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December 15, 1998

Dr. Frank Wattenberg, Program Director
Division of Undergraduate Education
National Science Foundation
4201 Wilson Blvd. Suite 835
Arlington, VA 22230

Dear Dr. Wattenberg:

Enclosed is a copy of our project entitled *Barriers to Web-enhanced Education for SMET Undergraduates.* It was written at the National Science Foundation's Division of Undergraduate Education during the period between October 24th and December 15 , 1998. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Washington, D.C. Copies of this report are simultaneously being submitted to Prof. Susan Vernon-Gerstenfeld and Professors Rivera and Demetry for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time you have devoted to us in the completion of this project.

Sincerely

Ben Clark

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Report Submitted to:
Professor A. Rivera
Professor C. Demetry

Project Center: Washington D.C.

By:

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In Cooperation with

Program Director Dr. Frank Wattenberg

National Science Foundation
Division of Undergraduate Education

BARRIERS TO WEB-ENHANCED EDUCATION FOR SCIENCE, MATHEMATICS, ENGINEERING AND TECHNOLOGY UNDERGRADUATES

Monday, December 07, 1998

This report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and not do necessarily reflect the positions or opinions of the National Science Foundation, Division of Undergraduate Education or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

This report was prepared for the Division of Undergraduate Education, a Division of the National Science Foundation, who are interested in investigating the barriers that prevent high-quality undergraduate SMET Web-enhanced education. This project explored the current ways in which the World Wide Web is used as an educational resource by SMET professors by conducting a qualitative analysis of professors' opinions. The project components were evaluated and recommendations were made as to how these barriers can be resolved.

Authorship Page

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BOLDED NAMES	*in THE FIRST COLUMN of the Authorship Page signify that the first draft was written by that person,*
BOLDED NAMES	*in any OTHER COLUMN signify that the first draft had gone under major revisions by that person,*
NORMALLY PRINTED NAMES	*names signify that it went under further edits but nothing major.*
	signifies that this sections' first draft was completed jointly.

Acknowledgements

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The next group of people we would to thank are all those who helped us out with our data collection at our primary sites: Roxanne Hiltz at the New Jersey Institute of Technology, Margaret Ross at Prince George's Community College, and Jan Peters at Florida A&M University. Each of these people were remarkably helpful with the arrangement of interviews and focus groups at their respective schools. To our regret, we cannot thank by name those who were gracious enough to be interviewed; they were promised confidentiality.

Finally, we would like to thank Gordon Uno for hiring us to feed and brush his cat while he was away. Twenty dollars can greatly improve the quality of life for three humble college students.

(Fine print: Ben would additionally like to thank all his family, friends, and brethren who were so helpful in getting him through this IQP. Special thanks to Joe for all the editing help!!!!)

Table of Contents

Executive Summary

This summary is meant to assist the reader by giving a brief description of this project, explaining what the project is about, and how the chapters in the project are organized, as well as what each of the chapters contain. We strongly encourage the reader to read the whole report in order to obtain a more precise understanding of this project.

Objective of Project:

The goal of this project is to improve effective, educational use of the World Wide Web by addressing the concerns of those who initiate educational growth: instructors. This report attempts to answer the following question: What obstacles present themselves to undergraduate Science, Mathematics, Engineering, and Technology (SMET) instructors who wish to incorporate use of the World Wide Web in their instructional methods?

Methodology Used:

This project involved the exploration of the obstacles to Web-enhanced/ Web-based learning in SMET related disciplines. Here we describe the steps taken to isolate these barriers. We followed qualitative procedures rather than quantitative methods, because the data in question were highly subjective. The method of data collection followed was a combination of interviews and focus groups, both of which were conducted at the institutions we visited.

Contained in this section are the details of our interview and focus group procedures. Also included are our criteria for interviewee and school-visit selection. Finally, a brief description of each visited school is presented.

Results & Analysis:

This section contains the data that was collected at institutions that we visited. Two preliminary visits were conducted at George Washington University and Georgetown University. Later, we performed three primary visits at the New Jersey Institute of Technology, Prince George's Community College, and Florida Agricultural and Mechanical University.

From the preliminary visits, we isolated five important themes that professors repeatedly touched upon - "The Five T's." These are: *Technology* (hardware), *Technical Support, Time, Tools,* and *Tenure and Other Incentives.*

Conclusions & Recommendations:

This portion of the report aims to inform the reader of the conclusions that we drew from our site visit data. These conclusions should not in any way be construed by the reader to be applicable to any undergraduate university. Despite this, we did attempt to make our recommendations as broad as possible so that other universities might use them.

We approached this section by addressing one or more conclusions for each of the aforementioned "Five T's." After each conclusion is drawn, one or more recommendations is presented. This section provides the reader with a brief overview of the largest problems faced, coupled with one or more recommendations as to how to eliminate each problem.

Chapter I

INTRODUCTION

1.0 Introduction

Technology such as the Internet and the World Wide Web (WWW) are increasingly affecting both the ways in which the National Science Foundation (NSF) interacts with faculty, and how educational institutions are innovating instructional methods. The principal focus of the National Science Foundation - Division of Undergraduate Education is to increase access to high-quality undergraduate Science, Mathematics, Engineering, and Technology (SMET) education for all peoples. One medium through which this increase in access can be achieved is the Internet and WWW. However, as is the case with most innovations, certain barriers present themselves to the Web's widespread educational use.

The goals of this project are twofold: first, to identify such barriers, whether they may be technological, psychological, institutional, or of any other nature; second, to analyze and provide possible solutions for these barriers. In this respect, we have developed a set of recommendations that the NSF can use to help increase the effective use of the Web as a medium for undergraduate education.

This project was funded by a grant from the National Science Foundation - Division of Undergraduate Education. The NSF is an independent agency of the federal government. It provides leadership and support for the nation's efforts to improve education in SMET, addressing every level of education.

Programs addressed by the Division of Undergraduate Education (DUE) have four important themes in common. "Teacher Preparation" and "Diversity" target student audiences. "Faculty Development" and "Integration of Technology into Education" identify high leverage education approaches. These last two themes provide the scope on which this project operates.

The NSF plays a crucial role in the development of the Internet, working together with other agencies to expand the use of the World Wide Web to improve the quality of SMET education. NSF is dedicated to the education and advancement of science and technology. The NSF-DUE considers it important to address the barriers that impede the use of the WWW for undergraduate education. It was our hope to identify these barriers through our data collection process. After conducting a thorough analysis of our findings, we developed a set of recommendations addressing these obstacles.

Upon completion of this project, it is hoped that the data found herein becomes a significant part of the Nation Science Foundation's existing store of information relating to undergraduate education. Ultimately, the NSF might consider funding follow-up studies designed to further explore our findings and test our recommended solutions. In addition, the undergraduate learning institutions themselves may wish to implement the solution strategies that we postulate.

Using our preliminary on-campus interviews at Worcester Polytechnic Institute (WPI), Georgetown University, and George Washington University (GWU), we isolated five types of barriers that instructors encounter in developing a Web-enhanced course; these are discussed in the Results and Analysis chapters.

The entirety of the data that we collected were obtained through the use of interviews and focus groups. This method was selected because the data we collected is primarily subjective, and we wished to keep our data collection methods open-ended to allow the interviewees to express unbiased opinions.

For our data collection sites, we traveled to three undergraduate universities around the country and collected data and opinions regarding faculty's experiences with Web-based education. In addition, we visited two preliminary sites in the Washington, D.C. area.

The Interactive Qualifying Project (IQP) is a degree requirement at WPI. It provides undergraduates with the opportunity to study the interaction between science, engineering, technology, and society in a particular field not necessarily related to their majors of study. This project will take a close look at the use of educational computing resources, particularly those located on the World Wide

Web. Since education profoundly affect all aspects of our society, this project qualifies as an IQP.

Chapter II

LITERATURE

REVIEW

2.0 Literature Review

The World Wide Web (WWW) has grown considerably since its 1989 introduction. According to Sloane (1997), the Web has potential to become a valuable resource for education. This literature review is intended to familiarize the reader with the basics of Web-based education. First, it will provide a definition of Web based (or online) education. Next, it will touch upon some of the existing barriers that either prevent or hamper the quality of undergraduate teaching and learning. Thirdly, the review will cover examples of online computing resources that are available to undergraduates today and have shown to be beneficial for Science, Mathematics, Engineering, and Technology (SMET) education. Finally, we will further develop a rationale for studying SMET education using the Web by exploring some resources that already exist online.

2.1 A Brief History and Background

Some background information on the technology comprising the Internet will be necessary for the reader to understand the issues at hand. What follows is an abbreviated guide to the Internet and World Wide Web that should help the reader to better understand the information in this report, as well as those in need of additional information on the subject.

2.1.1 The Internet

Web Developer's Virtual Library (1998) states that the Internet got its start when the US Department of Defense (DOD) commissioned the very first Wide Area Network (WAN). In the 1960's, the United States Government's *Advanced Research Projects Agency Network* (ARPANET) was developed when grants were provided to the Computer Science Departments and corporate institutions to research computer networks.

The ARPANET came online in 1969 and consisted of four interconnected computers (nodes) spread over the United States. The computers all operated individually, but they could communicate with each other over this cable network. The original aim of this network was to provide the armed forces with a method of communication which would not fail even if parts of the network were destroyed. This network has been in operation ever since, and it has grown to span half the globe.

Several military and academic Internet research groups continued to develop the ARPANET, creating in 1983 a new set of operating protocols, TCP/IP, which remains the standard today. The success of the ARPANET did not go unnoticed, and other similar giant-networks were created, such as BITNET (1981), which allowed for the connection between universities, and EUNET (1982), the European network. By 1984 the number of hosts had risen to over 1000, leading to National Science Foundation involvement. In 1986 the NSF established NSFNET, a backbone of high-bandwidth (capacity) cables, to carry the ever-increasing amount of traffic on the ARPANET.

By 1990, the ARPANET was just part of the many inter-connected networks around the world and could no longer be clearly identified. The existence of the ARPANET was officially canceled, and the inter-connected networks covering the world were named "The Internet." Also that year, the first commercial Internet dial-up access provider was created, allowing anybody to dial into the Internet using the telephone network. In 1991 the oft-mentioned World Wide Web was created. The NSF lifted commercial traffic restrictions on its much-coveted high-bandwidth backbone, NSFNET, and upgraded it to the ultra high-bandwidth T3 cables in use today.

The NSF created InterNIC in 1993 to help manage the Internet before removing the NSFNET backbone altogether in 1995, turning it into a research network. Private commercial backbone operators took over from the NSF, concluding the privatization of the Internet.

2.1.2 The World Wide Web

The following section is taken from Tim Berners-Lee (1996), who originally conceived the idea of the World Wide Web while he was working at CERN (the European Laboratory for Particle Physics) (Boutell, 1996). Berners-Lee envisioned a standardized network that would be made available worldwide for data transfer and information sharing. The problem inherent in the existing data retrieval systems was a lack of standardization. The moving of data from one system to another could be a very arduous task. Several early attempts were made at creating browsers, or software applications that use the HyperText Transfer Protocol (HTTP), that would retrieve data from the Web. These browsers, and all that have since followed, used a document standard called HyperText Markup Language (HTML) that allowed the format of a Web document to be specified through tags, or bits of data placed throughout the document.

One popular browser was written at the National Center for Supercomputing Applications (NCSA) and was called Mosaic. The NCSA at the University of Illinois at Urbana-Champaign is the leading site for the National Computational Science Alliance. In this capacity, NCSA anchors all Alliance teams and oversees the administration of all Alliance programs. NCSA leads the Alliance in its mission to maintain American preeminence in science and technology. Today, in 1998, several successors to the original Mosaic are available to the general public - among them are Microsoft's Internet Explorer™ and Netscape's Navigator™.

Over the three-year period from 1991 to 1994, usage of the Web grew exponentially. A Web server, a computer designed to handle network requests from other computers worldwide, was set up at CERN to monitor network use, and it was clear that the Web was being used by more and more people each year. In late 1997, an estimated 50 million Americans were using the World Wide Web (Dunlop, 1997). Today, the number of Internet hosts, or computers that distribute information on the Web, has reached almost thirty million worldwide (Kwon, 1998).

The World Wide Web makes use of Hypertext, a notion that brought about the adoption of the aforementioned Hypertext Transfer Protocol. Hypertext is a method of 'linking' documents together, and is Berners-Lee's solution to the problem of information sharing among different computer platforms. For example, using Hypertext, the World Wide Web allows users of UNIX, Windows, and Macintosh personal computers to link to documents housed on other types of machines, thus eliminating the "information linking" barrier that Berners-Lee found so problematic while working at CERN.

On the Web, each Hypertext link consists of highlighted text, and represents a pathway to another existing document. This document is, in theory, made instantly accessible to the user. The Hypertext Transfer Protocol's profound impact on information technology is that it provides the World Wide Web with the ability to transfer and store information in one format; links. Berners-Lee (1997) stated that people could reference virtually any other document that is accessible via networks.

2.2 A Description of Online/Web-Based Education

As its name implies, online or Web-based education involves learning or teaching that takes place over some type of network. For example, a local bulletin board service or the World Wide Web can be considered a network; also, local area networks (LANs) and organization-maintained intranets qualify as networks.

Also termed "Computer Mediated Communication" (CMC) by Kearsley (1998), online education is becoming more and more popular in schools, colleges, and even in professional training. At its beginning, online education was used solely to supplement classroom instruction. Gradually, it has also become a viable option for use by instructors as the primary form of interaction and information dissemination. In other words, this technology has evolved into a completely alternative teaching method for use by instructors.

The reader should take note of the fact that *online learning* and *Web based learning* terms are used interchangeably to describe courses of this type. *Distance learning,* however, is not and should not be used interchangeably with the above terms. This is for two reasons: firstly, distance learning may be implemented with other media such as television; secondly, it may involve use of the Web at a location far from the learning institution. Online and Web learning simply imply either partial or complete reliance on the Web for coursework; the learning may occur at any distance from the campus, and is often merely a supplement to the more traditional lecture-based classroom environment.

2.2.1 Pedagogical Elements in Web-Based Education

This section is primarily taken from Mason (1998), who delineates a common 'backbone' pedagogy that applies to all Web-based courses. These pedagogical elements should provide clarification as to what attributes are commonly found within any Web-based class. It is worthwhile to note that not every online course exhibits these traits; each is presented merely as a possible inclusion in Web-based curricula.

The first attribute of importance is the structured discussion. An online implementation of such a discussion might be as follows: an instructor may assign specific tasks to individual students or groups of students, who upon completing the assigned tasks will report their findings back to the rest of the class. The discussion takes place at this point and is mediated by the instructor. In an online environment, these discussions can take place via email, bulletin boards, or threaded discussion groups. For example, the bulletin allows students and faculty to post questions and answers in a forum where all have the opportunity to view them.

The second criterion for the online course is that of collaborative learning. Students may be assigned to work together on a research paper, or perhaps put up a Web site with each other's help. Traditional exercises and problems may be completed by students, who can then compare their solutions with others. Taking this last idea one step further, finished work might be posted to a students-only forum where each classmate may critique his or her peers' work.

Thirdly, Mason mentions the online assessment as a possible attribute of the online class. Students can now submit work via the Web, which may be corrected by automatic grading software and immediately returned. Multiple-choice exams or quizzes are the most easily implemented, but tools also exist for the grading of more open-ended questions. Practice exams could also be issued electronically so that the instructor might better gauge the class' understanding of relevant material.

Finally, Mason mentions interactive course materials. This goes beyond the repository-based information storing that many courses may implement; a course Web site is not deemed 'interactive', for example, if the instructor has simply Web-published a reading assignment or a course syllabus. Interactivity may be achieved with discussions, examinations, and with programs such as the University of Arizona's Project for Online Instruction and Support (POLIS) that is discussed in section 2.5.2 of this review.

2.3 Advantages of the Web as an Educational Tool

Sloane (1997) believes that the educational potential of the World Wide Web is still being realized. He discusses a study carried out at the University of Wolverhampton, in which the use of the Web as a teaching tool was examined. The study revealed that using the Web in this manner gives students increased access to more current information than what is obtainable at a traditional university library. In addition, it has allowed students to have both greater input into their own learning process and be less dependent on traditional lecturing. It has also permitted a more flexible, individual approach to assessment and learning than is possible in the aforementioned traditional style (Sloane, 1997).

What makes the Web so attractive as an educational resource? Mason (1998) has cited structured discussions, collaborative learning, and interactive course materials as three of four elements found in Web-based education, but he adds that all three of these could also be implemented in more traditional ways. What follows is a brief explanation of what differentiates education using the Web from the mbre traditional methods, such as the lecture-based style that is more prevalent on college campuses today.

The first differentiating factor is that students have much more flexibility in the scheduling of their learning endeavors, a phenomena discussed by Finklestein et al (1998). For example, Picciano (1998) mentions an administration class at the City University of New York (CUNY) held during the Spring of 1997. Students taking the class were mostly part-time students with steady jobs that made it difficult for them to attend class during normal business hours. As a result, the class was designed in an online format; Picciano (1998) reports that students found it especially convenient to have the ability to access the course material according to their own scheduling needs.

The online environment also provides what sometimes proves to be a less inhibiting environment for students. Mason (1998) asserts that the Web may help dissolve the invisible barriers that students may place between themselves and the teacher; this results in more peer-to-peer and student-teacher interaction. In this context, a barrier might be defined as any anxiety, fear, or apprehension a student may have when conversing with his/her classmates or professors. Consequently, Mason believes that this enhancement of interaction yields a better learning experience for all those involved.

Finally, the Web is an excellent media for distance learning. Should a student population be far removed from any learning institution, the Web may be used as the sole means of instruction. The same class previously mentioned by Picciano (1998) was attractive to the working students because they could study from the comfort of their own homes.

2.4 Existing Barriers to Web-Based Education

Bork et al (1998), Cravener (1998), Nissenbaum, and Walker (1998) discuss various barriers to Web-based education. Of these barriers, there are three chief types: technological, psychological, and institutional. The first category of barriers is technological in nature: for example, the availability of hardware and software educational tools. A second and perhaps less tangible group of barriers deals with human psychology; it addresses issues such as the reluctance to embrace new ideas, in this case the World Wide Web. The third set is barriers introduced by academic institutions: for example, the appropriation of funds for a relatively untried teaching method.

2.4.1 Technological Barriers to Web-Based Education

The following section is taken solely from Bork et al (1998). Bork raises several issues regarding Web-based education. First, he states that the main problem with distance learning on the World Wide Web is the lack of interactivity contained within many educational Web sites. Such sites, Bork believes, are sufficient at delivering information, but they are not sufficient to teach students such skills as open-ended problem solving, critical thinking, and creativity.

Secondly, Bork identifies network availability, reliability, and responsiveness as other problematic areas. With increasingly large numbers of students ready to use the Web, he believes that network slowdowns will hamper any learning that would otherwise take place. Network slowdowns would bring down the rate of accessibility of a computer, preventing the students from completing an assignment requiring the Web. In addition to network slowdowns, he says that most schools actually lack a network capable of providing such computing to every student.

Professor Karen A. Lemone (1998) of the Worcester Polytechnic Institute (WPI) in Worcester, Massachusetts, states that the tools provided to educators and students for the use of the Web must also be user-friendly. The current tools that are in place for distance learning at WPI, she says, are sufficient for those people who are computer literate. However, faculty outside of the Computer Science department have yet to make use of the online course tools available to them.

2.4.2 Human / Psychological Barriers to Web-Based Education

Cravener (1998), disagrees with Bork's observations concerning Web-based learning. According to Cravener, the real problems with this type of learning lie not in technological shortcomings but in the educators' use of the medium. Redd (1997) seems to agree by stating that teachers should once again assume the role of the student and be brought back to classrooms where they can be shown how to integrate the Internet with their curricula.

Professor Lemone (1998) revealed information concerning Web-based learning classes that she taught at Worcester Polytechnic Institute. She says that non-computer literate professors and students had a hard time adjusting to teaching and learning over the Web. Basic skills, such as making proper use of a Web browser, had to be taught to new students by a live teaching assistant. This lack of familiarity with the Web and its usage would almost certainly have an effect on the students' ability to learn.

Rogers (1983) notes that new innovations will inevitably spread at a slow rate unless their progress is actively encouraged. In terms of Web-based learning, Rogers would not expect faculty and students to instantly adopt such a new learning paradigm. Dr. Rachelle Heller (1998) seems to agree with Rogers, saying that instructors are divided into three types, the first of these being the 'early adopters'; this includes professors that have been active using the World Wide Web since its inception. The second category that she informally includes are the more cautious or reserved instructors, the "latter settlers", a group that might need more incentive to use the Web, or perhaps more proof that its use is worthwhile for their teaching endeavors. The third and final groups that she mentions are those professors who are firmly rooted in the realm of lecture-based instruction, and do not wish to alter their instructional habits.

The remainder of this section is taken exclusively from Nissenbaum and Walker, who state that some critics view computers in schools as a threat to the 'human relationship' between the student and the instructor. The authors believe that there is a fear that computers will displace teachers from their respected place in the classrooms, where they serve as intellectual leaders as well as coaches for academic standards and good conduct.

Nissenbaum and Walker raise two critical questions: will the student-teacher relationship will be harmed or weakened by the computerization of schooling, and should this possible weakening of the student-teacher relationship be a major concern at all?

The authors address these two questions by describing the roles that an instructor plays. Professors motivate and inspire students to learn, as well as guide the students' learning. They serve as an emotional bridge aiding the students' passage from the intimate world of the family to the impersonal public world. For these reasons, some may argue that teachers are critical, although computers may have some limited usefulness for teaching in such areas as basic skill development. Some critics believe that teachers' eventual replacement by computers would be a great loss. This would mean the loss of teachers' power to motivate students.

2.4.3 Institutional Barriers to Web-Based Education

Deden (1998) asserts that most college professors issue material during lectures. He believes that this type of teaching does not facilitate communication and teamwork skills, nor does it foster use of computing resources that might otherwise be included in the curriculum. In addition, he thinks that most lecturers do not know how to effectively conduct their classes in a format different from lecturing. He also mentions that throughout their own education, lecturing may be the only type of instruction that teachers received (Deden, 1998).

Faculty members are, according to Candiotti et al (1998), the most critical component when integrating computing with curriculum. Surveyed in 1991, recent alumni of New Jersey's Drew University reported that they received little in the way of computing assignments during their undergraduate education; faculty simply hadn't required that such assignments be a part of their curricula (Candiotti et al, 1998).

Faculty also need to be given adequate technical support, according to Reese (1998), Heller (1998), and Morrison (1998). Without adequate support, faculty members will almost certainly be less inclined to develop online course materials; technical support personnel are absolutely critical if an institution wishes to further its online education offerings (Candiotti et al, 1998). A recent study reported by Young (1998) reports that campuses everywhere are making increased use of technology, and that of the 571 two-year and four-year universities visited, "assisting faculty with the use of technology" ranked as the highest concern of college computing administrators.

Howard Kaplan (1998) raises other issues that concern faculty. First, they may resist the idea of distance learning, a subset of the more general 'online' learning, because they feel that it is a threat to their job security. He states that universities would not need to keep the same staffing levels if Web-based course offerings became more commonplace. Secondly, Kaplan adds that most instructors do not have the time to actually implement such courses - their schedules are already full. Development of interactive Web sites is a very time-consuming process, and is a skill that Kaplan believes few professors possess.

In addition to development time of online resources, Finklestein et al (1998) mention that maintenance time spent on Web-based learning sites by instructors and their teaching assistants may be greatly increased. This is largely due to the number of electronic messages posted by students. In addition, Finklestein et al (1998) note that students make more use of online tutorial sessions or 'office hours' than they otherwise might in the traditional lecture setting.

Both Marr (1998) and Morrison (1998) feel that incentives must be provided to faculty members if institutions wish to see increased used of the Web as an educational resource. Morrison feels that universities must place value not only on factors such as the amount of grant money an instructor receives or the research that they may complete, but on the innovation that such instructors employ in their teaching methods as well. This, Morrison feels, will provide a more supportive environment for the development of online educational resources at universities across the country.

Smaller colleges such as community colleges and two-year schools may be reluctant to allocate funds for such programs as distance learning. They feel other communication priorities may be more pressing when considering budgetary constraints. (Computer Science and Telecommunications Board, 1994).

2.5 Examples of Educational Resources on the World Wide Web

Explained below are just a few of the myriad examples of how the Web has been used as a quality educational resource. Perusal of this section should indicate to the reader how some institutions and faculty are currently making effective educational use of the World Wide Web.

2.5.1 An Interactive Physics Lesson

The following example is taken primarily from Kaplan (1998), who relates a multimedia physics lesson placed on the World Wide Web. This lesson is aimed at exposing undergraduates' physical misconceptions about circular motion. To do this properly, students are first shown a video of a ball rolling on a circular piece of track. The ball is stopped, and a section of the circular track is removed. After the ball starts rolling again, the video is frozen and students are queried as to what the ball's trajectory will look like after it leaves the track. Most students answer that the ball will continue to move in a circular fashion, but a rendered animation quickly depicts the correct trajectory of the ball.

Kaplan's research indicates that this sort of presentation raises test scores significantly. While this particular example could be implemented with a standard VCR tape, it is not difficult to imagine that such animations could be placed on the web and made more interactive.

2.5.2. The Project for Online Instruction Support (POLIS)

Cravener (1998) mentions the Project Center for On-Line Instruction Support (POLIS), which is the University of Arizona's World Wide Web-based interactive online discussion forum. POLIS works as follows: A debatable issue is presented to each student, who must then pick a perspective from which to view the issue. POLIS will then counter the student's view, and the student is expected to defend his/her position. Cravener believes that the strength of POLIS is that it engages every one of its distance-learning students in an analysis and discussion, something which few lecture courses provide.

2.5.3 Distance Learning

According to Phillips (1996), distance learning is not a new concept. In the 1980s, she says, students were introduced to the possibility of video-conferencing with cable television and the use of VCR's to view previously taped lectures. To Phillips, education in the comfort of one's home was becoming increasingly easier.

In the past few years, Colorado State University's Graduate School of Business has taken steps to move its video-oriented distance learning program towards the use of the World Wide Web. The University's director of distance education and media says that all courses now involve the use of asynchronous communications, such as bulletin boards, among students. Other materials, such as syllabi, are also available on the course Web sites. Independent ratings find the Colorado MBA students to be among the top 25 percent in the nation, regardless of whether students attend class on campus or via the Internet. One might infer from this that there is no difference between Internet learning and traditional learning; the reader should be advised that this is not necessarily the case.

The concept of the "virtual university", an example of which is the Internet Virtual University (http://www.ivu.com/), is another medium for online distance learning. According to this Web site, the Internet Virtual University (IVU) provides an online symposium for colleges to hold their classes. Each college that uses the Virtual University provides the instructors and course content, and the IVU helps the colleges customize their portion of the Virtual University to their own needs.

2.5.4. An Online Course offering at the Open University, UK

The entirety of this section is taken from Petre et al (1998), who discuss the use of the new technologies, more specifically the Internet, as an important advancement for distance education. According to the authors, simply translating the educational materials into an electronic media is not educationally productive. The value of the Internet technology lies in the transformation of support mechanisms to exploit the medium's potential range.

In the article, Petre et al observe that Web-based distance courses held via the Internet had a few drawbacks; among these are increased demand on staff time, complication of supporting administrative systems, and additional technological overhead for the students. At many institutions, more course materials are being shifted to HTML format and are less commonly printed on paper. For this translation of curriculum, however, little support is offered.

The aim of this transformation is to engage students in a "community setting of learning" which focuses on answering three important questions: Firstly, what is Internet's effects on education? Secondly, are the Internet and education complementary to each other? Thirdly, do the benefits offered by this type of learning outweigh the disadvantages?

To answer these questions, a study was conducted at the Open University (OU) in the United Kingdom, which taught approximately 150,000 students using distance learning technology. The study's main focus was on the development of electronic assignment handling system, including electronic assignment submission and automatic verification and record keeping, as well as conferences and Web resources. The OU's particular conferencing system allowed for one-to-many and many-to-many communications with a World Wide Web form-based system. It allowed for membership access control, sub-grouping and user selected email notification of any posting; loosely put, any posting made can include web-links which others can utilize to access other curricular materials.

For this study, the content delivered by both media (television and Internet) remained unchanged, meaning that the course structure, assignments, and course materials were the same for both. By holding the main factors constant for the study, it was possible to conduct an informative comparison between the presentation methods and student learning progress.

The study conducted at this Virtual University yielded some tradeoffs in cost and gains. As one can imagine, there are many costs to utilizing Internet-based systems versus conventional distance learning systems. The first of these was the need for more technical support, which required constant maintenance of key systems. Another cost was the expense of providing tutors with adequate hardware. Finally comes the issue of student expenses; students need to learn the tools and skills required to complete their work.

One of the key problems identified was the loss of social interactions for those involved. More specifically, those who preferred face-to-face interaction with other students found distance learning to be lacking. This was because it limited their ability to establish a "community of learning." For this particular study, it was clear that electronic materials and tutorials were no substitution to face-to-face interaction. The authors note, however, that there is still great unexplored potential of Internet-based distance learning.

2.6 Eliminating Barriers to Web-Based Education

Bork et al (1998) cite lack of interactivity of the Web as one of distance education's flaws. Perhaps the most cost-effective use of interactive education can be found in a fairly new concept introduced by Sun Microsystems - their Java™ Technology (Soloway, 1998). Java is highly modular and its programs are cross-platform, meaning that any applications written with it will run on a Macintosh, PC, or Unix machine (Kaplan, 1998).

Soloway (1998) says that this is good news for schools because they are likely one of the largest multi-platform computer markets. If more traditional methods are employed to write educational software, the developers must write platform-specific versions of the product. As a result, the purchase price of the software rises (Soloway, 1998).

Cravener (1998) suggests Integrated Distributed Learning Environments (IDLEs) as another way to circumvent the interactivity problem. IDLEs utilize the Web for both synchronous and asynchronous communications; this is so that students may collaborate with their peers via email and bulletin board services. IDLEs can offer other services to students and faculty as well- one good example of an IDLE is the Web-CT software discussed later in this section.

Kearsley (1998) suggests that the problem of interaction cited by Bork et al (1998) can be addressed through the use of discussion environments. Such environments may include questions or topics proposed by instructors, whereupon students could post their responses to a bulletin board for the rest of the class to peruse. This, Kearsley believes, may lead to further discussion on the topic and sharing of ideas.

Kearsley (1998) also asserts that feedback pertaining to the online submittal of ideas and other work is a key part of the online learning experience; it may encourage students to submit their ideas more often. He says it is up to the instructors to provide the students with such feedback. Peer-to-peer evaluations may also prove useful for the students to talk candidly about others' work.

It is the sentiment of Goldberg et al (1996) and Lemone (1998) that educators who lack a sufficient background in World Wide Web publishing need better tools to assist them in their efforts. Two examples of such tools made available to professors are Blackboard Inc.'s CourseInfo™ and the previously mentioned Web Course Tool, or Web-CT™. Web-CT provides a simplified development environment for instructors so that they may more easily place content on the Web; the software takes care of the more technical details of online publishing like HTML coding (Goldberg et al, 1996). Some online tools provided to the instructor by Web-CT are quiz capability, real-time chat features, bulletin boards, and self-evaluations for students.

Previously mentioned was the issue of technical support, moreover, the support of faculty in their online publishing endeavors. Morrison (1998) asserts that in order to deliver this support effectively it may take two forms: hardware and software support personnel, coupled with staff that run workshops specifically designed for faculty instruction. Candiotti et al (1998) mentioned such a workshop that is used at Drew University, stating that both the workshop and the full-time support personnel that staff the workshop were invaluable in the university's faculty support efforts.

Chapter III

Methodology

3.0 Methodology

As this project involved the exploration of barriers to Web-enhanced learning in SMET related disciplines, the data collected consists primarily of the experiences and opinions of instructors, administrators, and staff members. We gathered this data through a combination of interviews and focus groups; these were conducted at several institutions across the country, all of which will be discussed in greater detail in the sections below.

The following methodology provides both the procedure that was carried out, as well as the rationale associated with those procedures.

3.1 Methods of Data Collection

The data collected for this project was primarily qualitative. We favored qualitative methods because quantitative data proved less applicable to the task at hand. As a result, the bulk of our data came from the thoughts and opinions of interviewees.

Our team decided to conduct our data collection using interviews and focus group studies. Both methods lend themselves well to qualitative forms of research because they do not employ numerical or statistical data. Keeping in mind that we sought to identify barriers to the use of the World Wide Web as an educational tool, we decided upon a semi-structured questioning format. This format allowed the interviewee the opportunity to provide their own unbiased perspectives about barriers that were not necessarily known prior to the interview. In addition, it provided us with the freedom to probe our interviewees about whatever new topics they discussed.

3.1.1 Interview Procedures

To conduct the interviews, we first had to make an initial contact with each of the selected universities. Some groundwork was necessary for the selection of this contact. We located through use of the Web a faculty or staff member that would give permission to conduct interviews and focus groups at their institution, as well as make recommendations as to whom else we could interview.

After attaining the proper contact information we prepared an introductory letter that was sent to the interviewees. It included information about the study and a brief discussion of the type of instructor we were interested in interviewing. The interviewee list was assembled from the recommendations of the aforementioned contact person.

Before perusal of the results section, the reader should note that our interviewees were provided with anonymity. This was done because sensitive issues such as tenure were brought up in our data collection, and we felt it necessary to provide an environment in which professors could speak freely without fear of retribution from their institution.

The reader may wish to consult appendix B, which contains our interview questions.

3.1.2 Focus Group Procedures

To supplement the data from the interviews, we made use of focus groups. According to Aaron et al (1996), the focus group is a planned discussion designed to obtain a group of individuals' perceptions on an area of interest. These focus groups provided us with the opportunity to gather data from more sources than interviews would allow.

Before continuing, it might be useful for the reader to note some background information provided by Kreuger (1998), who says that from the late 1950's through the 60's, focus groups were seldom used in academics. Originally used on lay persons to gather information about consumer products, academics shunned focus groups because the "analyses were too confusing." Later on, academics slowly realized the benefits which focus group procedures could provide.

One of the advantages provided by focus groups is that of time savings. As we would only be staying a maximum of four days at each institution, the use of focus groups was an attractive addition to our data collection methods; it takes less time than interviewing each participant separately. We intended for the focus groups to have no more than six participants for the reason that a larger group may have proven too unwieldy to mediate,

Considering our interviewee population was also key to our procedures, it proved difficult to assemble a group of busy professors for any length of time. Ultimately, the group decided to hold lunchtime sessions for any focus groups we conducted in the hopes that instructors would be most available at that time.

3.2 Location Selection

All of the data was collected at a variety of undergraduate Science, Mathematics, Engineering and Technology (SMET) colleges and universities. We visited different types of institutions in an attempt to cover the broadest range of SMET colleges possible. To lend definition to "broad range," we isolated several attributes. First, the schools that we chose must have been two-year or four-year institutions. Secondly, we attempted to select both private and state-funded schools. Thirdly, geographic region was taken into consideration.

For the sake of our study, we felt it necessary to perform our data collection in two phases. The first phase, or Preliminary phase, was used to test our data collection methods. Two schools were considered satisfactory for this phase because they were easily accessible to us.

These Preliminary visits provided us with the chance to revise our data collection methods and focus group / interview questions. This practice would provide us with better data for our second phase, or Primary phase. The Primary phase was conducted at three schools selected by the criteria that are outlined later in the chapter.

Before outlining these criteria, it is worthwhile for the reader to note that our study was by no means a controlled experiment. We did not treat each of the following criteria as "controls," nor did we attempt to draw comparative conclusions among universities on the basis of these criteria.

Following from this fact, the reader should instead be advised that this was a survey study intended to convey possible areas in which the NSF may wish to provide grants for further exploration. A larger sampling of schools would almost certainly have led to more conclusive data and consequently a more thorough analysis; we felt that such a study, while more desirable, could not be reliably carried out given our time, personnel, and budgetary constraints.

3.2.1 Site Criteria

Due to restrictions such as the number of people and amount of time we have to complete this project, the number of institutions visited was limited to five. The two preliminary institutions were George Washington University and Georgetown University. The main function for the preliminary schools was to test our interview and focus group questions, as well as to provide practice in conducting them.

The primary institutions were the New Jersey Institute of Technology, Prince George's Community College, and Florida A & M University. From these sites come the bulk of our data. All three of these schools had in common at least one of the three characteristics explained below.

Firstly, the Primary institutions had NSF funded programs in the form of grants and awards. It is important to note that, while we decided to include schools that had NSF funded programs or projects; it was not necessary that the institutions received funds for Web-based education. An advantage to having NSF funded programs at the Primary institutions was to expedite the findings of possible contact persons at the selected sites. This method was never utilized, but it was hoped that this contact might be one through which we could network and obtain a list of desirable interviewees.

Secondly, we considered schools on Yahoo!'s 100 Most Wired colleges list. The rationales for this criterion are many: First was the guarantee that the institutions would have the hardware, software, and network connections necessary for constructing Web-based courses available to them. Second, the instructors and faculty at the institutions located on this list were more likely to be familiar with using the Web. Following from this, we assumed that the instructors and faculty would have some valuable experiences to share.

Our third and final criteria for school selection was they may be ABET (Accreditation Board of Engineering and Technology) accredited. To provide a brief background on ABET, the board accredits engineering, technology, and applied science programs. It also promotes quality and innovation in engineering, technology and applied science education. In addition, it consults and assists in the development and advancement of education in these areas. From this criterion, it was guaranteed that the selected schools had qualified SMET curricula.

A random sampling of schools was taken from ABET's Web site. Afterwards, we conducted a thorough analysis of the schools from their own Web sites, looking for features offered such as campus-wide email, distance learning programs, and other Web-materials posted by either the instructor or a Webmaster. If we determined that the campus had enough involvement in web-enhanced education, we considered their inclusion in our site visit list.

In selecting these institutions, the best attempt was made to include schools possessing a broad range of qualities. Public and private institutions as well as universities and two-year community colleges were included. We did not require that the schools have core curriculums related to engineering; in fact, we made many attempts to prevent exactly that from occurring.

To assist us in our data collection, the NSF granted us a travel budget to visit the schools that we selected. Since this budget was finite, we had to limit both the number of schools visited and the distance traveled to each school. For this reason, our schools are located on the Eastern Seaboard.

3.2.1.1 New Jersey Institute of Technology[1]

Criteria for Selection:

New Jersey Institute of Technology (NJIT), in Newark, New Jersey, was selected because it satisfied two of the aforementioned criteria. First, it was one of the top 100 most "wired" colleges in the U.S. (It made 2nd place)[2]. In addition to that criterion, it is also NSF funded. ["Studies of Distributed Multimedia Support for Group Collaboration via the Web" code: 9732354].

New Jersey Institute Technology was selected with a four-year technical college / university in mind. A thorough search of their Web site quickly led us to conclude that NJIT had a strong Web-enhanced learning curriculum.

Quick Overview:	Public coed university
Awards:	Bachelor's, master's, doctorate degrees.
Founded:	1881.
Setting:	45-acre urban campus
Endowment:	$13.6 million.
Total enrollment:	7,837

3.2.1.2 Florida Agricultural and Mechanical University[3]

Criteria for Selection:

Florida Agricultural and Mechanical University (Florida A&M), in Tallahassee, Florida, possessed two of our primary school selection criteria: It is ABET accredited and NSF funded. ["Institution-wide Reform of SME&T Undergraduate education "code: 9653692] Florida A&M University was chosen primarily because of the changes that its university is currently undergoing[4]. The "Information Technology Strategic Plan 1996/1997-2000/2001" is currently being implemented by the UPA[5] (University Planning Analysis) department. We hoped this initiative would provide us with interesting and informative faculty member concerns, as the university was quite clearly still in the process of becoming technologically sound.

Quick Overview:	Public coed university. Part of State University System of Florida
Awards:	Associate, bachelor's, master's, doctorate, first professional degrees
Founded:	1887.
Setting:	419-acre urban campus.
Total Enrollment:	10,448.

3.2.1.3 Prince George's Community College[6]

Criteria for selection:

Prince George's Community College located in Largo, Maryland, is a Technology Accreditation Commission (TAC) ABET accredited institution[7]. A two-year college was selected in keeping with our intent to provide the NSF with information from a broad range of schools; the reader should note that we had already selected two four-year institutions. This particular school was selected from a long list of other two-year schools because it has a strong web-based distance learning curriculum.

Other attempts were made to find other two-year colleges that were also "wired" or NSF-funded, but neither were very successful. Note: this particular school was found by cross listing Peterson's two-year College Guide[8] with ABET accredited schools and NSF funded institutions list.

Quick Overview:	County-supported 150-acre suburban campus with
Accreditation:	regional
Enrollment Profile:	97% state residents 11% transferred in, 1% international 53% 25 or older, 65% women 65% African American 1 % Native American 3% Hispanic, 6% Asian American.

3.3 Task Chart

Ben Clark
Adriano Palombizio
Taryn Syverain

Tasks

Become acquainted with our organization-the NSF

Continue research on web-based learning

Setup and Conducting of Interviews and Focus Groups at GWU, Georgetown, Prince George's:
'Set up interviews with professors and support personnel
'Arrange focus group dates, times, and places
'Conduct Interviews
'Conduct Focus Groups

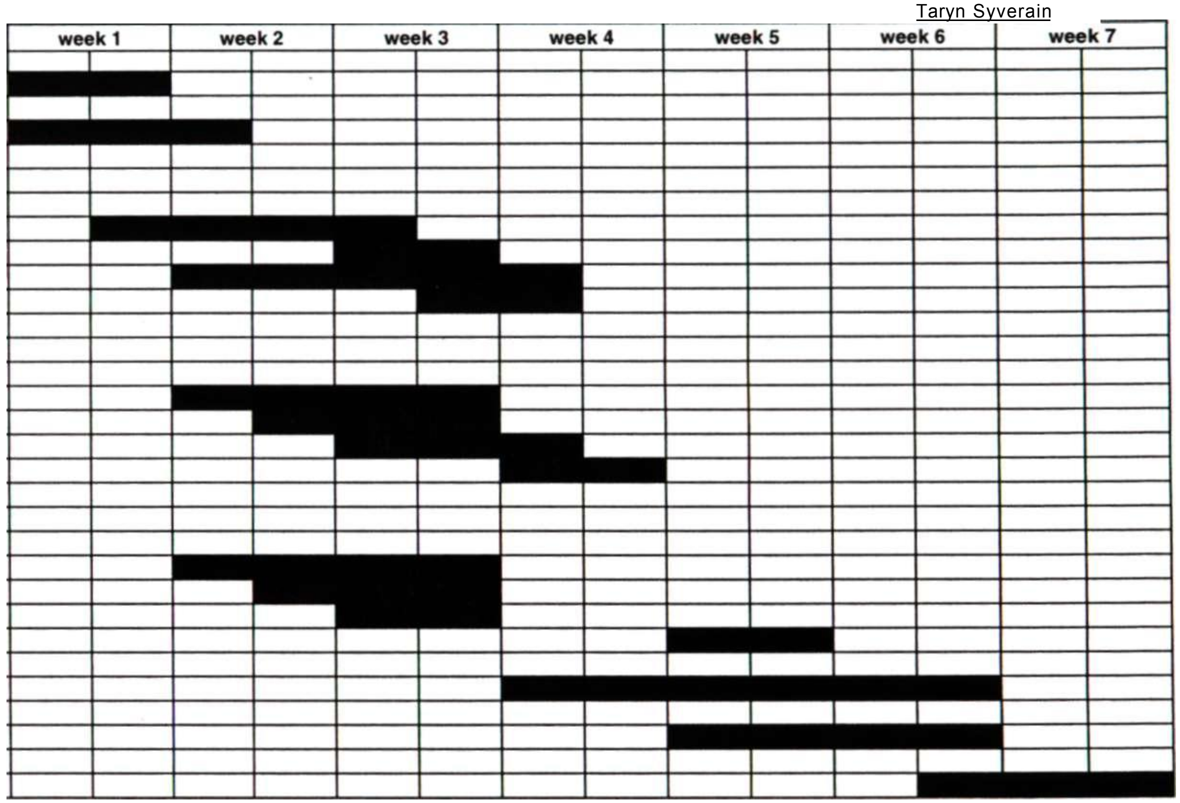
Setup and Conducting of Interviews and Focus Groups at NJIT (Taryn, Adriano):
Make travel arrangements(meet budget!)
'Set up contacts with professors and support personnel
'Arrange focus group dates, times, and places
'Stay at NJIT- conduct interview and focus groups

Setup and Conducting of Interviews and Focus Groups at FAMU (Taryn, Adriano):
'Make travel arrangements(meet budget!)
Set up contacts with professors and support personnel
Arrange focus group dates, times, and places
'Stay at FAMU- conduct interview and focus groups

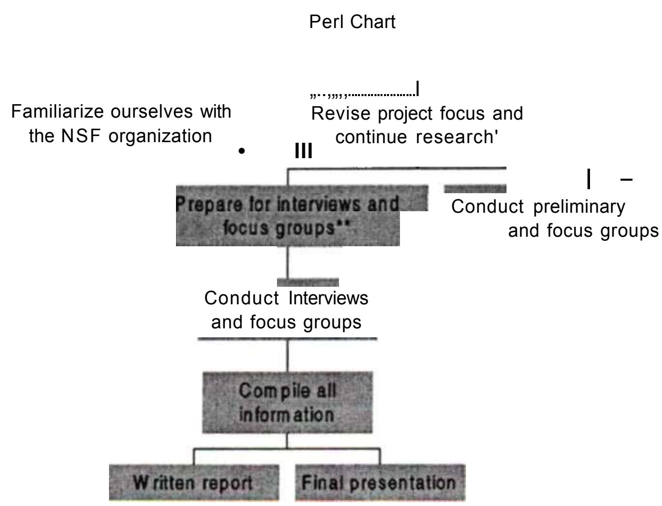
Compile information from interviews and focus groups

Write Report

Final Presentation



3.4 Pert Chart



* includes reworking of methodology and drafts of Literature Review and Appendix A

" includes background reading, preparing interview and focus group questions, selecting schools, finding contacts, and scheduling interview and focus group sessions

Chapter IV

RESULTS

4.0 Results

The following section contains the resulting data that was collected at both our preliminary and primary institution visits. The reader should recall that the preliminary institutions visited were George Washington University and Georgetown University; the primary visits were conducted at New Jersey Institute of Technology, Florida Agricultural and Mechanical University, and Prince George's Community College in Largo, Maryland.

Our project's investigations have been carried out through some 25+ interviews and two focus groups. Our findings have both supported and expanded our previous views regarding existing barriers to the use of the Web as an educational medium. Our preliminary site visits led us to adopt the "Five T Approach," which is explained later in this section.

The data collection process at the preliminary institutions was not as exhaustive as the process performed at the primary institutions. The preliminary institutions, in addition to providing us with the insight to adopt the Five T Approach, did indeed provide our study with relevant data. It is necessary, therefore, to include some data that was collected from these universities.

Five themes were isolated from each interviewee's primary concerns, and those themes comprise the Five T Approach:

1) **Time,** involved to learn, prepare and transform traditional class material into a Web-based format, as well as keeping up-to-date with the new technologies.

2) **Tools,** Web content creation software whose methods of utilization need to be made more apparent to instructors, and whose availability and accessibility need to be increased.

3) **Technical support,** which should be made available in sufficient supply, not only for computer maintenance, but for Web-specific, discipline-related difficulties as well.

4) **Tenure & Other Incentives,** which can be improved by altering tenure requirements to encompass pedagogical innovations (Web-related or otherwise), along with the more widespread use of more traditional incentive programs.

5) **Technology,** which includes the purchase and maintenance of ample, up-to-date hardware, as well as having more ubiquitous network access.

4.1 Preliminary Site Visit Data

The preliminary site visits were, for the most part, a practice run by which we could hone the data collection process. By gaining experience with questioning procedures, we hoped to perform our primary institution visits quickly and efficiently. Data collected at these sites are for the most part non-useful to the reader; this is because the questioning process had not yet been adequately honed. However, the focus group and interview that are mentioned in sections 4.1.1 and 4.1.2 were conducted at the conclusion of our preliminary site visits, and the questioning process had been refined to the extent that data gathered from these interviews is worthy of mention.

At the time of the preliminary interviews, the group was using a very structured interview list that left little room for probing. As the preliminary interviews were conducted, it became clear to the group that a smaller, more open-ended list of questions would be needed to adequately interview the primary site instructors. This was mainly because each interviewee had such vastly different experience with the Web, and we felt that further interviews would warrant a format that allowed for more probing.

Such was the questioning process employed for the two preliminary visits and all primary visits discussed later in this section. The preliminary visits only make mention of some of the themes and are presented without compartmentalization; each primary visit, however, is divided into five sections, each covering one of the Five T's.

4.1.1. Georgetown University

Georgetown University is an institution that relies almost solely on traditional lecture-based classroom environments. At the time of this writing, the university still had not completed much in the way of setting up Web-enhanced course curricula. We thought we might have to abandon the idea of gaining pertinent information from Georgetown's faculty members, as it was clear that they had little or no experience supplementing their course offerings with the Web. The reader should remember that, as a preliminary visit, Georgetown's selection resulted mainly from its accessibility from our place of work.

We did, however, garner some interesting information from staff member A, who was a Ph.D. and had taught at the undergraduate level prior to joining the staff at Georgetown. Staff member A had been at Georgetown for only a few months at the time of the interview, and was not teaching classes; interestingly, his position was that of Faculty Development Coordinator, and it was his job to facilitate the faculty's use of computing technology.

Staff member A had previous experience with using the Web for coursework, and was in the process of making Georgetown's faculty aware of what resources were available on the World Wide Web for their own teaching pursuits. He was certain of one barrier that almost every faculty member at research universities face, and that was the barrier of time and tenure acquisition.

Staff member A said that some larger universities place too much emphasis on research-related writing and grant procurement, and not enough emphasis on the quality of instruction. Smaller universities, he stated, might place more importance on instructional innovation.

Larger universities such as Georgetown, he said, are inclined to award tenure to faculty members who perform extensive amounts of research and publish many articles in prestigious journals. They are less apt, in turn, to award tenure to a faculty member that decides to innovate his/her teaching methods and spend extra time delivering high-quality course content. Staff member A made it clear that, while some instructors are very interested in what the Web could do for them, they are also concerned that spending too much time developing material for the Web might endanger their jobs.

4.2 Primary Site 1: New Jersey Institute of Technology

The reader should understand that New Jersey Institute of Technology (NJIT) was selected because of its tremendous involvement in Web-enhanced undergraduate instruction. During our visit, it was clear that NJIT is at the forefront of this learning field. According to "Yahoo! Internet Life Magazine's 1998 List of America's 100 Most Wired Colleges", NJIT has some very substantial computing resources already in place. These resources are doubtlessly an integral part of the Institute's Web-learning infrastructure, and they helped place the Institute at number 2 on Yahoo's '100 most wired colleges' list.

Yahoo! states that 50% of classes at NJIT have some form of online coursework. There are over 4,000 public computers on the 46-acre campus, almost one public computer for every two enrolled students! In addition, the Institute requires that each student possess a personal computer; students pay a slightly higher tuition bill in return for the provision of such a machine. To better illustrate how permeated the campus culture has become with this type of learning, students living on campus actually have the option of taking distance learning courses. This allows them to resolve scheduling conflicts, as distance learning courses allow students to participate at a time of their choosing.

4.2.1 Time

From the interviews conducted at New Jersey Institute of Technology (NJIT), the issue of time was the most mentioned obstacle for faculty members in their use of the Web as an educational tool. Professors isolated a number of different time-related concerns, all of which are outlined here.

Firstly, those professors who had done extensive Web-based work said that their initial attempt at using the Web was more time-intensive than subsequent tries. Professor A, for example, said that by the third attempt his Web course became far easier to conduct. This, he said, is because he can reuse the information and material from previous attempts with little to maintain or update.

Professor E also possessed experience with Online Distance Learning (ODL), and said that advanced planning was her biggest concern. She explained that the class had to be completely set up before the start of the semester. Course syllabi, lecture notes, and other materials required extensive preparation before they could be placed on the Web; compare this, she said, to a traditional lecture-based course, where she could simply write her notes on the blackboard. In agreement with professor A, she did indicate that setup time diminished somewhat for subsequent courses.

Professors A, B, C, F, and H all agreed that time was the most significant barrier to Web-related educational pursuits. In accordance with the concerns mentioned by professor E, they helped separate the issue of time into a number of different categories.

First, nearly all mentioned that setup time was their biggest problem. Why should they take valuable time away from their research and teaching pursuits, only to divert energy to a seemingly much less time-rewarding endeavor? Building on that question, instructors felt that the time taken to translate existing curricula into Web-friendly formats is too formidable. Second, most mentioned that the time required to interact with students online is much greater than that of a face-to-face lecture; diagrams can be written on a blackboard, and verbal explanations take less time to convey than a typed one might. Thirdly, Professor C said that it takes time to keep up-to-date with newly emerging Web-technologies; this is worsened by the alarming rate at which Web-related technologies change. Professor H agreed that the location of relevant Web materials is also a time-consuming process.

Professor B found that two important qualities a professor needs to create a quality Web-enhanced class are organization and creativity. Organization is necessary, he said, to prepare the material into a digitized format as well as structuring it in an easy-to-use interface. For example, the site should be set up so that the student need not follow several links just to find the information they need. Lastly, creativity is important to professor B, who stated that placing course information on the Web isn't enough; the site must be kept somewhat appealing for the students to use.

4.2.2 Tools

Many of the interviewed professors mentioned content creation software tools and their relationship to the development of Web-enhanced courses. Instructor F remarked upon the importance of NJIT's university-supported tools, like the Electronic Information Exchange (EIES) system, as well as third-party tools, like Web-CT. The importance of these tools, she said, is two-fold; they allow instructors a possible way to overcome the initial fear of the Web by providing a critical 'first step' towards a fully Web-enhanced course, and they allow those professors with little technical background to make effective use of the Web. The latter is especially important, she said, because instructors simply cannot be expected to learn the rigors of HTML and Web coding by themselves.

Another interesting issue discussed by professors at NJIT is that of the 'Virtual Chalkboard'. Our focus group participants, as well as instructor F, said that some discipline-specific material was extremely difficult to place on the Web. Some of the disciplines mentioned in this respect were mathematics, computer science, and electrical engineering. For example, a math instructor can easily write a complex differential equation on a blackboard. The same holds true for an electrical engineer's circuit diagram. These same materials, said the group, are not easily generated for the Web.

Professor A expanded upon this issue by making a fictitious example. By creating a Java-based electrical and computer engineering software package, an online electrical and computer engineering course might be developed with pictures, schematics, and other graphical learning aids that are essential to instructor A's perception of how the students should learn the material. If such a tool were available, instructor A says, he would be much more inclined to use the Web.

In addition to those problems, Professor D believed the biggest initial barrier for professors is learning to use the tools and transferring lecture materials to Web-based materials using those tools. The focus group participants later expanded upon this notion, saying that while certain tools might prove particularly useful to professors, these tools often do not form a part of a course creation process.

The aforementioned process, according to focus group member A, is of the utmost importance in the creation of online materials. Once teachers become familiar with a theoretical process for online curriculum generation, then and only then should they be expected to learn the software and hardware tools necessary for the task.

4.2.3 Technical Support and Technology

Interviewee C proposed some important responsibilities for technical support personnel. In the interests of professors everywhere, he suggested that support personnel could help keep the faculty 'up-to-date'. As mentioned before, Web-related technologies evolve rapidly; by holding information sessions that instruct faculty in the use of new tools, support personnel would allow a faculty member the time to concentrate on implementing those tools in an effective and innovative manner, thus improving the quality of education for their students.

Interviewee F raised a legitimate concern stating that, at her school as well as others around the country, each student is given a brand new computer and instructors are not. Computers provided for faculty would doubtlessly aid in the instructors' use of the Web, allowing instructors to answer the questions posed by students on weekends and increasing faculty members' ability to work on course preparation and any potential Web supplements.

Another statement made by interviewee F was that some technological barriers are never eradicated: they just change in nature. Presently, he said, insufficient hardware and inadequate network bandwidth are easily remedied, while minor software bugs and incompatibilities among products which currently hamper effective usage of the Web are prevalent: Web browsers need periodic bug-fixes, plug-ins are compatible with only certain versions of a browser, used-to-capacity modem banks need to be enlarged periodically, and network servers to be upgraded or expanded every three years or so.

Focus group member C recommended still an additional responsibility for technical support staff, the education of instructors in the transfer of material to the Web. He further mentions that he would like to transfer some of his classes entirely to the Web, but doesn't have the faintest idea as to the first step involved in the process. Member B reinforced this concern by stating that the faculty must first be initiated to the resources that are available on the Web.

A program whose mention solicited an approving nod from each individual we spoke with at NJIT was the STARS (Student Technology Advisors) program. This is a semester long program designed to familiarize faculty with the Web environment, technology, and tools by assigning them a student helper. Begun in early 1998, the program helps faculty by assigning them students experienced with HTML, Microsoft PowerPoint™ and Word™, and other day-to-day applications.

4.2.4 Tenure & Other Incentives

Instructor H shared with us an interesting hypothetical situation concerning teacher incentives and how they relate the state of academia today. Suppose, said instructor H, that he is seeking a job at another university. That university, he said, will base its decision on several criteria; he added, however, that these criteria are not always instruction-oriented.

To clarify, Instructor H felt that the university will not base its decision on positive student evaluations, the quality of his lecturing, or his use of the Web as an educational tool. Instead, he feels that the university will only look at the research material that he has published. It is this type of scenario, he said, that makes educators everywhere reluctant to pursue more exhaustive teaching methods. Instructor H said that they feel such behavior will detract from their ability to attain tenure.

Instructor H was not alone in this thinking. Instructors C and F, along with all four focus group participants, had almost identical positions on the issue of tenure. The focus group participants felt that the university must make it clear to instructors that the implementation of any innovative teaching method, whether it be the use of the Web or otherwise, should be recognized and actively rewarded by the administration.

To make the severity of the tenure barrier clearer to the reader, it is worthwhile to mention a loose correlation postulated by instructor F: 2 or 3 journal articles could be written, she said, in the time it takes an instructor to make the extra preparation for a Web-enhanced class. Given existing faculty award systems, any tenure-mindful professor would be more likely to conduct their normal research rather than consider implementing Web-enhanced instruction.

In contrast, instructors B and D felt that they faced no such institutional barriers to their use of the Web in coursework. Both felt that they had sufficient time to implement their courses, and instructor D made it clear that he felt the administration at NJIT is fair when considering pedagogical innovations and how they affect the awarding of tenure. Other instructors, he said, should know that a large part of their job relates to research, not just instruction. If teachers wish for administration to change their accreditation habits, says instructor D, they should take the initiative and make it clear to the administration that changes should be implemented.

The next issue that was addressed by the instructors and staff at NJIT is that of the quality of Web education. Several instructors voiced concerns pertaining to the Web's effectiveness as a teaching tool. If instructor H, for example, could be somehow convinced that Web-enhanced classes were better for students than traditional lecturing, he says that he would certainly be more inclined to adopt and advocate the use of the Web.

Building on instructor H's concerns, Instructors C and F agreed and said that assurance must be provided to instructors that the Web is not a second-rate teaching mechanism; they must be convinced that it is a wholly alternative and effective means of instruction. Until proof of this is provided, all three instructors fear that other educators may be justifiably reluctant to embrace the Web as an addition to their pedagogy.

The issue of intellectual property is another incentive-related barrier relevant to our discussion. Instructor H first mentioned that the Institute claims ownership of all material that teachers publish on the Web. Instructors, according to instructor H, felt that they should instead retain ownership of their Web-material.

Later, the focus group participants went into greater detail on this issue. The general consensus of all the participants was that the university did claim wrongful ownership of the instructors' Web-based course material. The reader should note that the instructors feel university ownership of such material is sometimes justified; one such example might be if the university had received a specific grant to develop a Web-based portion of a particular course. However, the Institute can and does claim ownership of almost any curricula on the Web; this, said focus group participant D, is "exploitation at its best."

Faculty member H brings up another important incentive for faculty: the familiarity of the student population with computing technology. He feels that professors might feel less inhibited in making use of the Web on a campus filled with technologically savvy students. The simple reason for this is because the professors need not be concerned about the reaction students will have to using the Web in their class work. Not only does he think that students at NJIT have little problem with the use of technology, he says that they in fact embrace it. This, feels instructor H, results in more incentive for other faculty to learn the rigors of the Web; in turn, they may then make it a part of their instructional repertoire.

The aforementioned STARS program implemented at NJIT should also be mentioned; a successful technical support initiative, it is also relevant to our discussion of teacher incentives. All instructors who had participated in the program received a brand new Pentium II™ desktop machine. Those that had used the program reported that the lure of a new computer was too hard to resist. The STARS program was not specifically aimed at facilitating the faculty's use of the World Wide Web; it is not difficult to imagine, however, that such an incentive program might be helpful to this end.

4.3 Primary Site 2: Prince George's Community College

Located in Largo, Maryland, Prince George's Community College did not possess the level of technological sophistication that we found so prevalent at NJIT. We did, however, find a number of instructors who were wholeheartedly behind the use of the Web for education.

The reader should remember that our data collection process hinged upon a broad surveying technique; it was our hope that the concerns of two-year faculty members would differ from those at four-year universities. For this reason, we felt a community college to be a vital addition to our study.

Before discussing in detail each of the Five T Approach, the reader should also note the extreme attention paid to student-related concerns by instructors at Prince George's. Practically every professor mentioned their students during interviews; moreover, student concerns are to be found within each of the Five T's listed here.

4.3.1 Time

At Prince George's, time was again of the highest concern to instructors regarding Web-enhanced instruction. The fundamental time-related issues uncovered were preparation, development, and implementation of online course sites.

Professors E and C both felt that time is a multi-part barrier. Firstly, they mention that the time required in putting the curriculum up on the Web is very extensive. However, Professor E does mention that teaching her second and third Web-based courses were less time-intensive. Secondly, both instructors felt the time spent interacting with students was extremely prohibitive; holding online communications took much longer than verbal communication in a face-to-face environment. To clarify, Professor E stated that in an online environment such as the one provided by her course software, TopClass™, any more than 20 students would be too overwhelming to teach effectively; more than this amount was simply too great a number of students with which to interact.

Professor D speaks of the faculty's normal time obligations. Up to 15 hours per week are spent in a lecture hall or classroom; not to mention, she said, the additional time required to correct homework assignments and tests. Professor D made it quite clear that teachers at community colleges don't have the kind of faculty support that would allow them the time to attempt new methods of teaching. This is in sharp contrast to four-year institutions, where a group of teaching assistants may assist professors in these efforts. Despite this, the reader should note that instructors at Prince George's have no research obligations to fulfill.

Even tenured professors have some difficulties in setting up a Web-enhanced course (Section 4.2.4 contains more information about the tenure process at this particular college). Professor F is a tenured professor who made use of many interactive elements in his site: these include both Java applets and JavaScript-enabled items, like graphs that are displayed with the click of a mouse. It was Instructor F's sentiment that other faculty members need to be shown what is possible on the Web; only then will they begin to consider what Web-related supplements would be best for their own courses. He hopes to demonstrate his Web site to other faculty members the following Spring, with the expectation that Web-usage by faculty members would become more widespread.

Professor B mentions student concerns pertaining to time. His sentiment was that most of his students on campus also worked 20 hours a week at part-time jobs and felt that they had insufficient time to spend studying. He feels that if students don't have the time to come to class, they are not going be motivated enough to use the Web as a supplement to the class.

4.3.2 Tools

It was made clear by the professors at Prince George's that course tools such as Web-CT, TopClass, and Serf can prove to be invaluable to some professor's Web-enhanced teaching pursuits. Other issues that were identified include the use of the Web to publish discipline-specific graphs, charts, and symbols.

Instructor E emphatically noted that the TopClass software package was indispensable in her Web-based distance learning course. She stated that software tools such as TopClass are absolutely critical for any instructor who endeavors to make a course of this nature. TopClass and other such tools, she said, are the critical first step in coaxing more reluctant professors into increased use of the Web.

Instructors D and A both agree, saying that their Web-curriculum tools are also of great value. Not only do they allow the instructors to add content easily, but they provide the user with a template Web site that is useful psychologically; in other words, having a pre-made template site helped reduce their "first-time" anxiety and made it easier for them to focus on the task at hand.

Discipline specific Web-publishing issues were raised by instructors C and D at Prince George's. Faculty member C specifically mentions that the Web does not support the displaying of complex mathematical symbols, for example. Instructor D adds that graphs and other types of pictures are not easily posted on the Web.

Familiarity of the tools available was also talked about by Professor A. She mentioned in the interview that a firm foundation of understanding the Web and its tools are needed for both the professor as well as the student. Following from this fact, she had adopted a basic approach that was free of any complicated design, sticking to mostly static content. The reader should note that this is in stark contrast to professor F's approach, which was very dynamic, colorful, and interactive.

Professor C supports Professor A's comments, saying that students still seemed to have problems maneuvering around the Web. Professor C feels that some pupils take an extended amount of time to adapt to the Web. For instance, the WorldGroup Manager, a software package 'bulletin board' used by faculty at PGCC, was used only minimally by students in a class taught by instructor C. He stated that some of his students had a hard time motivating themselves in a traditional educational environment, "so how are they going to learn via the Web at a distance?"

Professor C notes that other instructors.may have a hard time converting existing class materials into a Web based format. When asked to do this transformation, he says, most professors would have no idea where to start. Professor D supports this opinion, saying that the Web is not necessarily the best medium by which to deliver content. For example, she feels that, given existing tools, producing graphs on the Web would vastly overcomplicate her teaching endeavors.

4.3.3 Technical Support and Technology

It was previously mentioned that Prince George's simply did not have the technological background or infrastructure possessed by NJIT. Given NJIT's commitment to technology, this should come as no surprise to the reader. Professor E cited technological problems at the very beginning of her interview, saying that the objectives for better Web-use at Prince George's should be two-fold. First, she said, the college must build a better infrastructure. Currently, none of the distance learning classes available on campus are housed on local servers; Prince George's relies on other colleges for this purpose. Secondly, the college should provide permanent staffing positions for the purpose of technical support. At the time of this writing, Prince George's had no salaried support staff for this type of service. Only recently, said instructor E, had the college provided some money to fund the teaching of technology workshops.

Another important issue raised by professor C was that of student access. Not every student has Web access from their home, and he added that network access on campus is sometimes hampered by long waiting times at on-campus computing facilities. This would doubtlessly have an adverse effect on the delivery of Web-enhanced course materials.

In addition to the students' ability to use the Web, professor C discussed the hardware and software with which Prince George's faculty must work. The crux of the matter is that not all faculty members at Prince George's have the proper equipment to even attempt the creation of a more Web-enhanced course.

To lend some clarity to the issue, instructor C said that half of the faculty do not even have Web access from their own office. Furthermore, he added that some faculty members still rely heavily upon the use of DOS-based applications. Some professors even have no choice but to run Windows 95™ on IBM-PC 386 machines.

Expanding on the issue of hardware, interviewee B did not feel that computer technology is a problem. Similar to the opinions of most of our interviewees, he feels that computers are cheap and plentiful. However, he believed that the Web needs to be more interactive to be effective.

Interviewee B stated that personnel is the most expensive portion of technical support programs. It is also critical to the technical fluency of the campus — students and faculty. He states that colleges should consider hiring support personnel with backgrounds other than computer science. Interviewee B agreed with the statements of NJIT instructors, saying that curriculum-oriented personnel are more useful in the explanation of pedagogical concepts and in sympathizing with instructors' plights.

Professor A felt that instructors who are uncomfortable with computers are very unlikely to take advantage of the Web and its resources for their courses. This sort of universal concern is not surprising- many of the interviewed faculty members also concurred that students are far more familiar with technology than they. According to professor A, this results in even further intimidation and consequently less teacher inclination to use the World Wide Web.

As is the case with most of our interviews at Prince George's, professor A spoke extensively of her students. She said that, as well as faculty members, the students need technical support, especially in the area of distance learning. Many of her off-campus students contact her when they encounter difficulties, and she finds it extremely difficult to both teach and provide support at the same time. Instructor A feels that she is not alone in this regard, and that other Prince George's professors need someone to guide students and resolve their problems.

4.3.4 Tenure & Other Incentives

Tenure concerns at Prince George's were largely nonexistent. The college does have a tenure program, but it differs quite greatly from tenure programs implemented at most 4-year universities. Instructors can stay on as faculty members as long as they would like; if they are considered for tenure and rejected, they simply resume their jobs and wait until the tenure committee next considers them.

Instructor F first spoke of tenure at Prince George's, saying that the college possesses an environment that stresses quality of instruction above all else. This particular instructor had clearly invested a lot of time in his Web site, for it possessed elements like interactive quizzes, which made use of JavaScript and Java applets. He stressed the importance of the 'teaching first' atmosphere at Prince George's, saying that it was critical in providing him with the incentive to create such a Web site.

Instructor F also had much help from both the department and the administration in these pursuits. In return for his Web-enhanced education efforts, the Instructor F's department head allowed him a lighter course load for one semester. In addition, the administration granted several of his requests for tutorial manuals, new software, and better hardware. Instructor F felt quite rewarded with his work. He said that his students appreciated his efforts, and he feels that his Web site adds much to the quality of his students' learning.

Given the college's tenure allocation methods, it was not surprising that this issue was of little concern to the faculty members at Prince George's. It is extremely interesting to note that 5 out of the 6 interviewees placed particular emphasis on their students; some of those instructors even had to be prompted to focus on themselves, as the scope of our study only included the concerns of instructors.

To expand on this issue, instructors A, B, C, D, and E all voiced concerns pertaining to their students. Issues such as the students' comfort level with technology were of particular interest. Instructor C specifically mentions that he would be more inclined to make better use of the Web if he felt that the students at Prince George's were more familiar with it. The group observed that there were daily on-campus workshops held for students who wished to learn more about computing basics; these basics included the use of e-mail and the World Wide Web.

Instructor F contrarily felt that none of his students had a very large problem using his Web-related resources. He feels that the students at PG are for the most part comfortable with using the Web, and that he has never encountered any reluctance by the students in the use of his online quizzes.

Professor B raised the issue of intellectual property and ownership. He was unsure who should own the material that instructors place on the Web. While the teacher may indeed create Web-enhanced course material while using university facilities and receiving a salary, he felt that they should be at least in part compensated in situations where the university assumes ownership of the material.

This issue applies particularly to distance learning, whereupon the university may attempt to use previously generated course materials and re-offer the same course in subsequent semesters. To some teachers' dismay, added instructor B, some institutions may require that control of the course be transferred to another instructor, or perhaps a group of teaching assistants.

Instructor D offers a view on intellectual property rights that is contrary to the view held by instructor B. Instructor D was planning on teaching a Web-enhanced class the following year, and said that such property rights issues were of no concern to her. She did not feel that the college would at any time attempt to either take control or claim ownership of her course Web site.

4.4 Primary Site 3: Florida A & M University

Data collected thus far has come from an extremely technical university, followed by a community college that possessed far less extensive technological facilities. Florida A & M (FAMU) was decided upon because it complements the gap that exists between the previous two schools: it is a four-year teaching university that is currently undertaking significant efforts to enhance technological resources on campus.

These efforts are the direct result of a technology initiative program that intends to enhance technology on campus by the year 2000. At the time of this writing, the university was in the process of installing a higher-bandwidth campus network. In addition, a new center for distance learning had recently been installed, and was being prepared for use in the following semester. Finally, the university was in the process of generating its first-ever online degree program in the discipline of pharmaceuticals.

All of these efforts led us to believe that FAMU was well on its way to becoming a more technologically oriented institution. For this reason, we felt that the concerns of instructors there would be a welcome addition to our data.

4.4.1 Time

At Florida A & M University (FAMU) we found again that faculty time was a major obstacle to widespread use of Web-enhanced education. Professor A was teaching several classes that made use of the Web for both repository-style information and other more interactive elements like quizzes; he stated in his interview that while he would like to do more with the Web in his classroom, such as conducting lectures over the Web. He stated, however, that such a thing would not feasible because he lacked the time required to construct these materials.

Professor F said that she worked approximately 60 hours per week, citing a number of reasons for this huge time investment. One of these is that, in addition to her regular class offerings, she spent a good portion of her time learning how to use MacroMedia's Director™ tool. In addition, she needed a lot of time to convert her existing curricular materials for use in Director.

Professors B and E concur with these concerns, saying that the time to build a good Web-based course is of the utmost concern. Even with his experiences using RealMedia™, Instructor B said that it takes him roughly ten hours of preparation to deliver an hour's worth of lecturing using this tool. The reader should also take note that this estimate does not in any way include the large amount of time he spent just becoming familiar with the tool.

4.4.2 Tools

During Professor F's interview, she spoke of the tools that would be beneficial to her in the creation of a Web-enhanced course. The first of these is a Grading Software package coupled with an intelligent tutor, that will quiz students and provide explanations for why answers are either right or wrong. Secondly, she would like an automated Registration Software package that will keep track of her students using a database. Thirdly, she would like the use of efficient presentation software that will help translate existing material into a Web friendly format.

She also spoke of the 'help' function included with Macromedia Director. She feels that the tutorial for the program does not work, saying that having basic tasks demonstrated by the tutorial was not effective. Her major difficulty was that, after completion of the tutorial, she felt that she had learned a number of skills but at the same time had no idea how to apply those tool-specific skills toward the publishing of an online course.

Staff Member D also stressed the inadequacy of tools available to professors at FAMU. It was her belief that instructors should be shown how to convert face-to-face curricula to other formats. Simply giving them the tools and expecting faculty to use them, she said, is an inadequate solution.

4.4.3 Technology and Tech Support

FAMU is a school that had its share of technological problems. We observed that the computing lab facilities on campus were often crowded, and required the students to wait several minutes before they could get access to a machine. In addition, the group's access to the Web was hampered by intermittently working Web servers.

According to administrator C, the university was still in the process of becoming 'wired'. Although the fiber optic cable is laid out under the campus, she was concerned that the cable has not yet been pulled an installed in most classrooms and faculty offices. Both Staff member D and administrator C said that this infrastructure must be in place before the faculty will seriously consider the development Web-enhanced courses. Once the fiber-optic connections are made, they felt Web usage would flourish.

Professor E voiced many concerns pertaining to provision of computers to faculty members by the university. His own computer was a 486 running Windows 95, and he had no network connection to speak of except for a phone line and a 14.4 kbps modem, which was installed on his own personal laptop machine. Professor E said that, in order for the university to expect increased interest in the Web by faculty members, they must first get the machines on desks and the network connections into offices.

Staff member D also spoke of FAMU's plans in developing a more "wired" institution. She told us that a centralized support structure would be a critical part of FAMU's increased educational use of the Web. Currently, she said, the university is in the process of building a faculty development center for that specific purpose.

Administrator C said that, for the purpose of increasing use of Web-enhanced education, demonstrating what is available to teachers is of the utmost importance. To accomplish this, the faculty development center had about twenty multimedia workstations established for Web-CT teaching and training; these included PCs, Macs, and multimedia workstations. The purpose of the lab, said Administrator C, is to hold workshops for professors on the premise that they begin to develop their own Web-based course material by the conclusion of the workshop.

Professor A mentioned that student support, in the form of an independent study course, would be utilized the following term to help with the development of a Web-enhanced class. The idea, said the professor, was to have the students take the extra time to become familiar with the tool. Teachers could concentrate on implementation of curriculum, and ask the student for help when problems arise.

Professor B relates an interesting and potentially very useful faculty development program implemented at the FAMU/Florida State University College of Engineering. In this program, faculty members were provided with template Web sites by support personnel. These sites already contained 'skeletal' structures into which faculty could place repository-style information, such as course notes, syllabi, assignments, and Web links.

This program caters towards those professors who are interested in getting started using the Web in conjunction with their courses. This program, he said, provides a critical first step for faculty members, who need some sort of starting point in their Web-enhanced educational pursuits.

4.3.4 Tenure & Other Incentives

According to instructor B, the entire state of Florida is attempting to coerce four-year universities into becoming less research-oriented, thereby encouraging increased quality of instruction. Instructor B added that the administration at FAMU have echoed the state's concerns, saying that they agree with this assessment and will do what they can to increase quality of education.

Instructor B felt that, while the state and school administration have good intentions, teachers at FAMU will only acquire tenure if they generate enough in the way of grant money and research articles. There exists, according to the instructor, a decided gap between the administration's focus on education and its practice of rewarding those instructors who perform the most research. Furthermore, the instructor felt that this gap must be eliminated before instructors can be persuaded to undertake any Web-enhanced teaching pursuits.

Instructor B is not alone in his concerns for tenure- Instructors A and F and staff member D all mentioned the same concerns; teachers just don't feel supported by the administration enough to attempt incorporation of the Web with their teaching methods. Instructor A specifically said that he does not feel that the administration would provide him with any other incentives, such as released time, if he were to ask the administration for help in creating a Web-enhanced course. If the administration could somehow be convinced of the power that this kind of learning offers, he felt that they might finally be inclined to assume a more active role in assisting the faculty at FAMU.

Administrator C was working hard to address these concerns voiced by faculty and staff. She felt that, just as teachers may need incentive to use the Web, the administration needs incentive to accredit teachers for their use of the Web as well. To make use of the Web in classes more widespread, she said, is a two fold process: first, administration must make it clear to instructors that their efforts are fully supported; and second, both instructors and administrators alike must be convinced that the use of the Web will enhance the quality of instruction.

To provide both instructors and administrators with such convincing, administrator C had already planned an on campus study that will be conducted by examining student learning for classes delivered via three separate instructional methods- the World Wide Web, videotaped lecture, and traditional face-to-face lecture instruction. By performing such a study and keeping track of what students liked about each course medium, she hoped to present her findings to the administration and faculty members alike. By conducting such a study, administrator C may partially answer the question posed by many instructors: Is the Web worth it?

Staff member D realized that many of the instructors that she works with have tenure-related concerns. She and administrator C are working towards implementing some sort of award criteria for Web-enhanced classes, upon which the administration can delineate the effect Web-enhanced teaching will have upon an instructor's consideration for tenure.

In addition, staff member D said that more tangible incentives, such as a monetary incentive or new laptop computer, might be useful in enticing faculty members to give the Web a try. At the time, administrator C was working on appropriating money for just such a faculty incentive program; this program would provide a laptop computer for each instructor that decided to take a technology course the following semester. This type of incentive program could easily be implemented for a faculty Web development program as well.

Instructor B also discussed intellectual property rights as a possible barrier to Web-enhanced education. He was not sure whether the university has the right to claim ownership of his Web-based distance learning curriculum materials. The administrational ambiguity pertaining to this issue, when coupled with the previously mentioned ambiguities of tenure accreditation versus instructional innovation, both present a rather significant barrier to faculty members at FAMU.

Chapter V

ANALYSIS

5.0 Analysis

After close examination of the results, the reader may have noticed several discrepancies in the data collected; these discrepancies both follow from data collected at the same school, or they may be inferred from the concerns of faculty members at different schools. The purpose of this section is to illustrate any of these discrepancies. In addition, we shall postulate possible reasons supporting those discrepancies that cannot be adequately explained.

5.1 Time

It would be an understatement to call Time a 'theme' that resulted from our data collection: faculty time was by far the most mentioned obstacle. Every interviewee and focus group participant felt that time was a significant concern to faculty members who wish to use the Web in their class work.

Time-related concerns between professors at New Jersey Institute of Technology, Prince George's Community College, and Florida Agricultural & Mechanical University differ very little. All felt that the most time consuming involvement concerning the creation of Web-enhanced course is learning how to make the transformation of the traditional class material into a Web-ready format. This includes the transformation of professors' class and lecture notes, syllabi, diagrams, and drawings, and schematics, any other learning aids that the professor usually uses in his lecture-based classes.

Next is the critical question of what methodology teachers should employ in their classes. Once the decision has been made to put course on the Web, and the instructor has decided what form it should take and how they would like to present the material, they must decide which tools and latest technologies to use. This can be a daunting task given the number of newly emerging languages such as Java and the myriad course tools available, Web-CT, TopClass, FirstCourse, and Serf, just to name a few.

In addition, the professors touched repeatedly upon the difficulties of student/teacher interaction on the Web. Most instructors felt frustrated at the time that it took to converse with students, especially when answering questions that would normally be asked during face-to-face office hours. Conversations conducted via the Web were often required a much more careful, prepared, and therefore time-consuming response from the instructor.

Universities would find it extremely helpful if their instructors could simply devote twice as much time to their jobs, but this expectation is unrealistic. Because instructors can't simply be given more time, they will have to have the proper tools, technology, and support at their disposal, coupled with an adequate amount of incentive to use them. The following sections of analysis discuss further the issues most concerning to those individuals that shared their concerns with us.

5.2 Tools

Simply put, many teachers felt that course generation tools such as Web-CT were extremely valuable. Teachers at all three institutions said that learning environments, such as the one offered by Web-CT, provided the instructor with a valuable 'template' that an instructor can use to begin curriculum generation. This template gave teachers a kind of starting point, which helped psychologically as well as physically; teachers felt less intimidated once they saw that the backbone of the site was already in place, and also felt that Web-CT provided many interesting features that they would otherwise have no idea how to implement by themselves.

Many teachers also had extremely valid complaints concerning the issue of tools. Instructors at all three institutions said that discipline-specific materials, such as graphs and mathematical symbols, were extremely difficult to post on the Web without help. Because most classes involve the use of more interesting elements besides plain text, it appears as though every discipline of every instructor that we interviewed had some sort of graph, picture, or idea that they wished to place on the Web.

There also seems to be a marked difference in the methodologies adopted for the publishing of online courses, even at the same school. Prince George's faculty, for example, made use of at least three different types of Web-based learning environments for their distance learning classes; these were Web-CT, Serf, and TopClass. The very fact that instructors at one school cannot seem to agree on a set course methodology may indicate problems. The institutions in question may do well to implement a set course methodology instead of allowing faculty members to use whatever software they like.

This brings us to another important issue- New Jersey Institute of Technology does, in fact, have a set methodology after which teachers can model their courses. Standardized software tools, such as the Electronic Information Exchange System (EIES), were developed by professors at the Institute. Technical support personnel are trained in the use and implementation of these tools, and are ready to help professors in this respect.

It was the sentiment of the NJIT focus group, though, that even with a set methodology in place, most instructors on campus still didn't seem in a great hurry to include the Web in their teaching methods. The problem, it was felt, was that faculty members generally lacked awareness of the tools/resources made available to them by the institution.

This was also a problem at Prince George's. Instructor C, for example, felt that the Web simply did not possess the interactivity he felt was needed to be an effective means of instruction. The reader should understand that, just a few hours earlier, instructor F had shown us his interactive Web site - in the same building. Clearly, these schools would do better to make a more concerted effort to educate faculty not in the use of the Web, but simply in what sort of new materials and methods the Web makes available to them.

Lastly, usefulness and quality of these tools is an obstacle that needs to be resolved. Professors need to make use of more than repository-style information, such as the posting of course notes and syllabus information on their sites. Instructors at all three sites said that simply posting text-based materials should by no means be considered Web-enhanced education.

This is not the pedagogical approach to using the Web that professors need, professors want a tool that allows them to easily build a Web-enhanced course that fosters interactivity among students and allows for quick and useful content generation, but does not degrade the quality of instruction.

Although some software packages have some good features, it was the general consensus at all three schools that the currently available tools need more work. Both at NJIT and FAMU, teachers spoke of how software tools should become more oriented towards both the curriculum generation process and methods of content delivery; currently, they say, tools focus all too often on flashy interfaces. It was the feeling of instructors at both of these schools that more research needs to be done in how students learn differently on the Web, and that this research should be applied to the creation of better tools.

5.3 Tech Support/Technology

All of the schools we visited held similar views on the issue of technical support. Concerns pertaining to the effectiveness of support were raised frequently; teachers often stated that the main problem with technical support personnel is that they are well-versed in the use of technology, but ill-equipped to assist faculty with pedagogical concerns.

Computer or Information Scientists, for example, might be extremely good at figuring out a software problem or fixing a hardware difficulty; most instructors felt, however, that existing tech support personnel were simply not equipped to handle questions pertaining to the effective delivery of technologically-driven course content. As such, instructors using the Web for their classes would find it difficult to get help.

The NSF focus group, as well as Georgetown's interviewee A, had potentially helpful suggestions pertaining to the issue of technical support. Both parties said that support personnel with backgrounds in education as well as computing technology were necessary to properly facilitate faculty's use of computing technology. Georgetown's interviewee A also added that having educators on the technical support team would help eliminate the psychological barrier that teachers harbor towards technical support personnel- he said that instructors feel 'intimidated' if support consists of only technological types of people.

Another very important and potentially very cost-effective solution to the issue of support is the topic of student help. All of our primary visit interviewees felt that students are an inexpensive, knowledgeable resource. Moreover, there is certainly no shortage of students on any of today's campuses.

The STARS program at NJIT is a great example of this kind of program. Florida A&M's instructors A and F also planned on making use of student help on a smaller scale; they felt that many instructors on campus could benefit from offering students independent course credit for assistance.

5.4 Tenure & Other Incentives

The reader may first recall the difference in opinion shared by faculty members at NJIT on the issue of tenure. To recall the sentiments of instructor D, instructors at NJIT should take the initiative and convince administration that the Web is a worthwhile teaching pursuit. Also, both instructors B or D felt that they had sufficient time and support from the administration to complete their preparation of Web material.

In direct contrast to these opinions are those ideas shared by instructors C, F, and the focus group, who believe that it is up to the administration to support and accredit teachers for their usage of the Web. What could cause such a differing opinion to be shared by instructors at the same institution?

The reader may find it especially interesting to note that the two groups come from completely different disciplines; instructors B and D hail from non-technology related disciplines, but those who disagree with them are all instructors in technology-related fields. Taking into account that NJIT is largely a technical school, it may be the case that technical professors have a heavier course load then those in other fields. Or, perhaps there are differing attitudes of the administration between technical and non-technical departments; such attitudes might possibly have resulted in a more lenient working atmosphere for the non-technical professors, thus allowing them the freedom to pursue Web-related teaching efforts.

We, as interviewers, did not find it surprising that the instructors at FAMU and NJIT were so inclined to make mention of tenure. Furthermore, instructors at both schools did not need to be prompted to concentrate on the incentives that should come from the administration; i.e. released time, tenure, salary bonuses, etc.

Both four-year universities included in our study are working to assuming the responsibility of making additions to their tenure accreditation criteria. When implemented properly, faculty at NJIT and FAMU felt that such additions would encourage more instructors to use the Web in their teaching.

This recommendation is in agreement with the findings of the Boyer Commission at Stony Brook University. The report entitled "Reinventing Undergraduate Education: A Blueprint for America's Research University" (http://notes.cc.sunysb.edu/Pres/boyer.nsf/) contains a very pertinent recommendation:

> *"Research universities must commit themselves to the highest standards in teaching as well as research and create faculty reward structures that validate that commitment."-Conclusion IX*

The implications of this statement are clear: If the universities of today want to see further innovation in instructional methods and an increase in the quality of education, administration must make it clear to instructors that both research and instruction will be rewarded appropriately.

The implications of other faculty incentive programs, however, should not be ignored. The reader should consider the implications of successful programs such as NJIT's "STARS" initiative. While costly, such basic incentives as providing laptops or released time to professors should not be overlooked by the administration; these sorts of incentives could easily be offered to instructors who take courses in Web-enhanced course authoring.

Another possible recommendation is for more research to be conducted as to the Web's effectiveness as a teaching tool. Many of our interviewees felt that both they and their administrators had yet to be fully convinced that the Web was as effective as lecturing. Even if they were convinced of this, administration still need to be convinced that the use of the Web is cost effective.

With the proper research, even skeptics might be convinced that the Web might in fact be an alternative teaching method to lecturing. If adequate, controlled experiments are conducted, perhaps teachers and administrators alike can be convinced that the World Wide Web may hold distinct advantages over the more traditional lecture-based class. Ultimately, these studies may result in a more widespread use of the World Wide Web; the reader should recall the efforts of administrator C, who is planning on conducting research that compares the Web with other methods of instruction.

From the interviews of all three schools, it is safe to infer that the colleges of today should also make efforts to educate their student population as to the use of the Web; this must occur before teachers decide to offer instruction using the medium. Teachers at a particular institution may have the most administratively supportive environment in the country, but their students may or may not be willing to embrace the use of the Web in their day to day classroom work. Interesting to note is the simple fact that NJIT had the most technologically-familiar students in our study, and professors there made the least mention of student-related concerns.

At Prince George's, faculty members made little mention of such incentives besides that of released time; instructors at the community college felt that their 15-hour-a-week lecture load was more than enough to keep them occupied. Instead, faculty members at the two-year college spoke mainly of the quality of their students' learning.

From this, we might infer that the "teaching-first" environment leads instructors to concentrate on pedagogy and instructional quality, and to concern themselves more with the issue of student learning. Instructor F shares this sentiment, and feels that the learning environment at a community college is particularly conducive to the quality of learning.

It is interesting to note that NJIT's instructor H may have been right in his prediction that other, less technically oriented student populations would present barriers to instructors in their use of the Web. That he is correct could follow from the heavy emphasis on students that Prince George's instructors were willing to place on the discussion. However, the reader may remember that instructor F felt confident in his students' ability to use the Web. The reason for this contrast is not readily apparent, although it may follow from the fact that the use of his online materials by students is not mandatory. As a result, he might receive positive feedback from students that use his materials, but other students might simply opt not to make use of them.

In all three schools, few educators touched upon the issue of intellectual property. Tenure allocation seemed to be a much more prevalent issue at the four-year schools. At Prince George's, only one instructor mentioned property rights to be a serious issue.

It should presently be made clear to the reader that each educator who mentioned this issue used the Web primarily for distance education. Such education requires the instructor to place all course material on the Web before the class session has even begun. Thus, because virtually all of the course material delivered to students is pre-packaged, it is relatively easy for the institution to assume control and place whatever instructor they desire in charge of the course. This is obviously detrimental to instructors who would otherwise be inclined to use the Web.

Educators who used the Web as a supplement to their face-to-face lecture classes, however, did not seem concerned enough to make any mention of intellectual property. There are many possible reasons for this phenomenon. The first of these could be that such instructors did not generate much of their own material, instead using discussion board software or other third party materials that they did not own. In the case of Instructor D at Prince George's, who felt that property rights were not an issue, most of her course material was in fact generated beforehand by a publishing company. It was her intent to make minor modifications to this material before offering the class.

Chapter VI

CONCLUSIONS

and

RECOMMENDATIONS

6.0 Conclusions and Recommendations

This portion of the document aims to inform the reader of the conclusions that we have drawn from our data collection; for each of these conclusions we shall make recommendations to the NSF so that the agency may increase effective use of undergraduate Web-enhanced education. Conclusions and recommendations will be made for each of the "Five T's."

6.1 Time

Conclusion I: Instructors lack sufficient time to spend innovating their instructional methods.

Recommendation: As the number of hours in the day cannot be increased by even the most ambitious administrator, instructors must be provided with better process, tools, and support to eradicate this Time barrier, (see sections 6.2 to 6.4 for more details)

6.2 Tools

Conclusion II: There is no 'accepted' method of teaching over the Web: consequently, instructors cannot decide what instructional methods to employ.

Recommendation: The National Science Foundation should endeavor to perform research in the field of cognitive science in order to improve the tools that exist for teachers today. The NSF should examine different course-conduction methodologies and present recommendations as to which methods work best. If this is accomplished instructors will have an accepted methodology or group of methodologies on which to base their Web-enhance courses, eliminating much ambiguity.

Conclusion III: Discipline-specific content is extremely difficult to place on the Web.

Recommendation: The National Science Foundation might fund the development of curriculum-specific tools that are designed to place content on the Web. For example, instructors of a calculus course could use a tool that would place graphs of image files, equations, and symbols on the Web with greater ease.

Recommendation: Instructors across the country doubtlessly make use of the same textbooks every year. Why not let them use the same Web content? The National Science Foundation might, for example, fund the implementation of discipline-specific 'storehouses' of curricular information on the Web, not a library, but a repository that would allow instructors from across the country the freedom to add common content to their course Web pages. As an example, chemists across the country use the same molecular models, and these could easily be placed on a central server from which they could download pictures and animations. Eventually, instructors could post such material on their local Web server for use in their classes.

Conclusion IV: Teachers are largely unaware of the tools and resources available to them in the field of Web-enhanced education.

Recommendation: A campus-wide information consortium could be implemented at Universities and Colleges interested in Web-enhanced learning. This consortium might help eradicate the lack of communication that may exist between faculty members at a given institution, thus informing more instructors about teaching opportunities on the Web. Those instructors that are most involved in the field might present their experiences and methods to other instructors, who can then decide what's best for their teaching interests.

6.3 Technology

<u>Conclusion V: Teachers and Students must have access personal computers, both at school and at home.</u>

Recommendation: Universities might require the help of the NSF in providing their instructors with adequate desktop machines. In addition, the universities in question may set up a finance program that might assist instructors in their home computer purchases.

Recommendation: The NSF should consider playing a larger role in convincing the administrative world that technology is a recurring expense, not a one-time investment. Instructors need periodic upgrades of computing machinery, just as computer laboratories do.

Recommendation: Further research should be made in the field of Ubiquitous Computing, the college or university's provision of a personal computer to each newly enrolled student. The National Science Foundation could play a critical role in convincing universities that campus computing labs are by themselves insufficient to meet increasing student demand.

Conclusion VI: Teachers might not possess easy network access.

Recommendation: The National Science Foundation should also consider a school's network infrastructure; it is no surprise that instructors without network connections will doubtlessly be far less inclined to consider using the Web in their coursework.

6.4 Technical Support

Conclusion VII: Existing campus tech support facilities are intimidating and impersonal.

Recommendation: The Universities in question might be interested in the provision of departmental technical support. This support structure would allow a better rapport between faculty and support personnel, eliminating some of the psychological barriers instructors may harbor against the use of such support.

Recommendation: The National Science Foundation should encourage the widespread growth of a supportive, not coercive, faculty development initiative. This initiative could proceed in several stages; first familiarizing faculty members with the Web, eventually working with support personnel in the construction of a course Web site. This program would doubtlessly lead to increased faculty familiarity with the Web, eventually leading to more widespread use of Web-enhanced education.

Conclusion VIII: Instructors feel students to be a very inexpensive and knowledgeable technological resource.

Recommendation: The National Science Foundation should encourage universities to consider the use of their own students for the support of faculty members. The students could assist the faculty members in the development and upkeep of Web sites, as well as providing additional technically-oriented support.

6.5 Tenure & Other Incentives

Conclusion VIII: Tenure accreditation methods place too much emphasis on instructor research.

Recommendation: A revamping of tenure accreditation criteria is of the utmost importance. Administrators need to make clear to their faculty members that instructional innovations such as Web-enhanced education are taken into proper consideration during the tenure awarding process.

Conclusion IX: Instructors, primarily those interested in Web-based Distance Learning, need partial property rights to the Web material they create.

Recommendation: The National Science Foundation could help facilitate an agreement between faculty members and administrators regarding the issue of intellectual property. Universities and colleges might, for example, see fit to share with faculty the royalties generated by Web-based course material.

Conclusion X: Teachers and administrators need to be convinced of the Web's effectiveness as a teaching tool.

Recommendation: The NSF should heavily encourage research into the effectiveness of the Web as a teaching tool. By comprehensively studying how the Web functions in undergraduate education, coupled with its effectiveness when compared with alternative methods of instruction, instructors everywhere might be provided with the incentive to adopt Web-enhanced teaching methods.

As a final statement, we would again like to implore to the reader that these conclusions and recommendations are presented in the hopes that the NSF might implement them on a much broader scale. The NSF should remember that, according to our study, informing teachers of the tools, methodologies, and materials that are available on the Web is just the first step in the much longer process of convincing teachers to create and conduct effective, high-quality Web-enhanced courses.

APPENDICES

Appendix A- The National Science Foundation

The majority of the ensuing information was taken from "Increasing Public Awareness of Combined Sewer Overflows" (1991 NSF IQP). This write-up was updated using public information from the National Science Foundation's Web-site (www.nsf.gov), as well as information pamphlets and documents from the Foundation.

1.0 Mission Statement of the NSF

The events launched by science and technology during World War II led to Congress' realization that the United States had to take a leading role in the world's scientific community. As a result, Harry S. Truman enacted the National Science Foundation Act of 1950 (Public 81-501). This act created the National Science Foundation (NSF) as an independent federal agency dedicated to the advancement of science and technology. By establishing the National Science Foundation, the Federal Government recognized that support of long term research in all fields of science and engineering contributes to the strength and well being of the nation in many ways.

Research discoveries precede and underlie advancements in many important areas of federal responsibility, including national health, economic growth, use of energy, and our environment and agriculture. Thus, the Foundation was created to support and promote the progress of science, mathematics, and engineering in all fields and disciplines. This broad mission includes support for basic research as well as science and technology education. The National Science Foundation also encourages cooperation with the international science community and is committed to expanding the numbers of scientists, engineers, and science educators in our nation.

2.0 Research

The National Science Foundation does not conduct research. Rather, it provides funds intended for research to academic institutions, private research firms, industrial laboratories, and major research facilities and centers. The goals of research supported by the National Science Foundation include increased and expanded knowledge, excellence in education, economic competitiveness, innovation, productivity, and improved quality of life for all. The foundation supports research in the following fields:

- mathematical and physical sciences
- all fields of engineering
- biological and environmental sciences
- behavioral and natural sciences
- social sciences and economics
- computer and informational sciences
- atmospheric, earth and ocean sciences
- science and engineering education
- cross disciplinary efforts in the above fields

3.0 Education and Human Resources

The National Science Foundation recognizes the increasing importance of a basic scientific and mathematical literacy in America today. For this reason, the National Science Foundation is strongly committed to education in science, mathematics, and engineering at all levels. Not only does the National Science Foundation fund graduate level research, but it also gives awards for creative engineering, and offers fellowships to undergraduates. The foundation has public outreach programs as well; they are intended to improve scientific and technical awareness in the nation. These programs also encourage the underprivileged and minorities to pursue careers in the sciences and engineering by sponsoring developmental programs.

4.0 Structure of the National Science Foundation

The National Science Foundation's policies are set by the National Science Board, a twenty-four member board appointed by the President of the United States and subject to Senate approval. The President also appoints a Director of the National Science Foundation for a six-year term as well as a Deputy Director and Assistant Directors. Almost 2,000 other full-time employees help administer to the National Science Foundation.

Within the foundation, there are nine directorates, each representing a different field of science and engineering. Each directorate is further subdivided into divisions and then specific program offices. The nine directorates of the National Science Foundation are as follows:

1) Directorate for Biological Sciences
2) Directorate for Computer and Informational Science and Engineering
3) Directorate for Engineering
4) Directorate for Geosciences
5) Directorate for Mathematical and Physical Sciences
6) Directorate for Education and Human Resources
7) Directorate for Social, Behavioral and Economic Sciences
8) Office of Budget, Finance, and Award Management
9) Office of Information and Resource Management

The research projects supported by the programs in the Biological, Behavioral and Social Sciences Directorate are designed to strengthen scientific understanding of biological and social phenomena. Research for this directorate includes many areas, from the fundamental molecules of living organisms to the complex interactions of human beings and societal organizations.

The Computer and Informational Science and Engineering (CISE) Directorate's programs improve fundamental understanding of "information processing" and enhance the training of scientists and engineers who contribute and develop that understanding. The directorate for Computer and Informational Science and Engineering is inherently multi-disciplinary, supporting computer and informational scientists and engineers, electrical engineers, mathematicians, artificial intelligence and scientists.

The Directorate for Engineering seeks to promote the progress of engineering and technology, and to ensure national prosperity and security through the support of research and education at all levels and in all fields of engineering. This directorate is comprised of eight divisions, each consisting of various engineering programs.

The Directorate for Geosciences and the Directorate for Mathematical and Physical Sciences deal with "pure science" research and development. Research in the Directorate for Geosciences is supported to increase the scientific knowledge of the natural environment on Earth and in space. Research here also deals with the various effects of human activity that interact with this environment, geographic layout of cities, seismic activity, and cartography, for example. The Directorate for Mathematical and Physical Sciences aims to develop a fundamental understanding of the physical laws that govern the universe. Research results lay the groundwork for the technological developments upon which our economic and social well being depends.

The Directorate for Education and Human Resources has four major long-range goals:

1) to help insure the best possible professional education in science and engineering,
2) to help ensure that college-level opportunities are available to broaden the science backgrounds of non-specialists,
3) to support informal science education programs for the public and
4) to help ensure that high quality, pre-college education in science is available to every child in the United States.

The Directorate for Social, Behavioral and Economic Sciences combines National Science Foundation activities to promote healthy international relations. Programs here study science and technological policy issues as well as collect, analyze and publish data on the status of the nation's science and engineering resources. This Directorate helps to provide opportunities for small business firms to participate in National Science Foundation supported research and to extend greater research opportunities to all segments of the scientific community.

5.0 Proposal Review

Each year the National Science Foundation receives approximately 30,000 proposals for research and graduate fellowships, of which, 9,000 or more awards are granted. The Foundation gives awards for research in engineering and the sciences. Each awardee is responsible for conducting the research and preparing the results for publication; therefore, the National Science Foundation does not assume responsibility for such findings or their interpretations.

Most proposals come to the National Science Foundation from organizations and educational institutions rather than individuals. However, those conducting independent research may submit proposals under certain circumstances; for this reason, the foundation welcomes proposals on behalf of all qualified scientists and engineers. They also strongly encourage women, members of minority groups and handicapped individuals to compete for National Science Foundation awards. Also, the Foundation supports proposals that encourage collaboration between industry and university researchers, and between state and local governments.

In deciding which projects to support, the National Science Foundation relies heavily on the aid of advisory committees, outside reviewers, and other experts. Proposals for support are assigned to the most appropriate division or program office of the Foundation. A peer review system and advisory committees made up of over 59,000 scientists, engineers, educators, nonprofit researchers, educators, and industrial organizations decide which proposals to support. This review system is used to ensure that the decisions reached are fair and informed. To further assist the National Science Foundation regarding a choice of projects, a set of criteria has been established for the review and evaluation of the proposals. These criteria are designed to ensure fair selection of the most meritorious research projects.

The two criteria are as follows:

1) *Intellectual Merit.* The project proposed must advance the knowledge and understanding within its own field or across different fields. The proposal team (or individual) must be qualified; this is considered mostly with regards to the quality of prior work. The proposed activity must suggest and explore creative and original concepts. In addition, the project must be well organized and there must be sufficient and necessary resources to complete it (NSF, 1998).
2) *Broad Impacts:* The proposed activity must advance discovery and understanding as well as promote teaching, training, and learning. It should be able to enhance the infrastructure for research and education (instrumentation, networks, and partnerships) and the results should be disseminated broadly to enhance scientific and technological understanding. The proposed activity must also broaden the participation of

under-represented groups (those of gender, ethnicity, disability, etc.) as well as benefit society in general (NSF, 1998).

6.0 The NSF Budget

The funding for National Science Foundation research awards are derived from the Foundation's annual budget. For the fiscal year 1998, the National Science Foundation requested a $3,367 billion budget from Congress. The current plan is for approximately $3,457 billion. The Foundation's approved budget for the fiscal year 1999 is $3,672 billion. Including grants to more than 2,000 colleges, universities, and research institutions, funding from the National Science Foundation accounts for approximately twenty-five percent of federal support for basic research at academic institutions.

7.0 Division of Undergraduate Education

The Division of Undergraduate Education provided the grant that made this project possible. Located within the Directorate for Education and Human Resources, it serves as the focal point for NSF's agency-wide effort in undergraduate education. The programs and leadership efforts of DUE aim to strengthen and ensure the vitality of undergraduate education in science, mathematics, engineering, and technology (SMET) for all students, including:

- science, mathematics, and engineering majors;
- students in science and engineering technology programs;
- future teachers at the elementary and secondary school levels; and
- non-science majors seeking scientific and technical literacy.

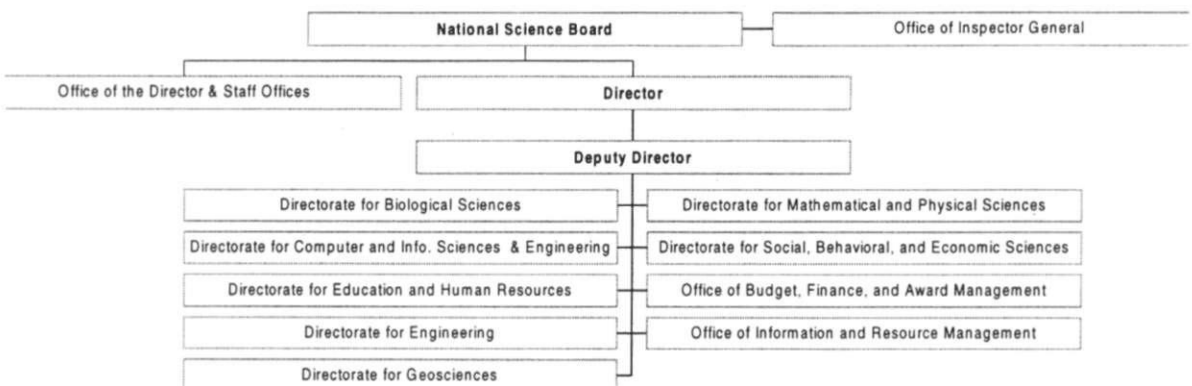
Programs within the Division enhance the quality of instruction in the diverse institutions of higher education, that is, two- and four-year colleges and universities. Particular emphasis is placed on improving access for all segments of U.S. society, including paraprofessionals, persons with disabilities, and populations previously underrepresented in SMET studies or in technical and teaching careers. Faculty members who vigorously combine teaching with scholarship are essential to quality education in SMET at any level and in any institution.

7.1 DUE Activities

Both curriculum and faculty development are supported by DUE projects, awards, and leadership activities. *Curriculum development programs* involve faculty in the creative and continuing renewal of undergraduate courses, curricula, and laboratories; the term "curriculum" is here inclusive of the modes and context of teaching and learning, as well as the content of instruction. *Faculty development programs* address the preparation of future faculty, teachers, other educators and SMET specialists at all levels, as well as the revitalization of the current organization of educators teaching undergraduates. DUE's budget that has grown slowly to the point where the 1998 version has crested 100 thousand dollars ($100,710).

8.0 Organizational Chart for the National Science Foundation

The chart below displays the hierarchical structure of the National Science Foundation. The Division of Undergraduate Education is contained within the Directorate of Education and Human Resources.



Appendix B - Elements of Our Interviews & Focus Groups

1. What experience do you have with Web-based education? <an 'icebreaker' question>

2. A number of barriers may present themselves to instructors during their publishing pursuits of Web-based course material. Could you expand on some of the stumbling blocks with which you must contend?

3. As an instructor, your time is quite possibly one of your most precious commodities. Could you expand on how this issue of 'time' might relate to the publishing of online course material?

4. The use of the World Wide Web automatically includes the use of many different types of computing technology. Do you have any technological concerns relating to the use of the Web as an educational resource here on campus?
   <possible probes include tools for Web publishing, network speed and connectivity, software packages for instructors, availability of computer labs, etc>

5. Technical support is another issue concerning the use of the World Wide Web for undergraduate coursework. Can you relate some of your thoughts on technical support and how it plays a role in your online publishing endeavors?
   <possible probes include use of hotlines, faculty workshops, support personnel availability, e t o

6. What sort of software tools do you use for the publishing of such course materials? Can you explain any difficulties you may encounter with such tools, or any features that you find particularly useful?

7. What incentives do you feel should be offered by administration to the faculty members on campus in return for increased use fo the Web? How does incentive play a role in your use/disuse of the Web?

Appendix C - Index of Web References

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6. Prince George's Community College Web Site: http://pqWeb.pq.cc.md.us/pqcc2.htm
7. ABET site http://www.abet.org/tac/TACWebsite.html
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Glossary[11]

ARPA:(Advanced Research Projects Agency). The Organization originally commissioned by the DoD (Department of Defense) to design the ARPANET

ARPANET: [The original network created by ARPA, which would develop into the Internet] (Advanced Research Projects Agency Network) -- The precursor to the Internet. Developed in the late 60's and early 70's by the US Department of Defense as an experiment in wide-area-networking that would survive a nuclear war.

Backbone: A high-capacity mainly cable network spanning many countries, to provide fast long-distance Internet links. The original Internet Backbone was NSFNET.

FTP: (File Transfer Protocol) -- A very common method of moving files between two Internet sites. FTP is a special way to login to another Internet site for the purposes of retrieving and/or sending files. There are many Internet sites that have established publicly accessible repositories of material that can be obtained using FTP, by logging in using the account name anonymous, thus these sites are called anonymous ftp servers

Internet: (Upper case I) The vast collection of inter-connected networks that all use the TCP/IP protocols and that evolved from the ARPANET of the late 60's and early 70's. The Internet now (July 1995) connects roughly 60,000 independent networks into a vast global internet.

internet: (Lower case i) Any time you connect 2 or more networks together, you have an internet - as in inter-national or inter-state.

Network: Any time you connect 2 or more computers together so that they can share resources, you have a computer network. Connect 2 or more networks together and you have an internet.

Node: Any single computer connected to a network.

NSFNET: (National Science Foundation Network) A backbone of high-bandwidth cables created in 1986 to carry the ever-increasing amount of traffic on the ARPANET. It ceased operating in 1995, as NSF no longer wanted to support it financially.

Protocol: A clearly defined set of operating instructions to allow machines on networks to Operate / Communicate with each other.

TCP/IP: (Transmission Control Protocol/Internet Protocol) - This is the suite of protocols that defines the Internet. Originally designed for the UNIX operating system, TCP/IP software is now available for every major kind of computer operating system. To be truly on the Internet, your computer must have TCP/IP software.

WWW: (World Wide Web) -- Frequently used (incorrectly) when referring to "The Internet", WWW has two major meanings - First, loosely used: the whole constellation of resources that can be accessed using Gopher, FTP, HTTP, telnet, USENET, WAIS and some other tools. Second, the universe of hypertext servers (HTTP servers) which are the servers that allows text, graphics, sound files, etc. to be mixed together.