# Drinking from the Fire Hose: Documenting Education at MIT [1]

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*The article reports on a project to document a mechanical engineering design class at the Massachusetts Institute of Technology. The author uses this experience to consider what is an adequate documentation of teaching and learning and how this documentary evidence can be used to study the educational process.*

This is a refereed article.

## Introduction

The floor of the large laboratory is littered with scraps of styrofoam. Groups of students cluster around parts of semi-assembled machines. When completed, the students hope, these machines will allow engineers and designers to cut foam models of products and designs with ease and efficiency. 'It's letting off too much smoke.' 'Why won't the portable cutter work?' 'We'll never have this ready in time!' Their experimental products - foam cut into the shape of Christmas trees and signs saying THANK YOU - line the lab counters. What, you might ask, is going on here? This is invention and innovation MIT style. This is education at MIT.

## The archivist in the classroom

What has brought an archivist into this laboratory? In the autumn of 1995 I was invited to work with the Mechanical Engineering Department as part of a documentary experiment. In the last of their four years at MIT, the Mechanical Engineering students are required to take a one semester course entitled 'Design and Manufacturing II', better known as 2.73, as all classes at MIT are known by their numbers. The course stresses the 'integration of design, engineering and management disciplines and practices'.

In their second year at MIT the Mechanical Engineering design problem is more abstract. The students (in 2.70) are all given a box of the exact same parts and asked to solve a specific design problem (build a mechanical system that will deliver more ping pong balls to a hamper faster than the competing machines). In 2.73, however, the students must solve a design problem in the real world. In addition to the mechanical considerations, they must conduct market research, consider safety and environmental factors, and formulate a business plan that reflects the design and market issues. At the very beginning of the course Professor Woodie Flowers gave the students their challenge: 'We've given you a project that's too big and a time period that is too short with a budget that is too small and a team that is too big - and you're going to succeed'. In approximately twelve weeks these students are expected to work with their team members to design and build a working machine, present their business plans and demonstrate their machines to a board of consultants by the end of the term. And, they all did it!

To support the 125 students in the class the department gathers a staff composed of a dozen members of the academic staff, outside advisers and teaching assistants. In addition the staff is joined by a team of librarians who are available to support the literature searching, data gathering and analysis that are part of the design and market research process. The idea of having librarians work with the teams of students was brought to the academic staff by Suzanne Weiner, the member of the MIT Libraries staff with principal responsibility for Mechanical Engineering. Suzanne saw this course as an opportunity to integrate the librarians into the teaching process and provide bibliographic skills as part of the curriculum. The library component has worked very successfully[2].

Hearing of the librarians' participation, I suggested that the course needed an archivist as well. In *Varsity Letters*, my study of documenting colleges and universities, I stated that one of the most difficult challenges facing an academic archivist was capturing an adequate record of the teaching and learning process.

> Archivists should recognize that teaching, one of the central tasks of higher education, is actually very difficult to document. Although who taught what course can be recorded easily, what was actually taught and how it was taught is much more difficult to capture . . . On the whole, few records exist that capture the information conveyed and the style of delivery.

My conclusion was that: 'Selectively, courses . . . could be targeted for fuller documentation'[3].

## Documentary goals

Seeing this course as an opportunity to test these assumptions I asked Professors Woodie Flowers and Warren Searing to allow me to use 2.73 as a documentary experiment. Is it possible to deliberately create a documentary record of a class activity? If so, what documentation should be created to add to the material that would have been available had we not intervened in anyway? What would such a documentary effort yield and to what extent would it capture the educational process? To my delight, the academic staff was enthusiastic about this opportunity and I became the archivist on the 2.73 staff.

What then did we want to know about this course? What were we trying to document? And what was required to assemble or create that documentation? To capture both the teaching and learning process I understood that an equal effort would have to be exerted to document the class from the point of view of both the students and staff. Among the aspects of this experience that I felt should be addressed were:

### *Intellectual*

- What were the intellectual goals formulated by the academic staff for this class?
- How and why was the specific design problem, the foam cutter, chosen as this term's project?
- What intellectual skills, knowledge and abilities did the students hope to derive from this class?
- How did this class relate to the rest of their education?

*Process*

- What methods/techniques were used by the academic staff to teach this course and how did they feel about the relative merits of the methods used?
- How did the students respond to and absorb the information offered in the course?
- How did the methods facilitate or diminish their ability to learn and accomplish their projects?

*Personal*

- How did the staff evaluate the success and failure of:

  the choice of the project

  the performance of the staff

  the work accomplished by the students

  the overall structure of the course to accomplish its goals?

- How did the students evaluate the success and failure of the:

  choice of the project

  the performance of the teachers and their fellow students, and their own accomplishments?

## The archivist as documenter

Before we proceed it is necessary to address what for many archivists is still a questionable practice: the role of the archivist as documenter, that is, participating in, influencing or creating a documentary record. Fond memories of my 1985 visit to Australia include endless arguments between the Jenkinsonians and the Schellenbergians. Is the archivist's task solely to collect what the creator has left behind, or can we, should we take a more activist role?[4] In *Varsity Letters* I advocated the activist approach:

> To meet the challenges posed by modern documentation, archivists and their colleagues must become active participants in the creation, analysis and selection of the documentary record. This places archivists, librarians and other curators in the role of documenters of their institutions, rather than simply keepers of their records . . . Archivists have conflicting reactions, however, to activities that engage them in the creation of records. Since the early 1970s, when Howard Zinn challenged the [American archival] profession to relinquish their passive 'keeper' mentality and become 'activist archivists', there have been debates about such interventionist roles. Archivists acknowledge the importance of records management techniques to control aspects of the creation and retention of records. The profession has also had to face the necessity of intervening at the creation of electronic records to assure that they will exist and continue to be useful. Archivists are more ambivalent, however, about their appropriate role in creating documentation when it otherwise would not exist. They recognize that certain phenomena will not be documented without active intervention: an archival record of a dance company requires the creation of a moving image record of the dances, and a more durable record of a culture that uses oral tradition will only be captured if visual and aural records are deliberately created. Archivists have come to acknowledge and participate in such documentary activities, but a professional consensus has not emerged about their legitimacy or necessity as a regular part of the responsibility of any institutional archivist . . . Yet, if archivists perceive their responsibility as documenting an institution, then the intervention to create or ensure the creation of records must be an integrated part of the documentary mission[5].

I took on this project, then, as a deliberate effort to document 2.73 as an educational experience. I realised that the nature of the documentary challenge would be shaped to a large extent by the nature of this specific educational activity.

## Modes of teaching and uses of technology

Teaching methods vary and are influenced by many factors:

- the size and academic style of a given university;
- the nature of and methods used by the academic discipline;
- the level of the course work (undergraduate vs. graduate work);
- the personality and style of the academic staff; and

- the style of learning, personalities and abilities of the students.

Three traditional teaching methods are still the most frequently used at most academic institutions. Large lecture courses supplemented by section meetings are still one of the most pervasive forms of delivery in both the humanities as well as the sciences. Smaller classes and seminars as well as independent study and tutorials are familiar as well in both the undergraduate and graduate curriculum. Laboratory work is often a key part of teaching the sciences.

Each traditional method of teaching poses its own documentary challenge. Some members of the academic staff may actually prepare written lectures, but often there is little tangible evidence of the lectures and seminars, especially the interaction of the teachers with the students, without the creation of a film or video record. Computers are now used as an integral part of all methods of teaching and offer new opportunities both to deliver and capture the educational experience.

Computers are used both to supplement traditional course work and also foster self-learning. Instructors in all disciplines are finding that computer graphics and simulations have the potential to enhance learning by visualising concepts and creating situations that could otherwise not be known or readily available. Students can see the flow of gases around the equator of a distant planet, and walk around the streets of Paris to study the architecture or practise their French. The growing use of computers in the classroom offers a rare and valuable opportunity to capture the teaching and learning process. Technical, preservation, intellectual property and privacy issues all pose significant problems - but the potential is there.

## The teaching of design

The advanced Mechanical Engineering course - 2.73 - used both traditional as well as electronic teaching methods. In addition however, the nature of the course was also influenced by its primary purpose - to teach design. Architects, civil and mechanical engineers as well as computer scientists must all develop design skills. But how does one teach design? How does a student learn to solve problems creatively? There is little agreement or authoritative opinion on how to teach individuals to think creatively. Alfred North Whitehead has written that: '. . . the key fact in education, and the reason for most of its difficulties is that necessary

technical excellence can be acquired only by training which is apt to damage those energies of mind which should direct the technical skills'. Jerome Wiesner, a former MIT president and Science Adviser to President Kennedy, provided the following addition to Whitehead's observation: 'The student with an enormous fund of knowledge, polished techniques, and a total lack of creative ability is an all too frequent product of our system'[6].

Among the articulated major objectives for the undergraduate program in Mechanical Engineering is

> to enable students to respond more creatively and effectively to future engineering opportunities and challenges. To foster this objective, the curriculum encourages active involvement of students in the educational process by emphasizing the use of various teaching and learning modes; the connections among engineering disciplines; applications of the fundamentals, laboratory activities, design and manufacturing projects; and independent study.

The catalogue description for 2.73 explains that the course: 'Emphasizes creative solutions to current engineering design problems, team work and fabrication of prototypes'[7].

The overall goal of the course is to develop the students design skills by forcing them to utilize and integrate the knowledge they have gained from their engineering, science, social science and humanities courses. Their challenge is to develop design skills by working in teams with limited time and financial resources while also constrained by the market forces at play.

To realise these goals the 2.73 academic staff utilised a variety of educational methods and tools. The students attended one lecture a week intended to provide background information about technical, design, safety and communication issues. The teams of students met formally at least once a week with their advisers and worked as a group in the laboratory more or less intensively through out the term. And, the individual students worked on their own to complete specific portions of the research and design. A great deal of work and communication was carried out using the Web site established for the class. Class schedule, assignments and readings were posted at the site and each team had its Home Page to coordinate activities and announce accomplishments. (The Home Page of the Yellow team announced: 'WE CAN DO IT!!') Finally, e-mail was a critical part of the way the

work got done. There were separate e-mail lists for the staff, students and each team.

## Methodology

For the archivist the question was how to capture this complicated, frenzied process. I started by envisioning what documentation the Archives might have gathered at the end of this course had there been no intervention. The usual tangible products are course handouts including schedules, reading assignments and handouts to support each specific lecture. If we had asked at the end we might also have received some of the material from the Home Page and maybe even a machine (or photographs of the machines) built by the students or one of their foam cut models. It was easy to surmise that the sum total of this material would tell us very little about this experience either from the point of view of the teachers or the students.

With the documentary goals as my guide (see documentary goals section above), the challenge became how to capture an adequate record to answer the questions posed. I formulated a plan based on the variety of settings in which these activities took place, as well as the staff and technology available to assist me.

The lectures and formal presentations by the students were the easiest to address. With advice from the academic staff we selected two lectures which were videotaped to capture both the presentations and the students' participation. Professor Flowers had already arranged to have the final presentation videotaped and so we arranged for the videotaping of the session at which the students presented the mockups of their designs. We knew that these videotapes would be supplemented by the photographs and videos which the academic staff created as part of their ongoing work with their teams. Suzanne Weiner and I attended all of the lectures and took notes on the intellectual content of each lecture, the teaching methods used, and the reactions of the students and staff. Each librarian was asked to take notes along a similar line as they participated in and observed the meetings of their teams. Suzanne and I also attended all staff meetings and were able to observe and record the deliberations about content, schedule, grades and performance by staff and students alike.

To supplement these materials I conducted five interviews: two with Professor Flowers and the others with three separate students. In this way I hoped to address some of the personal evaluative issues that I believed otherwise could not be

addressed. Again, I used the documentary goals as a guide to frame my questions. For Professor Flowers the questions were focused first on the 2.73 course: its history, the choice of the topic, and his evaluation of the successes and failures of the course this term. The interview also provided an opportunity to ask him to reflect on the current challenges and opportunities in the teaching of design, and more generally in the future of teaching and learning in higher education. For the students the questions were focused first on why they chose MIT and decided to major in Mechanical Engineering, and then on their evaluations of the 2.73 topic, assignments, structure, faculty, workload, grading, fellow students and their own accomplishments. As good archivists we tried to be very self-conscious and careful about keeping accurate records (recording dates and circumstances of creation) and revealing our role in the documentary process. The finding aid for the collection will contain an explanation about how the collection came about, and may also include this article as further background information.

At the conclusion of the course all of this material was gathered together in the Archives: the notebooks containing the observations made by the librarians and myself, the videotapes, handouts, promotional materials and business plans prepared by the students for their final presentations, and samples of the foam models cut by the students' machines. Lacking a sure long-term method to preserve the electronic version of the Web site and e-mail, we printed the e-mail and sample team pages to include in the record. Eventually the photographs, videos, lecture notes and other records created by the academic staff will come to the Archives as part of their manuscript collections.

## Findings and evaluations

In the end one has to ask: Is this an adequate record? Did we create and gather the RIGHT STUFF? In truth, I must say that I don't think we have definitive answers to those questions. Do we know more about this educational experience than we would have if we had done nothing but gather the natural remains? Yes, I believe that we have evidence that allows a variety of questions to be asked about this educational experience: what worked; what didn't and why?

For instance, the documentary evidence supports and illuminates the observations made by the academic staff about how hard it was for the students to work in team settings. Until this course, an MIT student's education is individualistic and competitive with their fellow students. The academic staff is coming to understand

that team skills must be introduced into the student's experience much earlier in their education. The evidence also reveals how technology was used to support the course. The use of e-mail and the team Home Pages contributed greatly to the communication process and the facilitation of the work.

The interviews with the students reinforced the observation made by the staff: the students did not like the project selected by the teachers (the foam cutting machine), but they loved the design courses as a way to synthesise and test all that they have learned as undergraduates. And the interviews confirm what we at MIT know: our students are extraordinary. During an interview an exceptional young woman said to me:

> I've realized that the most important thing you want to leave [MIT] with is the problem solving ability. I think a lot of people get lost in plugging and chugging, and they get lost in class and they don't take a step back and say, oh well, what's the overall thing I'm trying to achieve here . . . I don't want to say I learned three equations. I want to say that if someone gave me this situation, I could tell you how to design [a solution]. And then I would feel like I was someone who should be graduating from MIT[8].

I feel confident that this project enabled us to create and gather some useful evidence. Further analysis by archivists, educators and historical researchers will be required before we can judge if this is the RIGHT documentation. Such a process could begin now by asking the staff to examine what we gathered and critique that record. The evaluative process will also require comparisons with the fruits of other educational documentary experiments.

## Evaluation by others

Throughout, I was motivated by a belief in the value of this work as a documentary exercise. Until I began to discuss this activity with others at MIT and outside the Institute I did not begin to appreciate how others would perceive and value this work.

My two interviews with Professor Woodie Flowers provided an extraordinary opportunity to talk about 2.73 as an educational experience with a member of the academic staff who has given a great deal of thought not only to the teaching of engineering and design, but more generally to the radical changes that electronic communication and technology are bringing about in higher education.

'Chalk and talk is dead' is Professor Flowers' quick way of describing the problem. The students' evaluation of the 2.73 lectures confirm what educators have acknowledged for some time: the lecture system is not an effective method of delivering information to students. The challenge and opportunity offered by technology-based education is to develop more effective means to deliver information to students and actively engage them in the learning process. This is clearly the emphasis in distance education. But, as Professor Flowers says, while educators determine how best to use computers in the educational process they must also identify the unique experiences that can only be accomplished when teachers and students meet and work together.

Institutions of higher education:

> are going to be forced to rather precisely identify the core benefit proposition of the university. Because, if we don't figure out what it is that's unique about having students here, and what justifies the huge cost of being here, we simply won't be here[9].

Professor Flowers, I believe, saw this documentary experiment not only as an opportunity to capture the work accomplished by his colleagues and students, but also as an opportunity to evaluate their methods of teaching design. More broadly the examination of the relative success and failure of the educational methods used throughout this course contributed to his continuing questioning and evolution of new teaching methods.

At the time of this project I also had the opportunity to meet with the acting Dean of the School of Engineering. His enthusiastic reaction to my report stemmed from his commitment to the quality of teaching within the School. The School of Engineering is the largest of MIT's five schools and consistently ranks among the top engineering schools in the United States.

Promotion of members of the academic staff at institutions of higher education is, theoretically, based on the quality of their teaching as well as research and outside professional activities. To the greatest extent, though, the evaluative process has focused on the number of publications and the quality of research, as there is no consensus about acceptable techniques for evaluating teaching[10]. The Dean viewed the documentary record created as part of such an archival effort as providing a foundation for this evaluative process. Rather than focusing on using this record as an opportunity to evaluate the performance of a specific member of the academic staff, he saw this as an opportunity to evaluate effective teaching

methods and utilise that knowledge in the design and improvement of their curriculum in general.

Like most institutions of higher education MIT periodically steps back and questions the educational and social experience that we provide to our students. But in the past, most of these studies have focused on the curriculum: How many humanities courses should be required? Should biology be required? Now, rather, there appears to be more concern about how we teach and the environment in which that learning takes place. What are the most effective means of delivering the curriculum to the students? What situations promote the most effective teaching and learning between the students and the academic staff? Are there ways to address the pace of life and learning for MIT students?

MIT is currently in the midst of an institution wide reexamination of student life and learning. Given the opportunity to meet with Dean of Undergraduate Education, Rosalind Williams, about the work of the Task Force on Life and Learning I told her about the 2.73 experience. Dean Williams saw such documentary efforts as providing the evidence needed to analyse, evaluate and improve how we teach and how students best learn. She viewed this project as supportive of the current reexamination and future efforts as well.

I have always been an advocate for archival programs that are fully integrated and supportive of the mission of their institution[11]. An academic archives must support not only the administrative activities of their institution, but teaching and research as well. Many academic archives have been actively involved in teaching and research by working with staff and students to make materials available to support class assignments, and to provide instruction on specific historical topics as well as archival research skills. The documentary efforts described in this paper, though, suggest another means for archivists to support the educational process.

Educators and administrators are actively engaged in transforming higher education. What students are best served and what education is best provided through distance education? How can computers be used to support and enhance distance and on campus education and what traditional educational efforts will still best be conducted at an academic campus? Archivists can play a crucial role in this change process by working with the members of their academic staff to capture and create adequate documentation of a variety of educational activities -

traditional and electronic - that can serve to support the analysis of current programs and planning for future activities.

There should, we hope, be other uses for this documentation. Historical researchers could use such documentation to study teaching methods, learning styles, the evolution of a discipline or the accomplishments of a specific member of the academic staff. It is also true that at some point the documentation will be viewed as a means to evaluate specific teachers. It is this latter possibility that requires the active participation of the academic staff and administration in the creation of such documentation and an agreement on its immediate and future uses.

The result of the 2.73 documentary project was that a record of an educational effort was created and preserved. The teachers and students felt engaged in the documentary process and used the experience to examine and evaluate their own successes and failures. Members of the administration saw this effort supporting the Institute's goals to examine and improve the quality of education offered by MIT. In the end, therefore, I conclude that even though we have yet to evaluate the quality of the evidence created and gathered, the project must still be regarded as worthwhile. I can only hope that other archivists in higher education will undertake similar efforts. In this way a body of comparative information will be developed and archivists and educators can learn from each other.

There will be many fruits to be gained from these labours:

- For the archives and the archivists such programs provide the visibility and credibility that are so vital to the success of our programs.

- For our institutions such documentary efforts provide a more adequate record of their activities, and thereby support reflection, analysis and planning.

- For the archival profession such activities permit the testing of our ideas, the development of techniques and the examination that make us better professionals.

In final analysis, though, I must confess that I would leap at another opportunity to engage in such a project as it was a tremendous amount of fun. To be engaged in the educational process, working with the academic staff and students, is a great treat. I encourage my colleagues to give it a try.

## Endnotes

1 'Drinking from the Fire Hose' is one of the many expressions used by MIT students to describe their education. The pace and pressures of an MIT education have been a continuing concern. In 1898 the Overwork Committee was asked to investigate this problem, and almost every MIT President since that time has acknowledged this concern. MIT (the Massachusetts Institute of Technology) was founded in 1861 and is now located in Cambridge, Massachusetts. MIT is comprised of five schools: Engineering, Science, Management, Humanities and Social Sciences, and Architecture. The Institute Archives (established in 1961 on the Institute's centennial) is housed within the MIT Libraries. This paper is based upon a paper delivered at the 1996 annual meeting of the Society of American Archivists.

2 Suzanne T. Weiner, 'Librarians in the Lab: An Integrated Design Experience', *Science and Technology Libraries* 16, no.1, 1997 forthcoming.

3 Samuels, *Varsity Letters: Documenting Modern Colleges and Universities*, Scarecrow Press and the Society of American Archivists, Metuchen, N.J, 1992, pp. 64-66.

4 Rather than repeat the history of the profession's debate about appraisal, I refer the reader to Terry Cook's superlative paper: 'Archives in the Post-custodial World: Interaction of Archival Theory and Practice Since the Publication of the Dutch Manual in 1898', ICA XIII International Congress on Archives, Beijing, 1996, publication forthcoming.

5 Samuels, *Varsity Letters*, pp.12-13.

6 Jerome B. Wiesner, 'Education for Creativity in the Sciences', in *Creativity and Learning*, Houghton Mifflin Company, Boston, 1967 p. 96.

7 Massachusetts Institute of Technology, *MIT Bulletin*, 1996/97, pp. 184 & 320.

8 Neeta Verma, interview conducted by Helen Samuels, December 15, 1995

9 Woodie Flowers, interview conducted by Helen Samuels, January 26, 1996.

10 Two useful studies of college teaching that include discussion of the problem of evaluation are: Kenneth Eugene Eble, *The Aims of College Teaching*, Jossey-Bass Publishers, San Francisco,1983, and Martin Finkelstein, *The American Academic Profession*, Ohio State University Press, Columbus, 1984.

11 Janine A. Riley has presented a very effective analysis of an integrated approach in her thesis, 'Integration of Archives Programs with the Core Functions and Business Processes of the Independent School', submitted to Monash University, December 1995. I was very pleased that my article would appear in the same issue of *Archives and Manuscripts*, as Janine's report on her work.