionnaire II was administered at the end of the same student's sophomore year, one year after the test period. The Concourse students, the experimental group, were in the Concourse Program for their freshman year only (they self-selected the program during Orientation Week of the freshman year). They entered the regular curriculum their sophomore year. The control group, regular curriculum students, and a matched (to the Concourse students) subset of these students, participated in the regular curriculum for both their freshman and sophmore years. The basic experimental design is diagrammed in Figure 6. Again, note that the SAT's provide some "before" data.

Questionnaires I and II contain three primary types of meaures -- attitude measures, learning styles and behavior measures. Questionnaire I also contains items measuring academic program characteristics. The program characteristics serve to establish the similarities and difference of the Concourse Program and regular curriculum. They are, in a sense, the independent variables of the experiment. The attitude measures, learning styles, behavior measures (and CUM and Remote Associates Test at the end of the sophomore year only) are the dependent variables.

Figure 6 Experimental Design



Discovering changes in these dependent variables and, where possible, attributing them to the program characteristics, is the objective of the quantitative section of this study.

D. ANALYTICAL TECHNIQUES

In this section the analytical techniques employed to elucidate the data are outlined in terms of the data types to which they will be applied and the kinds of hypotheses they will test.

The evaluative strategy of this study is to approach the subject from two methodological perspectives, a simultaneously descriptive and statistical approach. The complexities inherent to a comprehensive description of the Concourse Program require a constellation of data sources and analytical techniques in order to yield a coherent, total picture. The statistical data enables causal issues to be examined. The central concern is then the process of coordinating and interweaving the various data and analyses. The hypotheses serve as the primary foci for organizing the data and analyses. However, the testing of the hypotheses augmented by some purely descriptive observations in order to complete a well rounded account of the Concourse Program.

Statistical data was obtained from regular curriculum students as well as Concourse students, for the purpose of establishing a basis for comparison betwen the two programs. The bulk of observational and archival data, however, pertains to only the Concourse Program.

1. Matched Group Selection. A matched group of students was selected from the control group of regular curriculum students. The criteria used to choose a match for each Concourse student were the responses to the attitude masures on Questionnaire I. The rationale for selecting a matched group on the basis of initial attitudes was as

follows: it would then be possible to eliminate selection bias (Concourse Program students are self-selected) as a potential explanation for subsequent differences, especially attitudinal, between Concourse and regular curriculum students. The regular curriculum students matched on this basis would initially have a similar array of attitude-value systems to those of the Concourse students after their first semester at M.I.T.

Given the above matching assumption, stronger conclusions may be made based on differential effects of the two programs which may be found in the results of Questionnaire II. It may be possible to discover whether differences between students in the two programs (after sophomore year) are due to initial attitudinal disparities rather than effects of the programs. Alternatively, it may be shown that students with the same initial attitude structure react differently to the two programs.

The matching selections were determined by the comparison of responses to seven attitude measures on Questionnaire I. A regular curriculum student was a match if his or her answers to each of the seven questions were within plus or minus one of the Concourse student's responses. If more than one regular curriculum student was matched to a Concourse student by this process, final selection was based on the matching of the students' choice of prospective departmental major and career type (on Questionnaire I).

The seven questions used to pick the matched pairs are listed in Figure 8 in Chapter III. It should be noted that the questions number

I-4, I-5, I-10, and I-16 are constructed so as to elicit a response relative to the perceived level of a particular activity in the students' program. These questions do not therefore, form the basis for a matching of absolute attitude strength; rather, they match an attitude relative to the experience of the program. In a sense these questions are a measure of agreement or satisfaction with the style of the program in which the student is enrolled. By matching based on both absolute and program-relative attitudes an effort is made to take into account the possibility that student's responses to certain attitude measures will be consistently skewed by the students' identification with publicized objectives of the program in which they are enrolled.

2. Comparisons. There are three groups of students that will be compared: the Concourse students, regular curriculum students and the matched group. Simple comparisons between the Concourse students and the other two groups will be performed on data gathered at three points in time. The first comparison is the SAT Math and Verbal score data, baseline data. The second is the data contained in Questionnaire I, which is also baseline data. The third time of comparison is Questionnaire II, which is follow-up data. The CUM data is also included in the follow-up or post-test comparison.

Simple comparisons betwen Concourse and regular curriculum data are made with the t-test meauring the difference of means. It is assumed that both populations are normal and the samples are independent. The matched pairs of the Concourse and matched groups are not however,

independent samples. Dependent samples are more appropriately compared by testing the hypothesis that the mean of the pair-by-pair differences is zero, a comparison of dependent or correlated means (Blalock, 1972).

Sample comparisons on the SAT and Questionnaire I data form the basis for determining initial similarities or differences between the Concourse and regular students. Comparisons of the CUM and Questionnaire II data form the basis for determining differences between Concourse and regular students possibly influenced by the differences in the programs or differences in the students attacted to each program. Simple comparisons of the program variables on Questionnaire I may confirm and highlight actual differences in the two programs as seen by the respective students.

In addition to the simple comparisons outlined above, longitutinal comparison provides a tool for analyzing the direction and extent of changes in the students from mid-freshman year to the end of sophomore year. Longitudinal comparisons are made under the same constraints as matched pair comparisons: the two samples are dependent. Thus the test for correlated means is used. Of course, longitudinal comparisons may only be made on questions or tests that appear in identical format on both Questionnaire I and II.

E. HYPOTHESES

The previous sections on methodology have described the kinds of questions that may be appropriately addressed by each type of data. The hypotheses offered in this section predict the findings on three issues which the quantitative data was designed to clarify: 1) What are the initial behavioral and attudinal similarities and differences between the Concourse and regular curriculum students? 2) What are the operational differences between the Concourse Program and the regular curriculum? 3) What are the attitudinal and behavioral differences between the Concourse and regular students after participating in their respective programs? The hypotheses presented below are grouped according to these issues.

Initial Condition Hypotheses

Hypothesis I: The Concourse and regular curriculum students will initially have no differences on the following attitudinal measures:

1) relevance of the humanities
2) preference for subject integration
3) preference for issue orientation of classes
4) amount of emphasis on the humanities
5) amount of structure in the academic program.

Hypothesis II: The Concourse students will initially score higher than the regular curriculum students on the following behavioral measures:

1) frequency of interaction with faculty for feedback and academic assistance

2) frequency of interaction with students for collaboration on studying.

Program Characteristic Hypothesis

Hypothesis III: Students will rate the Concourse Program higher than the regular curriculum on program variables pertaining to

1) the quality of instruction

2) orientation toward contemporary issues

3) the amount of integration of disciplines

4) the availability of the faculty.

Post-Test Hypotheses

Hypothesis IV: After the sophomore year the Concourse students will rate themselves higher than the regular curriculum students on the following attitudinal and behavioral measures:

1) attitude toward the relevance of the humanities

2) preference for subject integration

3) preference for issue orientation of classes

4) amount of interaction with faculty

5) amount of interaction with students

6) cooperation with other students

7) (lower) competition with other students

Hypothesis V: After the sophomore year the Concourse students will score higher than the regular curriculum students on a measure of creativity, the Remote Associates Test.

Hypothesis VI: After the sophomore year the Concourse and regular curriculum students will be be significantly different in academic performance as measured by CUM.

Hypothesis VII: After sophomore year the Concourse students will be divergent relative to the regular curriculum students as measured by the Learning Style Inventory.

The hypotheses in each of the above groupings will be restated at the beginning of the corresponding chapters in which the quantitative data is presented.

CHAPTER III

Initial Measures of the Students

The intent of this chapter is to present data which establishes the initial conditions, the similarities and differences between the Concourse and regular curriculum students at the mid-point of their freshman year. In addition, this data provides a reference against which subsequent measures of change, possibly attributable to charcteristics of the programs, can be determined. There are three primary data categories: attitude measures, learning styles, and behavioral measures. (The students were also measured in each of these categories subsequent to the test period) The balance of this chapter contains three sections. The first is a restatement of the Initial Condition Hypotheses. The second section presents the quantitative data which will constitute the summary test of these hypotheses. The final section contains a discussion of the data and the conclusions that may be drawn from it.

A. INITIAL CONDITION HYPOTHESES

Hypothesis I: The Concourse and regular curriculum students initially will have no differences on the following attitudinal measures:

1) relevance of the humanities
2) preference for subject integration
3) preference for issue orientation of classes
4) amount of emphasis on the humanities
5) amount of structure in the academic program

Hypothesis II: The Concourse students will initially score higher than the regular curriculum students on the following behavioral measures:

1) frequency of interaction with faculty for feedback and academic assistance

2) frequency of interaction with students for collaboration on studying.

Figure 7 Scholastic Aptitude Scores

(standard deviations in parentheses)

	Concourse	Matched Group	Regular Curriculum
	N=23	N=23	N=190
SAT Math	735 (51)*	763 (41)	739 (50)*
SAT Verbal	665 (86)	674 (69)	661 (70)

*Significantly different from matched group
$p < 0.1$ two tailed test

Figure 8 Initial Attitude Measures

(standard deviation in parenthes

ımber on ɔnnaire I	Question	Concourse N=23		Matched Group N=23		Regula Curric N=190
	In your academic program, would you like more or less emphasis on humanistic subjects? less 1 ---- 7 more	4.48	(1.50)	4.48	(1.35)	4.24
	In your academic program would you like more or less emphasis on technical subjects? less 1 ---- 7 more	4.17	(1.55)	4.17	(0.64)	4.23
	How important are humanistics subjects as a part of career preparation in a technical field? not important 1 -- 4 very important	2.61	(0.92)	2.57	(0.77)	2.69
	Would you like more separation or integration of technical and humanistic subjects? more separation 1 ---- 7 more integration	5.13	(1.30)	4.96	(0.91)	4.96
	... would you like to discuss contemporary issues more or less often then you are discussing them presently? less often 1 ---- 7 more often	5.22	(1.06)	5.09	(1.10)	4.94
	Do you prefer your academic program structured or unstructured? unstructured 1 ---- 7 structured	3.87	(1.54)	4.13	(1.36)	4.23
	Do you prefer your work load to be self-paced or externally paced? self paced 1 ---- 7 externally paced	3.09	(1.36)*	2.87	(1.12)*	3.79

*Significantly different from regula
ulum $p < 0.05$ two-tailed test

Figure 9 Initial Behavioral Measures

(standard deviation in parentheses)

Item Number on Questionnaire I	Question	Concourse N=23		Matched Group N=23		Regular Curriculum N=190	
(Learning Balance) I-6	How have you distributed your learning effort between humanistic and technical subjects? mostly humanistic 1 ---- 7 mostly technical	4.96	(1.43)	5.57	(0.77)**	5.46	(1.12)**
(Student faculty contact) I-19	How often do you speak with your faculty instructors outside of class? very seldom 1 ---- 7 very often	5.35	(1.60)	2.91	(1.35)**	2.73	(1.74)**
I-25	How often do you discuss reading assignments with your faculty instructor? very seldom 1 ---- 7 very often	3.78	(1.67)	2.78	(1.35)**	2.77	(1.48)**
I-27	How often do you seek help from faculty instructors on homework probems? very seldom 1 ---- 7 very often	3.74	(1.70)	2.35	(1.24)**	2.68	(1.50)**
I-32	How often do you discuss course content with your faculty instructors? very seldom 1 ---- 7 very often	4.09	(1.86)	2.70	(1.37)**	2.82	(1.43)**
I-33	How often do you discuss class style with you faculty instructors? very seldom 1 ---- 7 very often	3.74	(1.65)	2.52	(1.41)**	2.42	(1.44)**

CONTINUED ON NEXT PAGE

Figure 9 Initial Behavioral Measures (continued)

(standard deviation in parentheses)

Item Number on Questionnaire I	Question	Concourse N=23		Matched Group N=23		Regular Curriculum N=190	
(Student-Student Contact)							
I-24	How often do you discuss reading assignments with classmates? very seldom 1 ---- 7 very often	3.96	(1.78)	3.65	(1.71)	3.99	(1.74)
I-26	How often do you work together with classmates on homework problems? very seldom 1 ---- 7 very often	4.57	(1.84)	3.91	(2.08)*	4.05	(1.86)

Note: Significantly different from Concourse response * $p < 0.2$ two-tailed test
** $p < 0.05$ two-tailed test

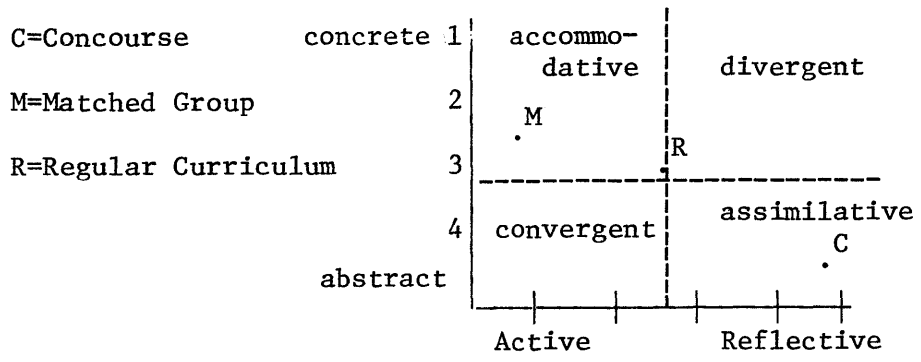
Figure 10a Initial Learning Style Inventory

(Standard deviation in parentheses)

Dimension	Concourse N=23	Matched Group N=23	Regular Curriculum N=190
abstract-concrete:	4.52 (5.28)	2.83 (6.98)	3.17 (6.27)
active-passive:	-2.48 (6.20)	2.78 (6.61)*	0.94 (5.94)*

*Significantly different from Concourse response
p < .05 two tailed test

Figure 10b The Initial LSI Plotted



B. QUANTITATIVE DATA

The one source of statistical data retrievable prior to the student's freshman year was the results of the Scholastic Aptitude Test (S.A.T.) taken during their senior year in high school. The scores are shown in Figure 7.

1. Attitude Measures. The responses to the initial attitude measures on Questionnaire I are summarized on Figure 8. Their use in determining a matched group was described in the earlier section, Matched Group Selection. On all of these measures, there were no significant differences between the Concourse and matched group scores, thus confirming the effectiveness of the matching procedure. In fact, the matched group scores are extremely close, and in some cases identical, to the Concourse scores. The general trend that emerged from this data is the fact that the regular curriculum scores are not significantly different from the Concourse initial attitude measures, with one exception -- the preference for self-paced versus externally-paced work load.

For all three groups, their respective attitudes toward the emphasis on humanistic and technical subjects (I-4 and I-5) are essentially neutral (midway on the response scale). This would seem to indicate that each group was content with the balance of humanistics-technical emphasis in their respective programs.

All three groups gave neutral responses indicating their attitude toward the importance of studying the humanities in preparation for a

technical career (I-8) and their preference for structure in their program (I-29). However, they all expressed a positive preference toward integrating their humanistic and technical subjects (I-10) and increasing the amount of discussion of contemporary issues in their programs (I-16). The only item on which the three groups did not respond identically is the preference for self-paced versus externally-paced work load (I-30). The Concourse and matched groups leaned toward self-pacing as a preferred style, while the regular curriculum students' response was neutral.

2. Behavior Measures. There are several self-reporting behavior measures on Questionnaire I, the results of which are summarized in Figure 10. Question I-6 shows a small (yet statistically signifcant) difference in the distribution of learning effort between technical and humanistic subjects. Concourse students initially spent proportionately more effort on the humanities than either the matched group or regular curriculum students. However, students in all three groups reported that they spent a majority of their effort on technical subjects.

Questions I-19, I-25, I-27, I-32 and I-33 pertain to the amounts and types of student-faculty contact beyond the formal class setting. On all five questions the Concourse students' scores were significantly higher than those of the matched group and regular curriculum students. Also, on all five questions, the matched group and regular curriculum student's scores were very close to one another, as well as being at the extreme low end of the response scales. The Concourse students' scores

on the frequency of discussion with faculty members about class style or content were in the moderate range; the matched group and regular curriculum students' respones at the extreme low end of the scale.

Interaction among students is measured by Questions I-24 and I-26. The responses of all three groups to both questions fell in the midrange of the response scale, indicating a generally moderate level of interaction among students for the purpose of discussing readings or collaborating on homework problems. There was a small but statistically significant difference in the amount that Concourse students worked with fellow students on homework problems as compared to the other two groups; the Concourse students worked together more often.

3. Learning Styles. The Learning Style Inventory scores on Questionnaire I are reported on Figure 9. The Concourse students were more abstract (though not at a statistically significant level) than the regular curriculum and matched group students on the LSI abstract-concrete dimension (see Figure 10a). The Concourse students scored much more reflective (statistically significant) than the other groups on the LSI active-reflective dimension.

The initial reflective orientation of the Concourse students relative to the other groups, coupled with the initial abstract orientation of the Concourse students relative to the other groups, indicates a substantial difference in the learning styles of the groups. The net result is that the Concourse students were initially assimilative in comparison to the other groups. Figure 10b, shows the relative positions

of the three programs on the two dimensions defined by the LSI. Note that the scores of the regular curriculum students are used to specify any origin around which the four learning style orientations are arranged. The matched group scores are located in a slightly accommodative direction relative to those of the regular curriculum students, though neither the abstract-concrete nor active-reflective scores of these two groups were significantly different from one another.

C. DISCUSSIONS AND CONCLUSIONS

One premise the Concourse Program has been built upon is that the students it attracts are typical of the freshman class as a whole. That is, Concourse students initially have the same range of attitudes and aptitudes as their regular curriculum counterparts. The two data sources available to test this assumption were the SAT scores and attitude measuring items on Questionnaire I.

The SAT scores indicate that there were no practical differences between the Concourse and regular curriculum students in terms of Mathematical or Verbal Aptitude at the time they applied to M.I.T. A persistent worry of the Concourse staff has always been that, because Concourse is an experimental program, it will be viewed by prospective students as an easy alternative to satisfying the Institute Requirements in the regular curriculum. The SAT results should allay that anxiety somewhat. My conversations with students also supported the assumptions that the program is as easy or difficult as the regular curriculum and that its students enter the program as well prepared as those not in the program. Concourse students perceived that the program was equally as demanding as the regular curriculum based on their comparisons of textbooks, problem sets, and quizzes. Regular curriculum students however, <u>did</u> to some extent view the program as easier than their standard courses. The source of these opinions is not clear; perhaps they originated with faculty advisors or upperclassmen. They did not seem to come from current or former Concourse students. It is certainly a question that

would merit further investigation.

The attitude measuring items on Questionnaire I provide the data for testing Hypothesis I. As anticipated, the Concourse students had the same response profile as the regular curriculum students (the matched group was selected on the basis of these responses). The assumption supported by this data is that the selection process for freshmen entering the Concourse Program did not favor a particular attitude profile in the student. My interviews with Concourse and regular curriculum students have tended to confirm this finding. Both Concourse and regular curriculum students, at the end of the first semester of their freshman year, reported that they were satisfied with the amount of emphasis their programs placed on humanistic and technical courses respectively. Students in both programs did seem to feel a need for more integration and cohesion among the core disciplines and many felt that the study of contemporary issues in science was a good way to pursue this goal.

On an absolute scale, students in both programs seemed unenthusiastic about the relevance of studying the humanities as part of preparing for a technical career. What did seem to distinguish Concourse students from the others was their specific preference for the particular theme studied in the program that semester. Thus it seems reasonable to conclude that the selection process for the Concourse Program did not discriminate between students with any specific attitudinal biases (towards the humanities or structured curricula) or aptitudinal discrepancies; the most important factor in the Concourse students'

self-selection of the program seemed to be their attraction to the specific interdisciplinary theme.

While the Concourse and regular curriculum students may not have differed significantly in their initial attitudes and aptitudes, there were dramatic differences in their self-reported behaviors. One difference was the distribution of learning effort between humanistic and technical subjects. The Concourse students spent proportionately more time and energy on the humanistic component of their program than the matched group and regular curriculum students spent on theirs. However, the responses of all three groups indicated that a majority of their effort was allotted to their technical subjects. This general trend was a reflection of the balance between humanistic and technical courses specified in the core requirements -- completion of the Freshman Institute Requirements demands that the student take three technical courses for every one humanities course. The additional emphasis Concourse students gave to their study of the humanities might be attributed to a number of factors. One might be that the humanities constituted a larger fraction of the subject matter presented in the Concourse Program. Another might be that the humanistic component of the Concourse Program was more attractive to Concourse students than the standard humanities courses were to regular curriculum students.

The most striking initial behavioral difference may be found in the results of items which test Hypothesis II. Hypothesis II predicted that Concourse students would interact with both faculty and students more

frequently than would regular curriculum students. All of the responses on Questionnaire I pertaining to student-faculty interaction supported that prediction. Concourse students often met with their instructors outside of the classroom in order to receive feedback, offer criticism, discuss readings, or obtain help on homework problems. In contrast, the regular students seldom met with their instructors outside of the classroom. The data did not indicate such large differences in the frequency of interaction between students and their peers. The response showed that the Concourse students worked together with their classmates on homework problems slightly more often than the matched groups or regular curriculum students.

My interview with the students of both programs strongly confirmed the statistical evidence. Concourse students identified the frequency of contact with members of the faculty as perhaps the single most positive aspect of their involvement in the program. It should be noted that social intercourse between students and faculty was strongly supported by the Concourse Program, as a means to complement and extend the opportunities for interaction around academic issues. The program sponsored weekly dinner-seminars and two weekend outings (one each semester). The primary effect of these events was to create, and perpetuate, a sense of community and an identification with the Concourse Program that included former Concourse students (from the previous year) as well as the current faculty members and students. This process was facilitated by the availability of a commons room for use exclusively by members of

the Concourse Program. The students often studied there, and the commons room (which includes kitchen facilities and a fireplace) was also the scene for the weekly dinner-seminars as well as the workshops and problem solving sessions that comprised the informal component of the academic program.

Many Concourse students reported that the extensive interpersonal relations and sense of community fostered by the program greatly aided their initial acclimation to M.I.T., in some cases surpassing the role of their living group in this process. Regular curriculum students told me that interactions within their living groups dominated the acclimation process for them and that their limited interactions with members of the faculty (during the first semester at M.I.T.) were rarely influential in that respect.

Taken together, the self-reporting data and my interviews with students support the conclusion there was a significant quantitative and qualitative difference in the relationship of Concourse and regular curriculum students to their respective instructors and fellow students. The Concourse Program played a larger, more active role than the regular curriculum, in acclimating its students both academically and socially during their first semester at M.I.T. Concourse students interacted with members of faculty more frequently and for a greater variety of purposes than regular curriculum students.

The balance of this section will discuss the initial measure of learning style. No hypothesis was offered predicting the initial results

of the Learning Style Inventory, because I was aware of no previous work which might support a reasonable predicion for learning style in an entering M.I.T. freshman. I did assume that, as was the case with attitudinal and aptitudinal measures, there would be no significant differences between the initial learning style (whatever it might be) of Concourse students and students in the regular curriculum. The initial LSI results, however, did show a significant difference between students of the two programs at the end of their first semester at M.I.T. The Concourse students were more abstract and more reflective than the regular curriculum (and matched group) students. Using the regular curriculum students' scores as a reference point, the Concourse students then had an assimilative learning style relative to other M.I.T. freshmen (or conversely, the other M.I.T. freshmen were more accommodative than the Concourse students). The above result implies that the Concourse students were initially more oriented toward inductive learning (as opposed to enactive learning) than the regular curriculum students. My early conversations with students in both programs did not touch upon issues which might lend support to this finding; at the time I was not looking for such a distinction in learning style. These results suggest two alternative possibilities: 1) the initial difference in learning style may be due to a self-selection bias for Concourse students or 2) the first semester in the program may have a rapid, pervasive effect on the student's learning style (I assumed a more gradual, persistent effect - see Hypothesis VII). In either case, the greater ability of the

student to assimilate disparate observations into integrated explanations would not run counter to the possible selection bias or short-term learning outcomes that would be consistent with an interdisciplinary learning situation.

Another interpretation of the initial differences in learning style concerns the ability of the LSI to distinguish between career orientations in students. Previous studies using the LSI (Kolb and Goldman 1973) have shown that students majoring in engineering at M.I.T. tend to have more active and convergent, or accommodative, learning styles, in contrast to science majors, who tend toward more reflective, inductive learning styles. Similar differences between practicing engineers and scientists have also been found (Kolb 1971). Thus, the initial difference in the learning styles of the Concourse and regular curriculum students may have resulted because the theme and style of the Concourse Program attracted students more likely to enter the School of Science than the School of Engineering. In fact, on Questionnaire I, about twice as many Concourse students indicated that their major would be in science as opposed to engineering; the initial preferences of the regular curriculum students were divided equally between science and engineering departments.

The above results indicate that initial attitudes and learning style may be factors in student's self-selection processes, including both the decision to join an interdisciplinary program, such as Concourse, and the choice of departmental affiliation.

Chapter IV

Program Characteristics

Statistical descriptions of the Concourse Program and the regular curriculum are presented in this chapter. These are based on the students' responses to items on Questionnaire I focusing on the quality of instruction, the subject matter, class style, and the availability of student-faculty interaction. The responses to the items measuring program characteristics are the independent variables of the study; the students' measures are the dependent variables. The central task is to identify changes in the students' measures possibly caused by the program characteristics. The responses to the program-characterizing items are summarized on Figure 11; the items are grouped according to their investigative focus. The hypothesis this data will test is restated below. The quantitative data testing this hypothesis, and the dis-cussion and conclusions based on the data are presented immediately following the hypothesis.

A. PROGRAM CHARACTERISTIC HYPOTHESIS

Hypothesis III: Students will rate the Concourse Program higher than the regular curriculum on the program variables pertaining to: 1) the quality of instruction 2) orientation toward contemporary issues 3) the amount of integration of disciplines 4) the availability of the faculty.

Figure 11 Program Characteristics

(standard deviation in parentheses)

Item Number on Questionnaire I	Question	Concourse N=23		Matched Group N=23		Regular Curriculum N=190	
(Instructor quality) I-11	...rate the quality of instruction in technical subjects? poor quality 1 ---- 7 high quality	5.22	(1.47)	5.52	(1.60)	5.51	(1.25)
I-12	...rate the quality of instruction in humanisitc subjects? poor quality 1 ---- 7 high quality	5.57	(0.97)	9.04	(1.30)*	4.19	(1.61)*
(Subject matter) I-13	How often are contemporary topics in science ... studied in your academic program? very seldom 1 ---- 7 very often	3.39	(1.18)	2.70	(1.12)*	3.04	(1.63)
(Class style) I-15	How often are contemporary issues in science raised in your academic program? very seldom 1 ---- 7 very often	4.22	(1.86)	2.57	(1.50)*	2.40	(1.42)*
I-9	How much has your academic program separated or intergrated technical and humanistic subjects? very much separated 1 ---- 7 very much integrated	5.35	(1.60)	3.00	(1.35)*	2.59	(1.56)*
(Student-faculty interaction) I-17	How easy or difficult is it for you to obtain feedback about your progress from your faculty insturctors? very difficult 1 ---- 7 very easy	6.09	(1.32)	4.09	(1.47)*	4.13	(1.66)*

CONTINUED ON NEXT PAGE

Figure 11 Program Characteristics (continued)

(standard deviation in parentheses)

Item Number on Questionnaire I	Question	Concourse N=23		Matched Group N=23		Regular Curriculum N=190	
I-18	How easy or difficult is it for you to contact your faculty instructors outside of class? very difficult 1 ---- 7 very easy	6.04	(0.81)	4.52	(1.06)*	4.16	(1.42)*
I-31	...How easy is it for you to give comments (feedback) concerning class style, content, etc. to your faculty instructors? very difficult 1 ---- 7 very easy	5.52	(1.86)	4.04	(1.55)	4.12	(1.56)*

*Significantly different from Concourse response $p < 0,1$ two-tailed test

B. QUANTITATIVE DATA

1. Instructor Quality. Questionnaire I contains two items that ask the students to rate the quality of instruction in their humanities and technical courses, respectively. At the time of response, the students had just completed their first semester at M.I.T. A majority of the students had taken at least one humanities course and three core science courses (calculus, physics and chemistry or biology).

Items I-II and I-12 on Figure 11 show how the three groups of students rate their instructors. There was no significant difference between any of the groups in their rating of the quality of technical instruction. All three groups gave their technical instructors ratings at the high end of the response scale. However there are statistically significant differences in the ratings of humanities instructors. The Concourse students rated their humanities instruction higher than both the matched group and regular curriculum students. In fact, the Concourse students' score is at the extreme upper end of the response scale, while the matched group and regular curriculum students' responses are in the midrange of the scale. Note that there was no significant difference between the matched group and regular curriculum students' ratings of their humanities instruction.

2. Subject Matter. Only one item on Questionnaire I deals directly with the subject content of the programs. Question I-13 on Figure 11 shows the results of asking the students how often contemporary topics

in science are studied in their academic program. The Concourse students reported that they studied contemporary topics slightly more often than the other groups, though all three groups' responses were below the midrange of the response scale.

3. Class Style. Class styles in the Concourse Program and the regular curriculum have previously been discussed in terms of my own observations and the documents generated by the programs themselves. Two items on Questionnaire I ask the students for their own reaction to the courses they had just completed. The responses to these questions are found in items I-15 and I-9 on Figure 11.

Item I-15 shows how often contemporary issues in science were discussed in each program. The results show that such issue-oriented discussion was a moderately frequent occurence in Concourse classes. Both the matched group and regular curriculum students experienced significantly less issue-oriented discussion than the Concourse students. The matched group and regular curri-culum responses were about the same, and both at the low end of the response scale.

The students' impression of the amount of general integration between technical and humanistic subjects is measure by item I-9. The Concourse students rated their program very high on this question. In addition, their response was very much different from those of the matched group and regular curriculum students, which were at the opposite, and lower, end of the response scale. It should also be noted that the matched group and regular curriculum scores were close to one another in

comparison to their distance from the Concourse measure.

4. Student-faculty Interaction. The results in this section are measures of the availability of faculty to students in each of the academic programs. Items I-17, I-18, and I-31 on Figure 11 show how the students responded to measures of the ease or difficulty of contacting faculty for various purposes. Item I-17 asks how easy or difficult it is for students to obtain feedback about their own progress in a course from their instructors. The Concourse students gave their instructors an extremely high rating on this measure. The matched group and regular curriculum students' responses were significantly lower: both groups rated the ease of obtaining feedback from instructors in the midrange of the response scale. The responses to item I-31, rating the easy of giving feedback to instuctors on class style and subject matter, followed the same pattern. The Concourse students responded at the high end of the scale. The matched groups and regular curriculum students again responded significantly lower, in the midrange of the scale and very close to one another. Item I-18 asks the students to rate the ease or difficulty of contacting faculty outside of the classroom for any purpose. Again, the Concourse students rated their instructors extremely high on this measure and significantly higher than the matched group and regular program students rated their instructors. The matched group and regular curriculum responses were quite close to one another, and in the midrange of the response scale.

C. DISCUSSION AND CONCLUSIONS

The data presented in this chapter includes the responses to questions designed to emphasize differences in the characteristics of the Concourse Program and regular curriculum as perceived by the students in each program. The characteristics tested represent factors which the Concourse faculty explicitly intended to differentiate their program from the regular curri-culum.

The first factor addressed by Hypothesis III concerns the students' ratings of the quality of instruction in each program. The Concourse, matched group, and regular curriculum students gave their instructors of technical subjects uniformly high ratings. My own observations tend to support that finding. The quality of instruction in technical courses at M.I.T. is generally quite high, and members of the Concourse faculty gave special priority to at least matching this high standard for the technical subject matter in the core curriculum. The Concourse faculty usually assigned the same technical texts, and many of the same homework problems, as were used in the regular curriculum. The objective was to make the calculus, physics, and chemistry skills taught in the program compatible with the subject matter in the standard courses, at least to be extent that Concourse students would no be deficient in these skills in comparison to regular curriculum students when they entered departmental programs during their sophomore year. This issue was at times a subject of debate and compromise among members of the Concourse faculty, especially when time limitations would seem to force a choice between

providing additional rigor in the presentation of technical skills versus exploring in greater depth the ramifications of the current interdisciplinary theme.

The humanities instructors of the two programs were not rated equally by their students. The Concourse students gave their humanities instructors a very high rating, while the matched group and regular curriculum students gave theirs a neutral score. Many students I spoke with seemed to consider the fulfillment of their humanities requirements a "necessary evil", and whether or not it was meritted, this attitude seemed to be accompanied, in many students, by an expectation of mediocre instruction in their humanities courses. While many Concourse students seemed to share this attitude with their regular curriculum counterparts, their expectations for the humanities in Concourse tended to be higher because of the explicitly stated intent of the program to present the humanities as a meaningful component of an integrated technical education. In addition, the Concourse staff members <u>did</u> take special pains to elevate the role of humanities in the program relative to the technical disciplines.

There is some difficulty in drawing conclusions about the actual quality of instruction in the two programs based on the students' ratings of instructor quality. The low validity of these ratings is to some degree compensated for by my own observations, conversations with students and faculty, and personal experience as an undergraduate. Concourse faculty members did seem more strongly committed to teaching freshmen

than is usual among the M.I.T. faculty. The effect of this factor would not be observable in comparisons with the also very high ratings of technical instruction in the regular curriculum. Thus the students' ratings of technical instruction could not reflect any possible differences in the actual quality of instruction. However, the neutral rating of humanities instruction by the regular cur-riculum students did provide a basis for comparison with the Concourse students' higher rating of their own instructors in the humanities. This difference might be attributed to the Concourse students higher expectations and/or an actual difference in the quality of humanities instruction related to the seemingly higher commitment to teaching which characterized members of the Concourse faculty.

Based on the above findings and discussion it is relatively safe to conclude that the quality of technical instruction was probably equal in the two programs. The conclusion that the humanities instruction was of higher quality in the Concourse Program than in the regular curriculum must be qualified by the lack of both a more objective measure and a control for differences in the expectations of the students.

The actual subject matter presented in the Concourse Program and regular curriculum has been well documented by the faculty members involved in each program and summarized in Chapter I and Appendix III. To a large extent the subject matter of both programs was constrained by the Institute Requirements. I had expected that the Concourse students would, however, report that they studied contemporary topics in science more often than regular curriculum students because the thematic aspect

of the program did at times focus on contemporary topics. The data, in fact, did not indicate a large difference between the two programs, possibly reflecting the fact that the first semester theme placed much more stress on the great men, and the technical and humanistic perspectives, of the Seventeenth Century than their contemporary counterparts.

While the study of contemporary subject matter did not dominate the first semester of the Concourse Program, the interrelationship of classical topics and contemporary issues did receive primary attention. The Concourse faculty members considered the discussion of contemporary issues to be an important mechanism for achieving subject integration. Thus, as expected, the data shows that Concourse students participated in discussions of contemporary issues more often in their program than other students did in the regular curriculum.

The confirmation of the diference in specific class style between the two programs is further supported by the results pertaining to the amount of general integration of disciplines reported by the students. This measure yielded the largest difference in a characteristic of the programs. Concourse students reported that their program integrated the disciplines to a large degree; the students in the regular curriclum felt that their program very much separated the disciplines. The Concourse students' sense of the integration of disciplines came from several sources including issued-oriented discussion, as described above, or other stylistic variations such as thematically organized class presentations and collaborative teaching by the multidepartmental

faculty of the program. My own experiences with the two programs strongly confirm the above results. In the majority of General Meetings (in the Concourse Program) that I attended or helped plan, an explicit effort was made to integrate technical and humanistic perspectives in either of two ways: 1) the selection of an interdisciplinary topic in which several disciplinary perspectives would converge during the course of its presentation, 2) the deliberate planning and participation in discussions specifically intended to compare and contrast the technical and humanistic perspective pertaining to a particular issue, topic, historical period, etc. On the other hand, students' descriptions and my own experience of core courses in the regular curriculum were, for the most part, devoid of instances in which attempts were made to integrate technical and humanisitc subjects. In fact, there often seemed to be a lack of coordination in the development of technical subject matter. For example, chemistry and physics courses often had to include lessons in various prerequisite calculus skills because the concurrently offered calculus course had not yet reached the corresponding stage in its own curriculum.

The above discussion indicates that the second and third specifications of Hypothesis III, which concern the orientation of the programs toward contemporary issues and the amount of subject integration, are strongly supported. It may be reasonably concluded that the Concourse Program, in fact, was characterized by more discussion of contemporary issues and, in general, a greater amount of integration of the

disciplines.

The last program characteristic investigated was the availability of the faculty members to their students. The consistent pattern revealed in the data shows that the Concourse students found it very easy contact their instructors, for any purpose, while students in the regular curriculum found it significantly more difficult to reach their own instructors. As stated earlier, the Concourse students considered this fact to be one of the program's most important advantages over the regular curriculum. The exceptional opportunities for student-faculty interaction within the program was a factor explicitly stressed in the literature and interviews comprising the selection process for Concourse students. In addition, during the first semester, faculty members actively encouraged contact with the students, both on an individual basis and in the groups that participated in the informal activities of the program. Students in the regular curriculum were not discouraged from interacting with their instructors beyond the necessary formal class situation, but they reported that they were rarely encouraged either. The active involvement of the Concourse faculty members, combined with the heightened expectations for student-faculty interaction fostered in their students, assured that the Concourse students would perceive, and take advantage of, the greater opportunities to extend their relationships with the faculty beyond the classroom.

In summary all aspects of Hypothesis III were strongly confirmed by the data and supported by my observations. It may be concluded that the

Concourse Program was significantly different from the regular curriculum in the following ways:

1) The quality of instruction in the humanities, as perceived by the students, was higher in the Concourse Program while the quality of technical instruction was perceived as equal in the two programs.

2) Contemporary issues were discussed more often in the Concourse Program.

3) The disciplines were integrated to a greater degree in the Concourse Program.

4) Members of the Concourse faculty were more available to Concourse students than regular curriculum faculty members were to their students.

Chapter V

Subseqent Measures of the Students

This chapter presents data collected at the end of the students' sophomore year. At that time the Concourse students had completed a full year in the regular curriculum away from their experience in the Concourse Program. As in the two preceding chapters, the hypotheses predicting the outcomes of the subsequent measures are restated first, then the actual data is presented. The discussion and conclusions based on the data and corroborating observations complete the chapter.

A. POST-TEST HYPOTHESES

Hypothesis IV - After the sophomore year the Concourse students will rate themselves higher than the regular curriculum students on the following attitudinal and behavioral measures: 1) attitude toward the relevance of the humanities, 2) preference for subject integration, 3) preference for issue orientation of classes, 4) amount of interaction with faculty, 5) amount of interaction with students 6) cooperation with other students 7) (lower) competition with other students.

Hypothesis V - After the sophomore year the Concourse students will score higher than the regular curriculum students on a measure of creativity, the Remote Associates Test.

Hypothesis VI - After the sophomore year the Concourse and regular curriculum students will not be significantly different in academic

performance as measured by CUM.

Hypothesis VII - After sophomore year the Concourse students will be divergent relative the regular curriculum students as measured by the Learning Style Inventory.

Figure 12 Longitudinal Attitude Measure: The Importance of the Humanities in Technical Education

Item Number On: Questionnaire I	Item Number On: Questionnaire II	Question		(Standard deviation in parenthesis) Initial Response	Subsequent Response
I-8	II-8	How important are humanities subjects as a part of career preparation in a technical field? (Not important/ very important)	Concourse N=23	2.62 (.92)	2.91 (.93)*
			Matched Group N=23	2.57 (.77)	2.52 (.93)**
			Regular Curriculum N=190	2.69 (.86)	2.68 (.99)**

* Significantly different from initial response $P < .2$ two tailed test

** Significantly different from Concourse score $P < .2$ two tailed test

Figure 13 Post-test Attitudes

Item Number on Questionnaire II	Question	Concourse N=23	Match Group N=23	Regular Curriculum N=190
II-10	To what extent do you like technical and humanistic subjects combined in your academic program? (Completely separated or completely integrated?)	5.17 (1.49)	4.00 (1.91)*	3.82 (1.61)*
II-11	How much do you like to study the interaction of science & society? (very little, very much)	5.26 (1.72)	4.39 (1.97)*	4.41 (1.76)*

*Significantly different from Concourse score $P < .1$ two-tailed test

Figure 14 Longitudinal Behavioral Measures

Item number on Questionnaire		Question		(standard deviation in parentheses) Initial Response	Subsequent Responses
I-6	II-5	How have you distributed your learning efforts between humanistic and technical subjects humanisitic 1 ---- 7 technical	Concourse	4.96 (1.43)	4.22 (1.56)*
			Matched Group	5.57 (0.77)**	4.83 (1.20)*,**
			Regular Curriculum	5.46 (1.12)**	5.12 (1.13)*,**
I-19	II-2	How often do you speak with your faculty instructors outside of class? very seldom 1 ---- 7 very often	Concourse	4.48 (1.38)	3.52 (2.06)*
			Matched Group	2.91 (1.35)**	3.04 (1.73)
			Regular Curriculum	2.73 (1.54)**	3.07 (1.72)
I-26	II-3	How often do you work together with classmates on homework problems? very seldom 1 ---- 7 very often	Concourse	4.57 (1.84)	3.30 (1.71)*
			Matched Group	3.91 (2.08)**	3.26 (1.75)*
			Regular Curriculum	4.05 (1.86)**	3.63 (1.96)*

*Significantly different from initial response
$p < 0.1$ two-tailed test

**Significantly different from Concourse responses
$p < 0.1$ two-tailed test

Figure 15a Longitudinal Responses to the LSI

(standard deviation in parentheses)

Abstract-Concrete Score

	Initial	Subsequent
Concourse	4.52 (5.28)	1.39 (5.56)**
Matched Group	2.83 (6.98)	2.78 (5.80)
Regular Curriculum	3.17 (6.27)	2.90 (5.66)

Active-Reflective Score

	Initial	Subsequent
Concourse	-2.48 (6.20)	-0.39 (7.20)**
Matched Group	2.78 (6.61)*	1.78 (5.89)
Regular Curriculum	0.94 (5.94)	1.61 (8.90)

*Significantly different from Concourse Score $p < 0.01$ two tailed test

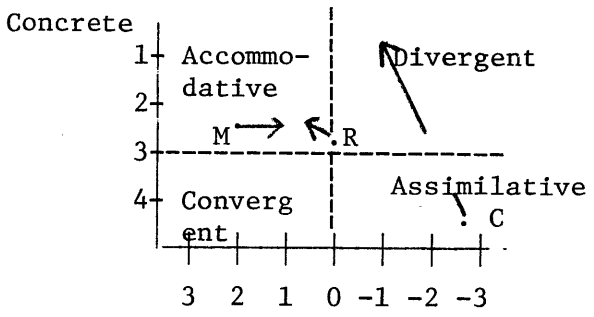
**Significantly different from Questionnaire I score $p < 0.2$

Figure 15b The LSI Responses Plotted

C= Concourse

M= Matched Group

R= Regular Curriculum



Note: Vectors point from Initial scores to Subsequent scores

Figure 16 Other Post-test Data

Item Number on Questionnaire II	Question	Concourse	Matched Group	Regular Curriculum
II-4a	On the following scales characterize your interaction with classmates:			
	cooperative 1 ---- 7 independent	4.48 (1.69)	4.70 (1.76)	4.18 (1.87)
II-4b	noncompetitive 1 --- 7 competitive	2.70 (1.37)	3.09 (1.67)	3.45 (1.71)*
II-14	If you could chose a university all over again... would you chose to come here? definitly yes 1 ---- 5 definitly no	2.22 (1.25)	2.61 (1.24)	2.32 (1.23)
RAT	Remote Associates Test	10.04 (2.99)	839 (2.04)*	9.69 (3.10)
CUM	Grade Point Average at end of sophomore year (5=A 4=B etc.)	4.09 (0.52)	4.14 (0.75)	4.26 (0.60)

*Significantly difference from Concourse measure $p < .05$ two tailed test

B. QUALITATIVE DATA

1. Attitude Measures. The only attitude measuring item to appear in identical format on both Questionnaire I and II is the one asking the student to what extent the humanities are an important contributor to technical career preparation. Figure 12 shows the responses to that question on the initial and subsequent surveys. The Concourse students' response increased significantly from the first to second measure, rising from the middle to near the upper range of the response scale. The matched group and regular curriculum students' responses remained essentially unchanged, in the middle of the response scale. As a result, the Concourse students subsequently gave a higher rating to the importance of the humanities than the other two groups.

Two attitude-measuring items appeared for the first time on Questionnaire II. The results of items measuring the students' preference for technical-humanistic subject integration (II-10) and the study of science-society interaction (II-11) are reported on Figure 13. The Concourse students showed a very high preference for the integration of humanistic and technical subjects while both the matched group and regular curriculum students reported significantly less desire for subject integration within their academic program. The matched group and regular curriculum students' responses were both in the middle of the response scale, with no significant difference between the two.

The results of the item measuring the students' attitude toward studying the interaction of science and society followed the same pattern. The Concourse students' response was at the upper end of the

response scale; the matched group and regular curriculum students showed a moderate preference for such study, in both instances significantly less than Concourse students.

2. Behavior Measures. Three behavior measures appeared in identical format on Questionnaires I and II. The responses to these items appear on Figure 14. Question I-6, measuring the distribution of learning effort between humanistic and technical subjects, contains several significant results. The subsequent response of the Concourse students was still significantly more slanted toward the humanities than the responses of the matched group and regular curriculum students. The Cooncurse students' response indicated about equal emphasis on the humanities and technical subjects, while the other students showed a moderate preference for their technical subjects. All three groups significantly shifted their emphasis toward the humanities after their sophomore year.

Question I19 measures the frequency of contact between student and faculty outside the classroom. The subsequent response of the Concourse students to this question was higher, but not significantly higher, than the responses of the matched group and regular curriculum students. All three groups responded somewhat lower than midpoint of the response scale. The subsequent response of the Concourse students was significantly lower than their initial measure, while the regular curriculum students' subsequent response was significantly higher than their initial measure, and the matched group's response remained unchanged.

Question I-26 measured how often students worked together with class-mates on homework problems. The subsequent responses of all three groups were slightly below the midpoint of the response scale and were all quite close together. For the three groups this represented a significant lowering in their frequency of collaboration with classmates from the initial to subsequent measure.

3. Learning Style. The students' responses to the Learning Style Inventory are reported on Figure 15. The actual scores on the abstract-concrete and active-passive dimensions of the LSI are summarized on Figure 15a. They are then plotted on the plane defined by these two dimensions on Figure 15b. The Concourse students' responses on both dimensions of the LSI changed significantly from Questionnaire I to Questionnaire II. Their scores became concrete as opposed to abstract, and more active as opposed to reflective. The direction of their change was from the assimilative toward the accommodative learning style. The matched group and regular curriculum students did not change significantly on either the abstract-concrete or active-passive dimensions. Their scores on both dimensions did move closer to each other. Their LSI scores on Questionnaire II were more abstract and more active than the Concourse students' scores though not significantly so in either case. The Concourse students' learning style was thus divergent relative to the learning style of the other groups at the end of their sophomore year.

4. Other Post-test Data. The following measures were obtained after the students' sophomore year only. The results appear on Figure 16. There were no significant differences among the three groups in their characterization of their interaction with other students as cooperative versus independent, Item II-4a. On Item II-4b, students characterized their interaction with other students on a scale measuring competitiveness. The Concourse students considered themselves to be very noncompetitive. The matched group students rated themselves as slightly more competitive but still below the midpoint of the response scale. The regular curriculum students rated highest in competitiveness, significantly higher than the Concourse student, yet also below the midpoint of the response scale.

Question II-14, which asks the students if they would choose M.I.T. again knowing what they now know, is a measure of general satisfication with their academic careers to date. The Concourse students' responses indicated that they were most likely to come to M.I.T. again, though not significantly more than either of the other groups. All three groups were somewhat positively inclined toward M.I.T.

The results of the Remote Associates Test show that the Concourse students has the highest score, though not significantly higher than the regular curriculum students' score. Both the Concourse and regular curriculum students' scores were significantly higher than the matched group's score.

The CUM or grade point averages, was determined after the completion of the students' sophomore year. There were no significant differences between the three groups and all three groups' CUM were in the B-plus range.

C. DISCUSSION AND CONCLUSIONS

One of the key results of this study concerns the students' attitudes toward the relevance of studying the humanities as part of preparing for a technical career. The regular curriculum and matched group students remained unchanged in this attitude from their freshman year to their sophomore year. The Concourse students, initially scoring the same as the other students, sig-nificantly increase their feeling for the importance of the humanities by the end of their sophomore year. My conversations with Concourse students, at the end of their freshman year and again at the end of their sophomore year supplied further explanation of the above finding. There seemed to be two factors working to increase the Concourse students' positive inclination toward the humanities. The first, apparent at the end of their freshman year, was that the program had, in fact, impressed upon the students the importance of integrating the humanistic perspective with the technical oreintation of a professional career. The interdisciplinary thematic organization of the General Meetings, the interactive class styles, and collaborative teaching in the program had succeeded in bringing home this point. The second factor, increasingly apparent after the sophomore year, was a delayed effect of the Concourse Program. During their sophomore year, their first in the regular curriculum, former Concourse students felt better equipped than their classmates. to put together the disparate disciplinary perspectives of their individual courses; at the same time, they missed the explicit interdisciplinary orientation of their freshman year in the Concourse Program and thus began to value it even more.

Two other subsequent attitude measures showed equally encouraging results. The Concourse students gave very positive responses to measures of their absolute preference for the integration of humanistic and technical subjects and preference for studying the interaction of science and society. The regular curriculum and matched group students gave neutral responses to both measures. These results reinforce the sense that there existed a unique attitudinal pattern in the former Concourse students at the end of their sophomore year and that much of it might be attributed to their experience in the Concourse Program. Interviews with former Concourse and regular curriculum students supported this view. Several Concourse students expressed a feeling of being different from their classmates because of their greater concern for maintaining breadth and coherence in the subjects they studied (which they had enjoyed in the Concourse Program) even as they were beginning to specialize in a departmental program. The Concourse students may have initially had greater absolute preferences for subject integration and studying the interaction of science and society (Questionnaire I did not contain items measuring the absolute strengths of these attitudes) but in any case their participation in the Concourse Program either sustained or improved these attitudes and definitely elevated their feeling for the importance of the humanities in a technical education.

The distribution of learning effort devoted to humanistic and technical subjects also reflected the former Concourse students attitudinal bias toward the humanities. As during their freshman year, Concourse students at the end of their sophomore year spent a greater

fraction of their effort on humanistic studies than did the regular curriculum and matched group students, though students in both programs still spent the majority of their time on technical studies. However, an interesting trend revealed by the data is that all three groups of students shifted their distribution of learning effort toward the humanities. An obvious explanation for this pattern was not forthcoming in my interviews, though one possible reason may be that as sophomores, M.I.T. students have a greater selection of courses available to them for fulfilling their upperclass humanities requirements than are available to freshmen for fulfilling their freshman humanities requirement. Thus it is likely that, as sophomores, the students participating in this study were able to find humanities courses that were more attractive to them than those they took as freshman, and thus were inclined to spend proportionately more time on them.

The results of the other subsequent measures of behavior were not as encouraging as the above findings. The former Concurse students at the end of their sophomore year reported that they were interacting with members of the faculty significantly less than they had as freshmen in the program. They were still contacting members of the faculty more often than were other students, but the difference was not longer statistically significant. (Regular curriculum students had not substantially increased the frequency of their contacts with their instructors by the end of the sophomore year.) What this finding implied (and which was confirmed in my interviews) was that the removal of the active

encouragment to engage in student-faculty interaction, which existed in the Concourse Program but not in the regular curriculum, dampened the students' motivation to seek out such opportunities. It had been the hope and expectation of the Concourse faculty that the former Concourse students would be more likely to actively seek out the additional resources available within the M.I.T. faculty at large. This assumption was not entirely unjustified, however. Members of the Concourse faculty and former Concourse students did report to me that the relationships established during the previous year continued to grow and flourish after the students had left the program. Members of the Concourse faculty became advisors and friends of their former students. It is quite possible that these expanded relationships with Concourse faculty members obviated the students' need to reach out to their current instructors.

The results of the subsequent measure of interactions among students (working together on homework problems) showed a trend similar to the one described above. The amount that Concourse students worked together with classmates decreased significantly from the midpoint of their freshman year to the end of their sophomore year. At this point the scores of all three groups were not significantly different, though the regular curriculum and matched group students' scores also decreased significantly during that year. This patter of decreasing interaction among all of the students may have several explanations. One possibility is that the pressures of departmental specialization, which become

increasingly strong during each successive year as an M.I.T. undergraduate, produce a situation in which sophomores take fewer courses together with their friends in their living groups -- during their freshman year everyone took the core courses together. Thus for sophomores, there would be fewer opportunities to collaborate on a shared homework problem. Another possibility is that competitive pressures may be inhibiting interaction among students; the competitive grading system of many upperclass courses (and the leaving behind of the pass/fail system for freshmen) could account for these findings. Students I spoke with at the end of their sophomore year left me with the impression that both of the above explanations were indeed factors that contributed to the evolution of their style of interaction with their peers. One observation, pointed out by former Concourse students, was that formal opportunities to work together with other students were completely lacking in the regular curriculum whereas, when they had been in the Concourse Program, such opportunities had been regularly structured into the interactive class styles.

Two other measures also bear on the above discussion. The three groups rate themselves identically as more independent than cooperative in their style of interaction with other students, at the end of their sophomore year. On the scale contrasting competitiveness with noncompetitiveness, however, the regular curriculum students rated themselves as significantly more competitive than either the matched group or Concourse students, though all three groups weighted their responses

toward noncompetitiveness. These results were consistent with the above findings and discussion on the frequency of interaction with classmates. The fact that the regular curriculum students rated themselves as more competititive could be attributed to their longer exposure to individual rather than interactive class styles.

In summary, it may be concluded that the higher subsequent attitudinal and behavioral measures predicted for Concourse students by Hypothesis IV were only partially supported by the data. An attitudinal bias toward the humanities, subject integration and issue orientation of classes in fact differentiated former Concourse students from those students in the regular curriculum at the end of their sophomore year. However, the subsequent differences between Concourse and regular curriculum students on behavioral measures were not as great as predicted though they were in the predicted direction. The general conclusion is that the Concourse Program had a definite effect on the attitudes of the Concourse students, but that the behavioral patterns prevalent in the regular curriculum might eventually dominate the behavioral outcomes associated with participation in the Concourse Program.

The results of the subsequent Learning Style Inventory augment the above discussion and lend strong support to the theoretical model of interdisciplinary education presented in Chapter I. The matched group and regular curriculum students' LSI scores had not changed significantly by the end of their sophomore year. The Concourse students' LSI

scores did move considerably, from assimilative to divergent relative to the regular curriculum students' learning style. This finding is in complete accordance with Hypothesis VII. It may be thus concluded that the multiplicity, and juxtaposition of disciplinary perspectives in the interdisciplinary learning situation, and the elevated status of the humanistic perspective in the Concourse Program, contributed to the emphasis on a divergent learning style in students who participated in the program.

A second theoretical assumption about the interdisciplinary learning situation was that higher creativity would also be a characteristic outcome. A measure of creativity, The Remote Associates Test, was administered only at the end of the student's sophomore year; thus there was no way to control for the initial level of creativity in each group. Nevertheless, the results of the R.A.T. were predicted by Hypothesis V: The Concourse students had the highest mean scores, slightly higher than the regular curriculum students and significantly higher than the matched group. While a strong conclusion cannot be made based on this evidence, the data does support the theoretical assumption and certainly suggests the need to carry out a more comprehensively structured experiment. Taken together, the results of the LSI and RAT moderately support the theoretical assumption that higher creativity and a divergent learning style are characteristic outcomes in students who participate in an interdisciplinary learning situation. Thus it may be concluded that the Concourse Program in fact created an educational environment that could be characterized as an interdisciplinary learning

situation.

The final result contained in the subsequent measures of the students' grade point averages, the CUM. Hypothesis VI predicts that at the end of the sophomore year there would be no difference in the academic performance of the Concourse and regular curriculum students as measured by their CUM. The data supplied by the M.I.T. Registrar's Office supports that prediction. There was no significant differences between the mean CUM of the Concourse students and students in the regular curriculum (and matched group). This finding is particularly important in evaluating the effects of the Concourse Program, because any deficiency in the Concourse students' ability to master the knowledge and skills prerequisite for an M.I.T. undergraduate would obviously be unacceptable. As was stated earlier, the members of the Concourse faculty were always cognizent of the fact that, whatever the attitudinal and behavioral objectives and outcomes of the program, first priority would be given to assuring that Concourse students were well prepared in the core subjects, that skill and knowledge learning in the core subjects would not have to be sacrificed in order to achieve the beneficial outcomes of an interdisciplinary learning situation. This is the essence of the experiment that was, and is, the Concourse Program. The data presented supports the conclusion that, in this sense, the program was successful.

Chapter VI

General Conclusions

This final chapter will serve two main functions. The first is to pull together the discussion and specific conclusions relating to the preceding presentation of data and focus them on the primary issues of this study. The second is to suggest how further research might clarify unresolved issues, improve upon the design of this experiment, or investigate new questions raised during the course of this study.

A. CONCLUSIONS

The two central purposes of this study were to evaluate the Concourse Program as an interdisciplinary innovation at M.I.T. and to lend support to the general concepts underlying the interdisciplinary approach to societal and technological issues. Conclusions based on the findings of this study in the context of these objectives are offered below.

1. Evaluation in the Context of an M.I.T. Innovation. Four evaluative issues were identified in Chapter I. The first of these was to determine the extent to which the actual Concourse Program, as presented to its students, was congruent with the planned program outlined in the original proposal and other descriptive documents. The critical factors in this determination were the structure and class styles employed in the program and the subject matter presented to the students. In fact, as supported by the statistical data, interviews with students, and my

own observations as a participant in the program, the Concourse Program fulfilled this objective. The General Meetings, thematic organization, techniques of Discipline workshops, collaborative teachings, etc., as planned and implimented, all served to provide an educational experience characterized by an interactive class style and a strong emphasis on both the learning of prerequisite skills and knowledge and the juxtaposition of the humanistic and technical perspectives as equal contributors to the interdisciplinary context. In conclusion, the evidence strongly supports the premise that the actual Concourse Program was an accurate representation of the program as it was proposed.

The second question, closely related to the first, was whether the Concourse Program was truly interdisciplinary in nature. The criterion for evaluating the findings relating to this issue was the definition for interdisciplinary education offered by Schein (1972): interdisciplinary education occurs when the subject matter of several disciplines is compared within a single course and when faculty members from several disciplinary specialties collaborate in the planning and teaching of such courses. The Concourse Program met, and surpassed, this test. The thematic organization of subject matter and its presentation in the General Meetings matched the first requirement of interdisciplinary education; and while interdisciplinary education is usually thought of as the combination of several disciplines within the sciences, engineering, or humanities, the Concourse Program attempted to and often suceeded in integrating humanistic and technical disciplines with each other.

The program fulfilled the second characteristic of interdisciplinary education as well. The extent of faculty collaboration in planning, and teaching is documented in Chapter I. The Concourse faculty members clearly represented a diverse group of departmental and professional specializations. In addition, the program successfully implimented interdisciplinary learning situations which went beyond the integration of disciplines to include the interactive class style as a model of behavior as well as substance for interdisciplinary education. Thus the findings of this study strongly support the conclusion that the Concourse Program provided an interdisciplinary educational experience.

The third evaluative issue was concerned with the outcomes of the interdisciplinary learning experience in the Concourse students. The model constructed in Chapter I predicted that Concourse students would, after participating in the program, be characterized by:

1) positive attitudes toward the humanities, the integration of disciplinary perspectives, and issue-oriented studies

2) high interpersonal competence including more cooperative and less competitive behavior

3) high creativity and a divergent learning style

The actual outcomes in the Concourse students, reflected in the statistical measures and personal interviews, strongly supported the above predictions. In addition, the Concourse students were well prepared in the core subjects; they experienced no particular difficulties in entering the regular curriculum as sophmores. It may thus be concluded that

the outcomes in the Concourse students were consistent with the objectives of the program.

The last evaluative issue was to compare the effects of the Concourse Program on its students with the same measures in the regular curriculum students. The model predicted that the Concourse students would score higher than regular curriculum students on the criteria outlined above, including attitudes, behavior, and creativity, and that their learning style would be divergent relative to the learning style of regular curriculum students. In addition, it was predicted that the Concourse and regular curriculum students would achieve an equal level of academic performance. The data supported all of the above predictions to a large extent. Where differences occurred between the two groups, they were in favor of the Concourse students. In particular, the attitudinal differences between the students of the two programs were pronounced, while the measures of behavior and creativity showed less difference, but still in the predicted direction: the Concourse students were less competitive, more creative. There were no significant differences in the grade points averages of the Concourse and regular curriculum students, and the Concourse students exhibited a divergent learning style in comparison to the regular curriculum students. In conclusion, the data indicates that Concourse students, in comparison to the regular curriculum students, became more creative, more divergent, held more positive attitudes toward the humanities,

etc., had higher interpersonal competence, and were equal in terms of academic performance.

2. Support for Interdisciplinary Approaches to Complex Issues. Three observations were of particular importance in providing support for the general trend toward interdisciplinarity. The first was the extent to which an interdepartmental faculty group could cooperatively interact in their planning and teaching roles. In this, the Concourse faculty were very successful as measured by their ability to collaboratively envision, then impliment, the Concourse Program. Highly structured planning and teaching situations, which demanded faculty cooperations, were designed into the program. A remarkable aspect of the program's history is that it evolved, from a group of faculty sharing common concerns about undergraduate education to an operational educational innovation, without the support of a single, dynamic leaders and a well defined objective. It was fueled by the cooperative energies of junior faculty members from the Schools of Science, Engineering and Humanities and Social Sciences.

The second crucial observation concerned the extent to which the Concourse students shifted toward more cooperative rather than competitive modes of interaction among themselves. The data supplied by the students and my observations were moderately encouraging on this issue. While participating in the program, the Concourse students did exhibit much more cooperative, and less competitive behavior than the regular curriculum students. This may be attributed to the interactive class

styles and small group activities structured into the program. However, when they entered d the regular curriculum as sophomores, the Concourse students began to decrease in the degree to which their interaction could be characterized as cooperative. They still rate themselves as less competitively oriented than that regular curriculum students, but the structure and style of regular curriculum classes clearly seemed to be eroding away the behavioral differentiations that characterized them during their freshman year. While this finding speaks well for the short term effects of participating in the Concourse Program, it also implies that a longer, or continuous, exposure to interdisciplinary modes of learning and interacting will be necessary to establish a long-lasting pattern of cooperative interaction.

The third critical measure was the students' attitudes toward the humanities and integration of the humanistic and technical perspective. As was earlier reported, the Concourse students did increase their positive attitudes toward the humanities and interdisciplinary studies while they were in the program. In addition (contrary to the above finding on related behaviors) these attitudes more strongly differentiated Concourse and regular curriculum students at the end of their sophomore year.

Considered together, the key measures above should provide encouraging support for the concept of interdisciplinary education as preparation for technologically-oriented participation in interdisciplinary

research and applications. This endorsement should be qualified in one aspect: interdisciplinary education cannot be a one-shot, limited experience if it is to be optimally effective in achieving lasting improvements in the students ability to function in interdisciplinary environments. As in anything else, regular practice and continued education will be necessary to maintain and improve interdisciplinary competence.

3. General Conclusion. The Concourse Program has created an interdisciplinary learning situation which improves the student's ability to function in interdisciplinary environments and at the same time maintains high standards for disciplinary learning outcomes. The program also provides a supportive environment for collaborative planning and teaching by an interdepartmental faculty group.

One implication of an overall positive evaluation of the Concourse Program is that the program should be well suited for institutionalization involving at least moderate expansion beyond its present scale. An important factor which would have to be considered when expanding the program is the process of selecting new faculty members. The original members of the "Clock Group" and all subsequent members of the Concourse faculty were self-selected in response to an invitation from the faculty group at the time. The differences between self-selected Concourse faculty members and other members of the M.I.T. faculty are probably far greater than the students' potential self-selection biases discussed in this study. Concourse faculty members, at minimum, have been characterized

by their high commitment to teaching freshmen, eagerness to collaboratively interact with faculty members from other disciplines, and strong belief in interdisciplinary education. The sharing of these attitudes by the Concourse faculty members may have contributed greatly to their success in cooperatively implimenting the program as planned. The ability of a randomly selected faculty group to impliment the same program is problematic; it is an issue that would have to be resolved if institutionalization to any modest extent was administratively considered. One possible approach might involve a gradual expansion of the program in which new faculty members were integrated during a training period with the existing Concourse faculty, a process similar to the one-for-one replacement of faculty members in the current program. However, a more pressing problem than the integration of new members into the program might be the paucity of willing volunteers for such an undertaking given the prevailing academic environment characterized by departmental and institutional retrenchment. In any case, the potential benefits of a growing commitment to interdisciplinary education, strongly supported by the experience of the Concourse Program compel one to conclude that such an investment of faculty and administrative resources and energy is well worth making.

B. Suggestions for Further Research

This final section will offer some alternative designs for future interdisciplinary innovations as well as some suggestions for additional research that would replicate and further validate athe findings in this study.

Two unavoidable shortcoming in the design of this study could easily be improved upon in any subsequent research on the Concourse Program. The first shortcoming is the fact that Questionnaire I and II were not identical; several items on Questionnaire II including the RAT did not appear on Questionnaire I. An important aspect of this project was the development of the questionnaires. Questionnaire II represents a suitable instrument for repeated administration, except for the individual items on the RAT; other sets of RAT items could be used for additional forms of the questionnaire. Obtaining longitudinal data on the RAT would provide a much needed control of initial creative differences in the students.

The second improvement in design would be to administer the initial measures to a new group of students during their first week at M.I.T. or, even better, before they came to M.I.T. and decided to join the Concourse Program. The goal would be to create a better approximation of a before-after design and to minimize potential selection bias in comparisons of the Concourse and regular curriculum students.

Another potential improvement in any further research on the Concourse Program would include a new strategy for determining a control

group. In recent years the program has been over-subscribed, having to select 50 students (randomly) from a group of 75-100 students who wished to join the program each fall. Using those students who selected the program, but were denied admission in the lottery, as the control group, would eliminate the effects of self-selection biases in comparisons of the two groups.

Other research projects of potential value could involve long term follow-up studies of former Concourse students and the control groups from which initial measures were obtained. Of particular interest would be data gathered at the end of these students' senior year. At that time, measures of their academic performance, attitudes, and behavior would be especially valuable, as well as interviews focusing on their post-graduate plans. Conclusions about the long term effects of a limited interdisciplinary educational experience could then be made.

I believe that the Concourse Program demonstrated the important role that interdisciplinary educational innovations can play at M.I.T. The program's success points to the potential benefits of more extensive experiments within the undergraduate curriculum. Such new innovations might go in either of two directions. The first would be the addition of new interdisciplinary options for freshmen, to be run in parallel with the Concourse Program. Different classroom techniques and interdisciplinary themes would be offered in each option (depending on the composition of the faculty in each group), providing freshmen with a wider choice of topics and styles. Other interdisciplinary innovations

could involve upperclassmen (the Unified Engineering Program in the Aeronautics Department is an example of one such innovation). These programs could entail the collaboration of three or four faculty members in creating a mini-Concourse Porgram (offering double or triple course credit) for students from two or three departments. For example, a program for seniors in electrical engineering, biology, or philosophy might center on the theme of artificial intelligence. Faculty from these departments would collaboratively plan and teach the program, which would constitute about half of each student's course load.

In summary, I believe that the Concourse Program only scratched the surface in terms of exploring the potentials for interdisciplinary education for technologically-oriented professionals. There is a need to both reconfirm the results of this pilot study and to initiate new interdisciplinary innovations based on the apparent success of the Concourse Program.

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Appendix I

Questionnaire I

Dear M.I.T. Student,

This questionnaire is part of a study whose purpose is to describe and evaluate certain aspects of the undergraduate programs at M.I.T. With your help, the results will yield a more accurate and detailed description of the style and content of undergraduate programs and the relationship between students and faculty. Your name is not requested on the form. This questionnaire is identified by a code number for the purpose of correlation with follow-up studies. Your name appears only on our mailing list and not on data tables generated by this study.

Please fill in the Background Information section then read the Instructions and complete the questionnaire. It should only take a few minutes to complete. Place the completed form (do not separate any pages) in the Institute Mail Envelope provided. Return simply by dropping it in an Institute Mail Box at M.I.T. (No postage is necessary). Thank you very much for your help in this study. This questionnaire has been approved for distribution by the Freshman Advisory Council and the Committee on the Use of Humans as Experimental Subjects.

If you have any questions about this study, contact M. Horowitz, Room 35-433, Ext. 3-3200.

Background Information

Age_____ Year at M.I.T. (circle one): 1 2

*Major department: Course#_____ OR Undesignated_____(check one)
*FRESHMEN - indicate course you are most likely to join sophomore year

Undergraduate Research Opportunities Program: Check if you have at any time participated in U.R.O.P. for at least one full semester _____

**ACADEMIC PROGRAM HISTORY

Freshman Year	Sophomore Year
__Regular Curriculum	__Regular Curriculum
__Concourse	
__Experimental Study Group	__ESG
__Unified Science Study Program	__USSP
__Freshman Project Year	

**Check Program enrolled in each year you have been at M.I.T. If you switched programs during one academic year indicate both and which semester you attended each.

(2)

There are two sections on this questionnaire. Carefully read the instructions preceding each section before completing that section.

Section I

This section is designed to determine several characteristics of your Academic Program and your reaction to those characteristics. There are no right or wrong answers. Feel free to use the COMMENT spaces to clarify answers, criticize questions, etc.

INSTRUCTIONS

1. Consider each question individually.
2. Each question is followed by a seven point scale between two extreme responses to the question. Indicate your answer with a circle around the number that represents your response along the answer scale. Circle one AND ONLY ONE NUMBER for each question. The answer "4" indicates a neutral, average or midway response to the extremes.

EXAMPLE:

How much do you like apple pie?

dislike very much 1 2 3 4 5 6 7 like very much

If you circled the answer	the meaning of the answer would be
1	dislike very much
2	dislike
3	dislike slightly
4	neither like nor dislike
5	like slightly
6	like
7	like very much

---

3. Some questions are followed by several possible responses (not a response scale). Simply circle the one response that best answers that question.

(3)

ACADEMIC PROGRAM QUESTIONNAIRE

The expression "Academic Program" as used in the questionnaire refers only to the particular group of courses you have taken during the current academic year, 1972-73.

I-1. At present, your primary career goals are in which of the following fields? (circle only one)
1) science 2) engineering 3) medicine 4) business 5) law
6) other (specify) _____

I-2. How much has your Academic Program helped you form your present career goals?

hindered very much 1 2 3 4 5 6 7 helped very much

I-3. How much has your Academic Program helped you toward deciding on a department in which to major?

hindered very much 1 2 3 4 5 6 7 helped very much

I-4. In your Academic Program would you like more or less emphasis on humanistic subjects (social science and humanities)?

very much less emphasis 1 2 3 4 5 6 7 very much more emphasis

I-5. In your Academic Program would you like more or less emphasis on technical subjects (math, science, engineering, etc.)?

very much less emphasis 1 2 3 4 5 6 7 very much more emphasis

I-6. How have you distributed your learning efforts between humanistic and technical subjects?

work mostly on humanistic subjects 1 2 3 4 5 6 7 work mostly on technical subjects

I-7. In your Academic Program, how easy or difficult is it to achieve the balance between humanistic and technical emphasis which you desire?

very difficult 1 2 3 4 5 6 7 very easy

I-8. How important are humanistic subjects as a part of career preparation in a technical field?
1) not important 2) slightly important 3) important 4) very important

I-9. How much has your Academic Program separated or integrated technical and humanistic subjects?

very much separated 1 2 3 4 5 6 7 very much integrated

COMMENTS:

(4)

I-10. Would you like more separation or integration of technical and humanistic subjects?

very much more separation 1 2 3 4 5 6 7 very much more integration

I-11. In your Academic Program, how would you rate the quality of instruction in technical subjects?

very poor quality 1 2 3 4 5 6 7 very high quality

I-12. In your Academic Program, how would you rate the quality of instruction in humanistic subjects?

very poor quality 1 2 3 4 5 6 7 very high quality

I-13. How often are contemporary topics in science i.e. radio astronomy, medical research, lasers, etc. studied in your Academic Program?

very seldom 1 2 3 4 5 6 7 very often

I-14. Would you like to study contemporary topics in science more or less than you are studying them presently?

very much less 1 2 3 4 5 6 7 very much more

I-15. How often are contemporary issues in science i.e. uses of technology, politics and the funding of research, etc. raised in your Academic Program?

very seldom 1 2 3 4 5 6 7 very often

I-16. In your Academic Program, would you like to discuss contemporary issues more or less than you are discussing them presently?

very much less 1 2 3 4 5 6 7 very much more

I-17. How easy or difficult is it for you to obtain feedback about your progress from your faculty instructors?

very difficult 1 2 3 4 5 6 7 very easy

I-18. How easy or difficult is it to contact your faculty instructors outside of class?

very difficult 1 2 3 4 5 6 7 very easy

I-19. How often do you speak with your faculty instructors outside of class?

very seldom 1 2 3 4 5 6 7 very often

I-20. Do you speak with your faculty instructors as often as you would like?

yes_____ no_____ (check one)

COMMENTS:

(5)

I-21. How much do you know about your faculty instructors' non-teaching work, i.e. writing, research, consulting, etc.?

very little known 1 2 3 4 5 6 7 very much known

I-22. How much did you discuss with your faculty advisor your reasons for choosing your particular Academic Program?

discussed very little 1 2 3 4 5 6 7 discussed very much

I-23. With whom else (besides your advisor) did you discuss your choice of an Academic Program? (Circle more than one if applicable)
1) Faculty instructors 2) students 3) Other _____ (specify)
4) No one else

I-24. How often do you discuss reading assignments with your classmates?

very seldom 1 2 3 4 5 6 7 very often

I-25. How often do you discuss reading assignments with your faculty instructors?

very seldom 1 2 3 4 5 6 7 very often

I-26. How often do you work together with classmates on homework problems?

very seldom 1 2 3 4 5 6 7 very often

I-27. How often do you seek help from your faculty instructors on homework problems?

very seldom 1 2 3 4 5 6 7 very often

I-28. Rank order the following modes of learning according to how effective they are for you. (Assign #1 to the most effective, #2 to the next most effective, and so on. . .)

___ studying (reading)
___ problem solving (homework)
___ attending class
___ taking exams
___ doing research projects

I-29. Do you prefer your Academic Program structured or unstructured?

completely unstructured 1 2 3 4 5 6 7 very highly structured

I-30. Do you prefer your work load to be self-paced or externally paced?

entirely self-paced 1 2 3 4 5 6 7 entirely externally paced

I-31. In your Academic Program, how easy or difficult is it for you to give comments (feedback) i.e. concerning class style, content, etc. to your faculty instructors?

very difficult 1 2 3 4 5 6 7 very easy

COMMENTS:

I-32. How often do you discuss course content with your faculty instructors?

very seldom 1 2 3 4 5 6 7 very often

I-33. How often do you discuss class style with your faculty instructors?

very seldom 1 2 3 4 5 6 7 very often

Section II

LEARNING STYLE INVENTORY

This inventory is designed to assess your method of learning. As you take the inventory, give a high rank to those words which best characterize the way you learn and a low rank to the words which are least characteristic of your learning style.

You may find it hard to choose the words that best describe your learning style because there are no right or wrong answers. Different characteristics described in the inventory are equally good. The aim of the inventory is to describe how you learn, not to evaluate your learning ability.

INSTRUCTIONS

There are nine sets of four words listed below. Rank order each set of four words assigning a 4 to the word which best characterizes your learning style, a 3 to the word which next best characterizes your learning style, a 2 to the next most characteristic word and a 1 to the word which is least characteristic of you as a learner. Be sure to assign a different rank number to each of the four words in each set. Do not make ties.

1.	___discriminating	___tentative	___involved	___practical
2.	___receptive	___relevant	___analytical	___impartial
3.	___feeling	___watching	___thinking	___doing
4.	___accepting	___risk-taker	___evaluative	___aware
5.	___intuitive	___productive	___logical	___questioning
6.	___abstract	___observing	___concrete	___active
7.	___present-oriented	___reflecting	___future-oriented	___pragmatic
8.	___experience	___observation	___conceptualization	___experimentation
9.	___intense	___reserved	___rational	___responsible

PLEASE RETURN THE ENTIRE FORM (6 PAGES) AS SOON AS POSSIBLE. THANK YOU.

MARTIN HOROWITZ

Appendix II

Questionnaire II

Dear M.I.T. Student,

This questionnaire is the final part of a study (begun last year) the purpose of which is to describe and evaluate certain aspects of the undergraduate programs (freshman and sophomore year) at M.I.T. The focus of this study is the kind of learning outcome and development of learning style not usually reflected in the normal grading procedure. Your participation in this study is essential for it to yield useful, valid results.

Your name is not requested on the form. The questionnaire is identified by a code number for the purpose of correlation with earlier questionnaires. Your name appears only on our mailing list and not on the data tables generated by this study.

Please fill in the Background Information section, then read the instructions and complete each of the three short sections. Try not to exceed the suggested time allotments for each section. Place the completed form (do not separate any pages) in the Institute Mail envelope provided. Return simply by dropping it in an Institute Mail Box at M.I.T. No postage is necessary.

If you have any questions about this study, contact M. Horowitz Room 35-433, Ext. 3-3200. Thank you very much for your help.

BACKGROUND INFORMATION

A. age__ Year at M.I.T. (circle one) 1 2

B. At present, your primary career goals are in which field (circle one only):

1) science 2) engineering 3) medicine 4) business 5) architecture
6) social science 7) other _____(specify)

C. *Major Department: Course # ___

D. **Academic Program History--check appropriate program for each semester you have been at M.I.T.

	Freshman Year		Sophomore Year	
	Fall	Spring	Fall	Spring
Regular Curriculum	__	__	__	__
Concourse	__	__	__	__
E.S.G.	__	__	__	__

E. Did you participate in any special programs in high school (ie. self-paced study, team-teaching, independent study, etc.)?

(check one) yes___ no___
(If answer is yes) What kind of program? _____

* FRESHMEN--indicate department you will most likely join.

** FRESHMEN--indicate Academic Program you plan to take Fall semester Freshman Year only.

(2)

SECTION I

Instructions

A. The term Academic Program refers to courses you took during the academic year just completed. (Freshmen--answer these questions in reference to your senior year in high school.)
B. Consider each question individually. Most questions are followed by a seven point scale between two extreme responses to the question. Indicate your answer with a circle around the number that represents your response along the answer scale. Circle one and only one number for each question. The answer "4" indicates a neutral, average or midway response to the extremes.
C. Other questions are self explanatory.

Allot a maximum time of about 10 minutes for this section.

II-1. On the following scales, characterize your personal experience of the academic year you just completed.

a) not very interesting 1 2 3 4 5 6 7 very interesting

b) very easy 1 2 3 4 5 6 7 very difficult

c) not very challenging 1 2 3 4 5 6 7 very challenging

d) not very satisfying 1 2 3 4 5 6 7 very satisfying

e) not very relevant 1 2 3 4 5 6 7 very relevant (to your educational goals)

II-2. How often do you speak with your faculty instructors outside of class?

very seldom 1 2 3 4 5 6 7 very often

II-3. How often do you work together with classmates on homework problems?

very seldom 1 2 3 4 5 6 7 very often

II-4. On the following scales, characterize your style of interaction with classmates.

a) very cooperative 1 2 3 4 5 6 7 very independent

b) very noncompetitive 1 2 3 4 5 6 7 very competitive

II-5. How have you distributed your learning efforts between humanistic and technical subjects?

work mostly on humanistic subjects 1 2 3 4 5 6 7 work mostly on technical subjects

II-6. How much has your Academic Program separated or integrated technical and humanistic subjects?

very much separated 1 2 3 4 5 6 7 very much integrated

II-7. How often are contemporary issues in science ie. uses of technology, politics and research funding, etc. raised in your Academic Program?

very seldom 1 2 3 4 5 6 7 very often

II-8. How important are humanistic subjects as a part of career preparation in a technical field?

1) not important 2) slightly important 3) important 4) very important

(3)

II- 9. Rank order the following subjects according to their importance in contributing to your achievement of your educational goals (write 6 for the most important, 5 for the next most important, etc.)

chemistry.....___
history.....___
literature....___
mathematics...___
physics.....___
social science___

II-10. To what extent do you like technical subjects and humanistic subjects combined in your academic program?

completely separated 1 2 3 4 5 6 7 completely integrated

II-11. How much do you like to study the interaction of science and society (eg. uses of atomic energy, research in population growth, etc.)?

very little 1 2 3 4 5 6 7 very much

II-12. On the following scales, rate if the following learning situations facilitate or hinder your learning:

a) lectures----------hinder 1 2 3 4 5 6 7 facilitate
b) recitations----------hinder 1 2 3 4 5 6 7 facilitate
c) seminars----------hinder 1 2 3 4 5 6 7 facilitate
d) labs----------hinder 1 2 3 4 5 6 7 facilitate
e) reading----------hinder 1 2 3 4 5 6 7 facilitate
f) problem solving----------hinder 1 2 3 4 5 6 7 facilitate
g) reflection----------hinder 1 2 3 4 5 6 7 facilitate
h) examinations----------hinder 1 2 3 4 5 6 7 facilitate
i) feedback from instructors---hinder 1 2 3 4 5 6 7 facilitate
j) feedback from classmates----hinder 1 2 3 4 5 6 7 facilitate

II- 13. On the following scales, how would you characterize your own style of solving problems?

a) not intuitive 1 2 3 4 5 6 7 very intuitive
b) slow 1 2 3 4 5 6 7 fast
c) not methodical 1 2 3 4 5 6 7 very methodical
d) uncreative 1 2 3 4 5 6 7 very creative
e) uncertain 1 2 3 4 5 6 7 very confident
f) simple 1 2 3 4 5 6 7 complex
g) adequate 1 2 3 4 5 6 7 optimal

II-14. If you could choose a university all over again knowing what you now know about M.I.T. would you choose to come here?

1) definitely yes 2) probably yes 3) undecided 4) probably not 5) definitely not

END SECTION I

SECTION II Learning Style Inventory

This inventory is designed to assess your method of learning. As you take the inventory, give a high rank to those words which best characterize the way you learn and low rank to the words which are least characteristic of your learning style.

Instructions: There are nine sets of four words listed below. Rank order each set of four words assigning a 4 to word which best characterizes your learning style, a 3 to the word which next best characterizes your learning style, a 2 to the next most characteristic word and a 1 to the word which is least characteristic of you as a learner. Be sure to assign a different rank number to each of the four words in each set. Do not make ties.

Allot a maximum time of about 10 minutes for this section.

1.	2.	3.	4.
___discriminating	___receptive	___feeling	___accepting
___tentative	___relevant	___watching	___risk-taker
___involved	___analytical	___thinking	___evaluative
___practical	___impartial	___doing	___aware

5.	6.	7.	8.	9.
___intuitive	___abstract	___present-oriented	___experience	___intense
___productive	___observing	___reflecting	___observation	___reserved
___logical	___concrete	___future-oriented	___conceptual-ization	___rational
___questioning	___active	___pragmatic	___experiment-ation	___responsible

END OF SECTION II

(5)

SECTION III

This section tries to assess your ability to find associations among groups of words as a measure of your verbal problem-solving style and ability.

Instructions: In this section you are presented with three words and asked to find a fourth word which is related to all three. Write this word in the space to the right.

For example, what word do you think is related to these three?

cookies sixteen heart _____

The answer in this case is "sweet." Cookies are sweet; sweet is part of the phrase "sweet sixteen" and part of the word "sweetheart."

Here is another example:

poke go molasses _____

You should have written "slow" in the space provided. "Slow poke," "go slow," "slow as molasses." As you can see, the fourth word may be related to the other three for various reasons.

Try the next two:

A. surprise line birthday _____

B. base snow dance _____

The answers are at the bottom of the page.

Now turn this page and try the groups of words on page 5. Many of these are not easy, and you will have to think about some for a while. If you have trouble with some groups of three, go on to the next and come back to them later.

Allot a maximum time of about 20 minutes for this section. (Please do not exceed 20 minutes on this section; additional time does not usually improve scores, but can impair the validity of this section.)

The answers are: A. party, B. ball

(6)

1.	stop	petty	sneak	_____1
2.	lick	sprinkle	mines	_____2
3.	stalk	trainer	king	_____3
4.	walker	main	sweeper	_____4
5.	envy	golf	beans	_____5
6.	athletes	web	rabbit	_____6
7.	bald	screech	emblem	_____7
8.	cherry	time	smell	_____8
9.	chocolate	fortune	tin	_____9
10.	wicked	bustle	slicker	_____10
11.	habit	pouch	road	_____11
12.	blood	music	cheese	_____12
13.	widow	bite	monkey	_____13
14.	inch	deal	peg	_____14
15.	jump	kill	bliss	_____15

PLEASE STOP AFTER 20 MINUTES.

END OF SECTION III

PLEASE RETURN THE ENTIRE FORM (6 PAGES) AS SOON AS POSSIBLE. THANK YOU

Appendix III The Regular Curriculum

A. Institute Requirements

The requirements referred to in this section were in force during the academic year 1972-1973, the freshman year of the student subjects of this study. These requirements have undergone yearly modifications at M.I.T. primarily in terms of the number of course options available for fulfilling each requirement. These options have not varied significantly in terms of the subject matter encompassed; rather, the array of class styles and applications of the same skills has evolved and increased.

The Institute requirements apply to all M.I.T. undergraduates; they are alternatively referred to as core requirements or general Institute requirements. In addition to Institute requirements, students must fulfill more specific departmental requirements, set by the department in which they major. Department requirements are normally fulfilled with courses taken in the student's sophomore, junior and senior year. Most students try to complete their Institute requirements in their first two or three semesters at M.I.T. -- most Institute requirements courses are prerequisites for departmental requirement courses. The Institute requirements are summarized below and then those that normally apply to freshmen are described in more detail.

The science requirements are comprised of three specifications: the chemistry/biology requirement (one course, four choices), the calculus

requirements (a two course sequence, two choices) and the physics requirement (a two course sequence, four choices).

The humanities requirements are divided into three segments: freshman humanities (a two course sequence, nine choices), sophomore humanities (two courses, about fifteen choices) and upperclass humanities (four courses, three choices from one of twelve areas).

The science distribution requirement is composed of any three courses chosen from a large list of courses beyond the elementary level (the courses chosen must be outside the student's major department).

M.I.T. students typically choose to complete the science requirement (all three specifications) and the freshman humanities requirement during their freshman year. Fulfilling these requirements means taking seven core subjects: since freshmen normally enroll for between 8-10 subjects during their first two semesters, this leaves 1-3 elective subject slots available. More detailed descriptions of the core subjects follow.

The chemistry/biology requirement course options contain two introductory and two intermediate courses for students who already have solid preparation in chemistry. Solid state chemistry and organic chemistry are each offered in introductory courses. The solid state chemistry course encompasses structures of solids from the atomic and crystalline levels to the macrostructures of metals, ceramics, and polymers. The organic chemistry course begins with the electronic structure of

atoms and molecules and proceeds to acid-base reactions, substitution reaction, and carbonyl group chemistry. The intermediate course options cover chemical equilibrium and general biology. The chemical equilibrium course investigates the laws of thermodynamics in macrosystems with special emphasis on state functions such as ethalpy, entropy and free energy. The general biology course contains two parts. The first part focuses on molecular biology using examples of macromolecules including enzymes, the second part addresses genetics in higher organisms, moving from chromosomes to evolution and development in multicellular organisms. Some aspects of neurobiology are also covered. (Freshman Advisory Council, 1972).

The calculus requirement is fulfilled by passing either two course sequence offered. The standard sequence begins with differential and integral calculus of functions of one variable and also includes Taylor series and simple differential equations. The second semester contains multivariate calculus, partial differentiation, and vector integral calculus. The other calculus option covers the same topics with a greater emphasis on exploring a variety of techniques and methods used in scientific applications (Freshman Advisory Council, 1972).

The physics requirement may be fulfilled by completing one of the following two semester sequences. The standard sequence covers classical mechanics including conversative forces, two-body systems, rotational motion and orbits during the first semester; second semester covers

electromagnetism including electrostatics, electromagnetism, and Maxwell's equations. The first alternative sequence focuses on a broader range of physical phenomena emphasizing conceptual understanding rather than mathematical analysis. A second alternative sequence covers the same topics as the standard sequence in a different style, using more detailed mathematical analysis assuming more advanced calculus skills. The third alternative sequence is skewed toward potential medical students. The first semester topics parallel the standard course but uses applications in biology and physiology. The second semester differs considerably: statistical mechanics and thermodynamics are the primary foci. An additional variation on the standard sequence is the seminar-tutotial option. In this option the same standard sequence topics are covered in small classes and tutorials rather than lectures and recitations. It is more of a stylistic variation than a alternative subject (Freshman Advisory Council, 1972).

The freshman humanities requirement is completed by passing one of nine two semester sequences focussing on the following topics: modernization of societies; the Western tradition: the Greeks and the Christian Era; the Western tradition: Greeks and Romans and Jews and Christians; the Western tradition: The Sixteenth through Nineteenth Centuries; culture and society in America: the rise of technological civilization, the technological society; three major texts: Plato, the Bible, Marx; identity and purpose in Black America; writing and experience; contemporary moral issues; or for students with adequate background in French,

the Greek and Judeo-Christian traditions (Freshman Advisory Council, 1972).

B. Class Style

The class styles are essentially identical for the majority of course options fulfilling the science requirements in calculus, physics and chemistry/biology. These courses typically are taught in three lectures (one hour each) and one recitation (one hour) each week. The lectures are attended by several hundred students. There is usually little opportunity for students to interact with the lecturer; the communication is essentially one-way. In recitations, usually attended by 20-25 students, the instructor may review lecture materials, offer examples of problem solutions or field questions from the students. The recitation instructors are usually graduate teaching assistants or junior faculty. The recitations provide the main opportunity for students to interact with faculty, usually once a week for most courses. The only exception to the lecture-recitation format is the seminar-tutorial option for the standard physics course. In this option, lectures are replaced by three weekly meetings between an instructor and about twelve students. The small size of the seminar group enables discussion and presentations involving the students. In this option there are also supplimentary tutorials on an ad hoc basis for individual students or small groups.

The class style of all the freshman humanities options are similar to one another. These subjects normally meet for one hour three times a

week in the recitation format. The balance of emphasis on faculty presentation, student presentation, or discussion varies depending on the individual course instructor.

There are some significant variations in the grading strategies of the core courses. In most of the science requirements options the grades are determined on a competitive basis, measured by class average performance on quizzes, problem sets and final exam. The major exception to the above grading policy is the system used for the standard calculus sequence. A student passes each course in the standard sequence when he or she has successfully completed six unit examinations. The passing criterion for each unit exam is set at 80 percent prior to the test -- there is no competitive grade determination. A student who does not pass a unit exam may retake it until it is passed. The course is self-paced: students may take the unit exams at any interval during the semester. Of course the presentation of material in the lectures associated with the standard calculus course proceeds at a predetermined, fixed rate.

The freshman humanities courses are graded on a less well defined basis. A passing grade for courses in the humanities options is determined on the basis of the satisfactory completion of a number of written assignments ranging from one or two terms papers to weekly short papers. The grading criterion is usually scaled to the individual student's learning progress and not to any competitive measure.

C. Faculty Interaction

For the purposes of this study, two types of interaction between faculty members are considered. These may be catagorized as inter-departmental interactions and intradepartmental interactions. Inter-departmental interactions include relationships between faculty from different departments and, more significantly, from different areas of specialization. The particular interactions of interest are those which contribute to the selection of the actual subject matter presented to students and those which influence the actual class style employed by the faculty including the method of presentation and the criterion for grading. The question is, to what extent, if any, is subject matter and class style discussed among faculty from different academic specializations.

In reference to the above question, there is a consistent impression left by those faculty with whom I have spoken. This includes both faculty members in the Concourse Program (in reference to the courses they teach in the regular curriculum) and non-Concourse faculty members. Most of them report that they have participated in very little inter-departmental interaction with other faculty members, with the following exception: the faculty members in charge of jointly sponsored inter-disciplinary courses interact to some extent in the planning of such courses. In general, however, members of the faculty reflect the notion that the subject matter of most courses, and especially core courses, is primarily in the domain of the sponsoring department, thus precluding interaction with non-departmental faculty on this issue. The degree of

reluctance of most faculty to interact around the issue of subject matter is not necessarily proportional to the unrelatedness of the departments represented. The barriers between mathematics, physics, and chemistry faculty appear to be just as imposing as those between humanities and electrical engineering faculty.

The second category of faculty relationship is intradepartmental interactions. These interactions include relationships between faculty from the same academic department and, in particular, between members of the same specialization, or group, within the department. Again the interactions of interest pertain to the issues of subject matter selection and the determination of class style (including presentation methods and grading).

The faculty interviewed, for the most part, report a high degree of interaction within their specialization group concerning the selection of of subject matter, especially for core courses. Much of the substance of the core course in mathematics, physics, and chemistry/biology is determined by traditional departmental guidelines, the product of continual informal interaction and periodic formal review among the faculty of each department. The general subject matter of each of these courses was summarized above. In the humanities requirement courses, the selection of subject matter is more responsive to the individual preferences and capabilities of the faculty teaching a particular course in a given year. As a result, changes in the faculty's view of what subject

matter is relevant may be more readily implemented in the humanities core courses. Thus, while in the science departments there is a more deep rooted traditional subject matter around which faculty formally and informally interact, in the humanities department the great autonomy of the indiviudal faculty enables a more immediately responsive reaction to informal intradepartmental interaction.

There seems to be, on the other hand, little intradepartmental interaction around the issue of class style. The prevalent view of the majority of faculty interviewed was that their clasrooms were essentially under their exclusive control. Other faculty are rarely present in the classroom. Even in jointly sponsored interdisciplinary courses, where planning was a collaborative undertaking, the actual teaching was done primarily on an individual "take your turn" basis.

In general, this apparent lack of faculty interaction seems directly attributable to a paucity of structured opportunities for collaboration, either in the planning, the classrooom, or any formal interaction for the purpose of evaluaton and criticism. To a large extent, the faculty in the regular curriculum are effectively isolated from one another. Faculty from the same department, or group within the department, do have the occasion to interact around research-related issues; however, they report that discussions initiated in order to address research problems rarely stray into the educational realm.

Appendix IV

Faculty Interaction on the Concourse Program

from Concourse: Report to the C. E. P., 1972, p. 13-15

Concourse is an "interdisciplinary" program. Many people are intensely interested and hopeful about the outcome of "interdisciplinary" interaction, and many people have had bad experiences trying it. There is enormous promise in the idea of one field of knowledge retrieving the deficiencies of another, but, in practice, most attempts to bring several fields together seem to result in frustration and boredom, or the subjection of all fields to one.

Our experience has been good. Concourse is unusual in that it has no hierarchy among the staff, formal or informal. Because we come from different departments and are mostly of the same age and rank, no natural tendency to defer to each other exists among us; we have also resisted the temptation to create functional hierarchy in the form of a chairman or spokesman. We depend for survival on our loyalty to each other and for effectiveness on the energy our projects call forth in each one of us. We have no way of enforcing decisions and a "decision" taken without enthusiasm will generally not be implemented simply because no one will take the trouble.

We do not for the most part act in our usual roles of "engineer" or "critic" in Concourse staff meetings. We often bring to meetings critiques of our own disciplines rather than defences. Our experience is that we disagree continually with each other, but that the coalitions that form continually shift as issues change. On the few occasions when the staff

polarized and found itself for a time split in the same way on different issues we felt our survival as a group threatened and our effectiveness reduced to zero. In normal circumstances one member finds himself alternately delighted with the good sense of another when they agree and horrified at his obtuseness when they disagree. This alternation builds both respect and humility in the group.

Each of us finds himself caught, in one way or another, in a dilemma posed by the existence of different ways of knowing things. The most striking division here is between the "scientific" way of knowing (though we have learned that science is by no means monolithic) and a variety of "humane," "literary" or "experiential" ways of knowing the world.

There is a fundamental asymmetry between "scientific" ways of knowing and the others. Science has built into it a drive to give consistent explanations of all phenomena in a single coherent theory, in this sense it imperializes knowledge and tends to push out the other ways of knowing. We have discussed this imperializing drive of science very often, especially in connection with the belief that science can deal with human and social phenomena. We all sense our own intellectual powerlessness to resist this drive, and to a greater or lesser degree, we all feel a strong emotional desire to resist. This tension brought us together.

The asymmetry mentioned above is reflected in characteristic differences in the way scientists and non-scientists try to resolve their feelings of fear and respect for science. Non-scientists are accustomed to accepting different ways of knowing and exploring the relations of different

kinds of truth; they tend to want to treat science as another mode of knowing, but only one among equals, like religion, philosophy, literature, drugs, art, or psychotherapy. The scientists cannot accept this because of their powerful personal experience of a sense of natural confirmation of scientific truth; whereas the humanist tends to see all human knowledge as the free creation of the human imagination, the scientist tends to see the substance of scientific truth as pre-determined, a jigsaw puzzle already cut out, but needing human imagination for reconstruction. The scientists tend toward a sharp dualism, or compartmentalization of their experiences, with some problems defined as "scientific" and amenable to exact solution (and worthy of great effort) and other questions inherently unsettlable, perhaps even impossible to discuss fruitfully (but worth doing evenings after a day in the lab).

Concourse exists because neither the scientists nor the non-scientists are content with their resolution of the imperial claims of science. The non-scientists sense (though they have not experienced and often shy away from experiencing) that science is hard, unyielding and convincing in a way that other constructs of the human imagination are not. The scientists suspect with a kind of dread that their dualistic view is sterile and shallow, and is inadequate to give them guidance in directing the power they find themselves wielding.

We have rarely found ourselves able, even with the substantial reservoirs of trust and respect we have assimilated to confront these issues directly. Although we have not all come to Concourse with the same needs or desires, at least some of us had the ambition to achieve a better resolu-

tion of these issues in our own lives. Perhaps we moved toward teaching freshmen because it offered a common ground where we would not face directly the great difficulties inherent in the issue of science, and with some idea that we could catalyze in our students changes and advances in attitude toward science that were beyond our own personal resources.

In some way we have come to see the dilemma of the claims of science more clearly, and perhaps have sparked some recognition of it in our students. We are exploring the idea of trying to do some joint research as a way of inventing a new and better truce between society and science. The tension that brought us together to begin with remains largely unresolved, threatening us with frustration, but at the same time serving as our fundamental resource of energy.

Martin Horowitz -- Biography

Education:

- B. S. Aeronautical and Astronautical Engineering, MIT, 1970.

Publication:

- Horowitz, M., et al., The Making of a Clock, Cambridge: Commission on MIT Education, 1970.

Professional Experience:

- 1971 to Present: Staff member of Concourse Program, MIT
- March, 1975 to Present: National Institute of Mental Health program evaluator for the Children's Grant in the Harbor Area (Chelsea, Revere, Winthrop, East Boston, Charlestown, North End, Beacon Hill).