

**OKLAHOMA STATE UNIVERSITY
ACADEMIC PROGRAM REVIEW
EXECUTIVE SUMMARY**

DEPARTMENT OR DEGREE PROGRAM: M.S. in Telecommunications Management

The Master of Science in Telecommunications Management (MSTM) program mission – “to become a nationally prominent, exemplary center for telecommunications education, research, and outreach” – is fundamentally linked to OSU’s three-pronged mission of instruction, research, and outreach. MSTM is also pursuing the OSU mission of serving state, national, and international communities through the extensive use of distance learning technology and other outreach efforts.

The MSTM program was developed in response to industry’s request for skilled and knowledgeable telecommunications managers. After five years of research and development, with the help of a \$50,000 grant from the Southwestern Bell Foundation, the MSTM program began in August of 1995. Currently, the program is offered on the Stillwater and Tulsa campuses as well as through distance learning across the world.

Structurally, MSTM is a 35 credit-hour interdisciplinary program that draws on the combined expertise of the College of Business Administration; the College of Engineering, Architecture, and Technology; and the College of Arts and Sciences. Students may choose electives from 9 different disciplines to achieve a depth of knowledge in an area best suited to fit their career aspiration. The MSTM curriculum is developed and revised through the input of an interdisciplinary academic program committee as well as the MSTM Industry Advisory Board.

Program resources for the MSTM program have been sufficient in the areas of library resources, academic support services, and facilities and capital equipment. The program added an additional faculty member in the fall 2001 semester, which, when combined with the downturn in the telecommunications industry, helped meet the need of additional faculty resources. The Telecommunications Laboratory saw a dramatic increase in equipment with an influx of monies from the campus-wide Student Technology Fee funding and the Cisco Academy designation. The technology fee allowed the program to purchase 20 new desktop computers, four videoconference machines, and Internet-protocol telephones. Gaining Cisco Academy status allowed the program to equip the lab with Cisco routers at a substantial savings in cost and offer Cisco Certified Network Administrator classes for the students.

In the area of productivity, MSTM continues to attract quality students. To date, 412 students have earned their degrees. The MSTM program is also notable for its pioneering efforts. For example, MSTM is one of the few OSU academic program to host a full-time Executive-in-Residence program designed to bring in current telecommunications executives to teach in the program. MSTM is also the first OSU program to use video streaming technology, which allows any enrolled student access to class lectures on a home computer.

In other measures of quality, MSTM has Ph.D.-level faculty teaching 80% of all core and elective courses. Two MSTM courses not taught by a Ph.D. are Industry Overview and Telecommunications Applications and the Telecommunications Practicum. These classes are taught by an adjunct through the program’s Executive-in-Residence program or a retired telecommunications industry executive.

The average student GPA for all MSTM program courses has been over 3.4 since 1996-97. Numerous MSTM students have received industry scholarships and memberships in honorary societies, have published papers, and have received recognition in the press. Prior to 2000, student job placement

had been close to 100% with many students receiving numerous offers the semester before they graduate. Since the telecommunications industry downturn, placement dropped to 22.4%, but this should improve as the telecom sector improves. Indications are the industry is in recovery and, while it will not return to the dramatic levels of the 1990s, hiring levels are increasing.

In the area of program duplication, there are other telecommunications programs but none compares to the interdisciplinary, graduate level program offered at OSU. The curriculum draws on the expertise of the College of Business Administration; the College of Engineering, Architecture, and Technology; and the College of Arts and Sciences. This interdisciplinary approach prepares a well-rounded student ready for the dynamic nature of the industry. The program's Telecommunications Laboratory is a one-of-a-kind facility exposing students to the transmission of data, video, and voice. Other labs may go deeper in one of these areas, but the MSTM covers all three areas to a sufficient depth to prepare students for the workforce.

In summary, the strengths of MSTM lie in its industry support and industry focus; an award-winning faculty and staff; pioneering uses of distance learning technology; and proven achievement in instruction, research, and outreach. The two primary concerns for MSTM are to maintain current enrollments in the program and to expand the curriculum to meet the ever-changing demands of the telecommunications industry.

Five-year goals for the program are:

- complete the Virtual Laboratory Project, which will make the extensive lab projects available at a distance;
- complete planning and implementation for an online journal with United States Telecommunications Association (USTA) and/or other national organizations;
- increase network security component through improvement of the Center for Telecommunications and Network Security Management; and
- develop one of more emphases and/or certificates in telecommunications management.

Dean _____ Date _____
(Signature)

Note: If your program is accredited by an outside agency, the self-study and subsequent comments from the review team can be submitted to fulfill requirements of this program review. This review can be scheduled to coincide with your accreditation process. You **must** complete page 1 and 2 of this document to submit with your accreditation materials.

OKLAHOMA STATE REGENTS FOR HIGHER EDUCATION

1999- 2003
ACADEMIC PROGRAM REVIEW

1. BACCALAUREATE, MASTERS & DOCTORAL DEGREES

2. OKLAHOMA STATE UNIVERSITY

Master of Science in Telecom Management

Title of unit or degree program reviewed (Level III)

With options (Level IV) in: _____

Master of Science

Degree designation as on diploma (Level II)

MS

Formal degree abbreviation (Level I)

Degree-granting academic unit Department of Management 302
(Name) (Cost Center)

CIP code 5 2 1 2 0 4

HEGIS code 0 5 9 9

Instructional Program code 4 0 3

Name of department head

(person who oversees degree program listed above) Dr. Mark Weiser

Program holds specialized accreditation from Association to Advance Collegiate Schools of Business

Name and title of contact person Dr. Mark Weiser
(Name)

Director, M.S. in Telecommunications Mgmt Program
(Title)

Date of Institutional Governing Board Review: AY 1998-99

President _____ Date: _____
(Signature)

OVERVIEW

A. Description of the Departmental/Program Review Process

This review is a collaborative effort involving the MSTM program office, the College of Business Administration, and the office of University Assessment. Jay Boyington, MSTM Assistant Director, with assistance from Ruth Owens, Coordinator of the CBA Research and Financial Services office, composed the initial draft of the review using program records, annual reports, information provided by University Assessment, and the program's student database. The draft was reviewed by Dr. Mark Weiser, MSTM Director; Dr. Rick Wilson, Head of the Management and Information Systems Department; and Dr. Gerald Lage, Associate Dean for Graduate Studies. The final document was submitted to Dr. James Lumpkin, Dean, College of Business Administration, for review.

The MSTM program and the College of Business Administration have a long history of keeping thorough records, and this was certainly helpful in reviewing the past five years of the program. Following the initial assessment in 1999, the program conducted annual reports similar to the five-year assessment. A copy of our 1999 report was used as a guide and reference. In some cases, the information requested simply needed updating, particularly in the centrality and curriculum and structure areas. The CBA Research and Financial Services offices provided the Program Finances information on pages 7 and 8. The content in the tables on pages 11 and 12 comes from data provided by University Assessment and records from the MSTM program office.

B. Recommendations from Previous Program Reviews.

Goals from the previous program review were as follows.

- Delivering the MSTM degree program classes to the desktops of our student constituents.
- Develop a collaborative OSU/Industry-sponsored major research facility in either Tulsa or Stillwater.
- Develop online telecommunications management journals to enhance OSU's reputation and to disseminate knowledge in the field. This would include a student-run, practitioner-focused publication and a traditional academic, research-focused journal.
- Continue to provide new outreach programs and economic programs that benefit the State of Oklahoma and our many program constituents, for example, making the Telecommunications and Technology Symposium an annual event, offering new professional development programs developed by faculty, etc.

All core courses, with the exception of the hands-on laboratory, are available directly to the desktop computer, making the program classroom independent. This allows degree candidates greater flexibility in getting the content, especially those students working full-time jobs while attending classes. Work continues on the development of online telecommunications management journals. Responsibility for the journal, however, will shift to the Center for Telecommunications and Network Security Management.

The collaborative research facility between the program and industry has not happened. Facilities in both Stillwater and Tulsa are available, but the focus in each lab is teaching rather than research. The economic decline in the telecommunications sector eliminated company funding for this option. The decline had a negative impact on the interest in making the symposium an annual event as well.

CRITERION I

Program Centrality

A. Goals & Objectives of Degree Programs

Degree Program: Master of Science in Telecommunications Management

Program Clientele: Graduate level students with backgrounds in business, engineering, and computer science as well as working professionals in the field of telecommunications.

Program Objectives: The purpose of the MSTM program is to prepare masters-level students to excel in professional careers in telecommunications management. Employment areas for MSTM graduates include both the public and private sector.

Expected Student Outcomes: MSTM graduates

- will have broad knowledge in business, technical, and telecommunications disciplines;
- will have in-depth knowledge in specific elective areas that are best suited to the students' career aspirations;
- will have a working knowledge of all sectors of the telecommunications industry as a result of the telecom industry overview course;
- will have hands-on technical experience as a result of the telecom laboratory course;
- will have real-world telecom experience as a result of the telecom practicum;
- will demonstrate respect for others, integrity, and ethical behavior; and
- will demonstrate a love of learning and scholarship and a commitment to lifelong learning.

B. Linkage of the Program to Institution's Mission

The MSTM program's mission statement is as follows: To become a nationally prominent, exemplary center for telecommunications education, research, and outreach.

The MSTM mission is fundamentally linked to Oklahoma State University's mission in that we are committed to accomplishing OSU's three-pronged mission of instruction, research, and outreach. We are achieving the OSU mission of serving state, national, and international communities through our extensive use of distance learning technologies.

CRITERION II

Program Curriculum and Structure

A. Program Structure (Attach copies of the current degree requirements sheet)

Attachment A, "Course Descriptions" document includes required core courses as well as all the possible electives that students may include on required Plan of Study.

A student must maintain a 3.0 GPA to remain in the MSTM program, unless circumstances justify the student's continuation under an academic probationary status. Students must complete 35 credit hours of MSTM course work with at least a 3.0 GPA in regular course work as well as a B or better in the creative component course.

1. Business Core Option requiring one of the following:
 - a. ACCT 5103 Financial Accounting and Analysis
 - b. FIN 5013 Business Finance
 - c. ECON 5113 Managerial Economics
 - d. MKTG 5133 Marketing Management
2. ECEN 5553 Telecommunications Systems
3. MGMT 5113 Management and Organizational Theory
4. TCOM 5012 Telecommunications Laboratory
5. TCOM 5113 Industry Overview and Telecommunications Applications
6. TCOM 5123 Telecommunications Systems II
7. TCOM 5143 Telecommunications Analysis, Planning and Design
8. TCOM 5163 Telecommunications Practicum
9. 12 hours of electives as approved by the MSTM program

B. Distance Education (List the courses offered by electronic or other distance delivery methods)

In addition to multiple electives that vary by semester, the program offers:

1. ACCT 5103 Financial Accounting and Analysis
2. ECEN 5553 Telecommunications Systems
3. FIN 5013 Business Finance
4. MGMT 5113 Management and Organizational Theory
5. MKTG 5133 Marketing Management
6. TCOM 5113 Industry Overview and Telecommunications Applications
7. TCOM 5123 Telecommunications Systems II
8. TCOM 5143 Telecommunications Analysis, Planning and Design
9. TCOM 5153 International Telecommunications Management
10. TCOM 5173 Global Telecommunications Regulations
11. TCOM 5223 Information Assurance Management
12. TCOM 5233 Applied Information Systems Security

C. Articulation Agreement (Identify the articulation (2+2) agreements the program has with community colleges)

Not applicable

B. Multidisciplinary programs

Given the interdisciplinary nature of the MSTM program, the program faculty provides instruction from multiple disciplines in every class offered through the program. Students from the computer science and electrical engineering programs take MSTM courses as electives for their respective degrees. Specific courses include TCOM 5012, 5113, 5123, and 5143. The benefit for each program is the addition of management skills in network resources.

CRITERION III Program Resources

Program Finances:

- Departmental Expenditures: Regular Funds (state appropriations, student fees, and miscellaneous institutional income)
- Departmental Expenditures: Special Funds (from grants, contracts, and gifts or any sources other than those regularly appropriated by the state or provided by student fees, e.g. college foundation, E & G Part II)

DO NOT CROSS-REFERENCE FINANCIAL INFORMATION TO OTHER STANDARD INFORMATION FORMS

Master of Science in Telecommunications Management

Name of Department

Annual Expenditures		Regular Funds			Special Funds		
		2000-2001	2001-2002	2002-2003 (estimate)	2000-2001	2001-2002	2002-2003 (estimate)
Salaries and Wages:							
Administration	Amount	104,890	94,680	96,360	61,454	53,700	76,908
	Number of FTE*	2.0	2.0	2.0	1.25	1.25	1.25
Faculty	Amount	93,609	121,652	123,615			
	Number of FTE	5.25	5.25	5.25			
Regular	Amount	86,589	114,902	116,865			
	Number of FTE	4.25	4.25	4.25			
Adjunct	Amount	6,750	6,750	6,750			
	Number of FTE	1.0	1.0	1.0			
Student Assistants	Amount				38,258	36,447	63,318
	Number of FTE				11.33	10.79	18.76
Clerical	Amount	18,000	19,800	20,700			
	Number of FTE	1.0	1.0	1.0			
Other (Specify)	Amount						
	Number of FTE						
Fringe Benefits:		60,792	65,870	67,233	17,695	15,545	19,523
Equipment:		1,600	540	2,403	9,500	49,193	251
Supplies:		25,373	14,062	4,662	3,122	1,443	3,472
Travel:		4,630	1,704	1,766	2,392	2,715	3,774
Other (Specify):						31,000	
TOTALS:		405,503	439,960	443,354	132,421	190,043	167,246

*1 FTE equals 1 full-time position, or the equivalent in part-time positions.

Program Finances (Continued)

- Grants, Contracts, and Gifts Awarded to Program Faculty.

External Funds			Dollar Amounts				
Name of Grant, Contract, or Gift	Principal Investigator	Source of Funds	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Performance Issues of TCP/IP Over ATM	Mark Weiser	AA-5-53149		5,329			
SBC Online Degree Prog.	Mark Weiser	AA-5-65792			150,000		
MSTM Lab Implementation in Tulsa	Mark Weiser	AA-5-66101				375,000	
Telecom Virtual Lab Development	Ramesh Sharda	AA-5-72722					221,187
Externship for Assistance in Development & Maintaining Web Sites	Ramesh Sharda	AA-5-75053					6,466
CATT Phase V Predictive Modeling	Mark Weiser and Ramesh Sharda	AH-5-25321	28,000	37,446			
CATT Phase VI Problem Parts Analysis	Ramesh Sharda and Mark Weiser	AH-5-66411		62,854			
CATT Phase VI Web Based Instruction	Ramesh Sharda and Mark Weiser	AH-5-66621		110,031			
CATT 2000-WBS 3.1.1.1 Knowledge Network	Ramesh Sharda and Mark Weiser	AH-5-73111		40,039			
CATT 2000-WBS 3.1.1.1 Knowledge Network	Mark Weiser and Ramesh Sharda	AH-5-73111			40,039		
CATT 2000-WBS 3.1.1.2 Score Enhancement	Ramesh Sharda and Mark Weiser	AH-5-73121		61,757			
CATT 2000-WBS 2.1.1 Customer Focused Deployment of CATT Derived Technology	Ramesh Sharda and Mark Weiser	AH-5-77111		83,128			
Southwestern Bell Comm	Mark Weiser	Foundation	28,000	400,586	240,039	375,000	227,653

A. New Facilities and Major Equipment

Over the last five years, the MSTM program received an equipment contribution from Amoco/British Petroleum, a substantial monetary gift from Williams Communications, and a significant amount of equipment from Cisco at a generous reduction in price. These contributions have had a tremendous impact on the program laboratory facilities in Stillwater and allowed the program to establish a lab on the OSU-Tulsa campus.

In spring 1999, an alumnus of the program working for Amoco contacted the program concerning an internal list of equipment being reallocated or disposed of following British Petroleum's purchase of the company. The result was a contribution of several brand new Ethernet transceivers, fiber Ethernet hubs, router cards, and 10 Mbps level-one hubs. With this equipment, the laboratory class has increased flexibility in network configurations and the introduction of a new data link protocol.

In 2000, Williams Communications provided a gift of \$375,000 to OSU-Tulsa to enhance the campus' ability to offer a technical curriculum. The donation was matched by state funds and earmarked for the development and implementation of an advanced telecommunications laboratory on the Tulsa campus. The facility was completed in spring 2002 and fully supports training and applied research, voice, video, and data education. The lab is equipped with 35 desktop computers, eight 10 Base T 8-port hubs, telephony, and videoconference equipment.

In fall 2001, as part of the ongoing commitment to the program, the College of Business Administration provided an extensive upgrade of the Stillwater laboratory. Much of the network infrastructure and computing resources were replaced and new Wide Area Network simulation hardware and software was added. In addition, an agreement with Cisco allowed the program to use the CBA funding to purchase 41 Cisco routers, six Cisco hubs, six Cisco Internet-protocol telephones, two Cisco Call Managers, and one Cisco Catalyst 4000 switch.

The program also purchased equipment in association with the Virtual Laboratory grant, including 24 PC cameras and five Polycom Video Conferencing units. In addition, the program has purchased a Sun Microsystem computer and four Extreme 48i Layer 3 Switch with Gigabit Ethernet.

B. Academic and Administrative Efficiencies

The most significant impact on administrative efficiency occurred six years ago when the program initiated an enrollment management program, thereby eliminating special-student admissions and prohibiting non-degree students from enrolling in the TCOM prefix classes without written permission. The impact was immediate with a reduction in student-to-teacher ratio and a much more manageable process for the program administration.

The program traditionally produced a resume book and mailed copies to perspective employers in the telecommunications industry. In 2002, the program moved to an online database offered through OSU Career Services and eliminated the cost of developing and mailing the resume book. Employers received a postcard detailing the process for accessing the resumes. This method is user-friendly for employers as it allows them to search for specific skills and interests.

Distance learning has evolved from videocassettes to video streaming, CD-ROMS and ZIP files. The new formats are far more efficient in distribution and in cost of production and mailing. The MSTM program has consistently used the Internet for disseminating information about the program to

prospective and current students. In 2003, the program made significant changes to the look and navigational aspects of the web site. The application material is now available through the web, eliminating the cost and time involved in mailing material.

CRITERION IV
Productivity

A. Enrollment

Fall	Headcount Enrollment	Grade Point Average of Majors
1999	332	3.49
2000	287	3.51
2001	198	3.31
2002	195	3.51
2003	142	3.61

B. Degrees Conferred

Year	Degrees Conferred
1998-1999	32
1999-2000	87
2000-2001	70
2001-2002	57
2002-2003	53

C. Program Non-Completers (*Identify the number of students, average number of hours attempted and earned, and average GPA of students who completed at least 100 credits but did not graduate within 6 years – we will provide this data later.*)

Fall	Number of Non-completers	Number of Hours		Grade Point Average
		Attempted	Earned	
1999	0	0	0	0
2000	0	0	0	0
2001	1	39	33	2.833
2002	0	0	0	0
2003	0	0	0	0

Based on a minimum of 28 credit hours completed toward the degree.

D. Student Demand for Academic Unit's Offerings

Year	Student Credit Hours				No. of Courses/Sections (Lecture/Discussion Only)				Average Section Size*	% Classes Taught By Tenure/Tenure Track Faculty			Student/ Faculty Ratio**	Student/ Faculty Ratio***
	Lower Division	Upper Division	Graduate	Total	Lower Division	Upper Division	Graduate	Total		Lower Division	Upper Division	Graduate		
1998-1999	0	0	2036	2036	0	0	21	21	25	0%	0%	60%	1: 61	1: 52
1999-2000	0	0	1944	1944	0	0	21	21	21	0%	0%	50%	1: 68	1: 56
2000-2001	0	0	1961	1961	0	0	27	27	15	0%	0%	55%	1: 45	1: 45
2001-2002	0	0	1530	1530	0	0	28	28	13	0%	0%	50%	1: 55	1: 46
2002-2003	0	30	1190	1250	0	1	21	22	14	0%	0%	80%	1: 55	1: 60

Information based on material provided from Institutional Research and from information drawn from the MSTM student database.
 * Lecture/discussion only, ** faculty only, *** includes graduate assistants.

CRITERION V
Quality

A. Program Faculty
1. Faculty Qualifications

Name	Faculty Status (Regular or Adjunct)	Faculty Program FTE	Degrees Earned				Related Work Experience (Years)
			Highest		Highest in Teaching Area		
			Type	HEGIS	Type	HEGIS	
Ali Amiri	Regular	0.25	Ph.D.	0702	Same	Same	7
Mike Applegate	Regular	0.25	Ph.D.	0517	Same	Same	30
Bob Arnold	Adjunct	0.25	Ph.D.	0909	Same	Same	34
Jong-Moon Chung	Regular	0.25	Ph.D.	0909	Same	Same	7
Martin Crossland	Regular	0.25	Ph.D.	0702	Same	Same	24
Bill Dare	Regular	0.25	Ph.D.	0504	Same	Same	3
Tim DeGroot	Regular	0.25	Ph.D.	0506	Same	Same	17
Ken Eastman	Regular	0.25	Ph.D.	0506	Same	Same	18
Richard Germain	Regular	0.25	Ph.D.	0509	Same	Same	13
Charles Gray	Adjunct	0.75	B.S.	0909	Same	Same	45
Charles Jones	Adjunct	0.25	M.S.	0838	Same	Same	35
Janet Kimbrell	Regular	0.25	Ph.D.	0502	Same	Same	25
Tim Krehbiel	Regular	0.25	Ph.D.	0504	Same	Same	17
Lee Manzer	Regular	0.25	Ph.D.	0509	Same	Same	31
Greg Marshall	Regular	0.25	Ph.D.	0509	Same	Same	18
Stephen Miller	Regular	0.25	Ph.D.	0509	Same	Same	30
Tim Peterson	Regular	0.25	Ph.D.	0506	Same	Same	38
Richard Olsen	Adjunct	0.25	B.S.	0909	Same	Same	37
Scott Shephard	Regular	0.25	Ph.D.	0909	Same	Same	13
George Scheets	Regular	0.25	Ph.D.	0909	Same	Same	17
Mark Weiser	Regular	0.25	Ph.D.	0702	Same	Same	8

B. Evidence of Regional/National Reputation and Ranking

The MSTM continues to be one of the unique programs of its kind in the nation. While there are other telecommunications programs, this degree reminds one of the few interdisciplinary programs drawing on the expertise of multiple colleges. The MSTM Laboratory is a one-of-a-kind facility because it gives students exposure to data, video, and voice transmission in one setting rather than focusing on one of the three areas.

C. Methods Used to Evaluate Student Achievement of Program Outcomes for Each Degree Program

Degree Program	Assessment Methods Used	Years
M.S. in Telecom Management	Capstone course results	1999, 2000, 2001, 2002, 2003
	College Grad Tracker	2001
	Graduate program alumni survey	2002
	MSTM program Graduate Survey	1999, 2000, 2001, 2002, 2003

D. Overview of Results from Program Outcomes Assessment

MSTM students recognize the value of the curriculum offered in the program, as indicated by the responses on the MSTM program Graduate Survey. Core course evaluations consistently show the students are pleased with the curriculum, particularly ECEN 5553 Telecommunications Systems, MGMT 5113 Management and Organizational Theory, TCOM 5012 Telecommunications Laboratory, TCOM 5113 Industry Overview and Telecommunications Application,; and TCOM 5123 Telecommunications Systems II. Students indicate these courses, specifically ECEN 5553 and TCOM 5123, give them a strong foundation in their jobs with relevant skills.

Students have offered suggestions for improvements. The TCOM 5012 Telecommunications Laboratory is one of the program's more popular classes, but it is also one the students would most like to change. The class is an intense, four-day course that covers a number of topics. Students have asked for a longer period of time rather than the accelerated class. Doing so would reduce the overall availability of the lab facility and the opportunity for individual experimentation. In an effort to balance the logistical issues with the needs of the students, the program has developed three new labs: Wireless Communications, Linux/Unix Administration, and a Security Lab. Each lab focuses on a particular topic and is a reflection of the current trends in telecommunications. The Linux/Unix class addresses a suggestion the program received through the Graduate Student Survey. Additionally, the surveys indicate a desire for curriculum in networking programming. Through our partners in the Computer Science Department, the program has responded to this request immediately with CS 5283 Computer Network Programming, now an approved elective in the program.

The expected student outcome for the degree program is completion of the 35 credit hour program, including the TCOM 5163 Telecommunications Practicum course, and employment in the telecommunications industry. Since 1999, the program has graduated 299 students, or 85% of the 353 admitted. Placement has declined from 95% in 1999-2000 to a current rate of 22.4%. The reason for this dramatic decline in placement is the current situation in the telecom sector where lay-offs and bankruptcies have been commonplace for the last three years.

In addition, in calculating the placement figures the employment status of the students at the point of admission and at graduation must be taken into account. When the employment status is taken into consideration, the placement figures rise to 38% because it only reflects those students who attended the

program as full-time students and who were not working in the industry while earning their degrees. Furthermore, nearly 13% of the graduates during 2001-2003 went on for additional college study and over 8% returned to their country of origin. Tracking the rest of the students from this three-year period has presented a challenge, so the best information indicates another 40%, or 47 students, have gone back to school, returned home, continue to seek employment, or are currently employed.

E. Feedback from Program Alumni/Documented Achievements of Program Graduates

In 1999 and 2000, placement of MSTM graduates hovered around 95% across the country. Many students did not complete the degree because they were able to find work with high salaries. As the telecommunications sector declined over the last three years, including lay-offs, bankruptcies, and company closings, placement has declined to 22%. The program's international students, who make up the majority of the on-campus degree candidates, are having a very difficult time finding work within the country, and 40% have returned to their home countries. Another 14% are continuing their education at the master's or doctoral level. Unfortunately, the program has lost contact with the remainder.

MSTM graduates have been generally pleased with the program and its curriculum. Graduate surveys indicate approval for the program but offer suggestions related to:

- expanding the curriculum into other areas, such as security, wireless technology, and Voice over Internet Protocol (VoIP);
- limiting program admission to students with technically-oriented bachelor's degrees;
- forming research partnerships with industry;
- increasing the number of technical courses, including networking classes; and
- expanding the Telecommunications Lab class from the current four-day format to a full semester course.

The program takes all suggestions seriously and responds accordingly. The curriculum has expanded in areas of security and wireless technology, and the Telecommunications Laboratory curriculum now includes VoIP. Technical classes are and have been available on the Stillwater campus; the challenge here is distance learning. Many of the more technically-oriented classes require hands-on lab activities, which would prohibit a distance-learning component. Expanding the Telecommunications Lab class to a full semester format would negatively impact the availability of the lab for other purposes, including individual experiments. Pursuing research partnerships with companies has been discussed but not pursued because the program's facilities will not support such agreements.

F. Other Program Evaluations

Not applicable

CRITERION VI

Program Demand/Need

A. Occupation Manpower Demand (If applicable)

1. Advisory Committee Membership

- Mr. Andy Aiello, COO and EVP of Business Operations, Trendium, Inc.
- Mr. Marshall E. Allen, Director, The Institute for Telecommunications, OSU
- Ms. Mollie Andrews, Vice President, General Manager, Cox Business Services, Oklahoma City
- Colonel John D. Bartrug, USAF Retired, Tinker Air Force Base
- Dr. Raja Basu, Vice-President, Academic Affairs, OSU-Tulsa
- Mr. Jay Boyington, Assistant Director, MSTM
- Dr. George Conklin, Christus Health
- Mr. Ron Cooper, Director, Center of Excellence in Information and Telecommunications Technology OU/OSU Research & Graduate Education Center, OSU-Tulsa
- Mr. Terry Feix, Regional Vice President, Major Accounts, Southwestern Bell Communications, Oklahoma City
- Mr. Charles (Chuck) P. Jones, Southwestern Bell Communications, retired
- Mr. Rick Lett, Manager, Technology Research, Sprint
- Mr. Jim Liebhart, Partner, Accenture
- Mr. Dean McDaniel, Manager, Network Supported Accounts, Cisco Systems, Inc.
- Mr. Ed McLaughlin, VP and General Manager of Network Operations, WilTel
- Dr. Norman L. Mejstrik, IAB Board Chairman, Manager-Oklahoma City Eng. Office, Northrop Grummen
- Mr. Ray Newell, DISA Megacenter, Tinker Air Force Base
- Mr. Richard Olsen, Southwestern Bell Communications, retired
- Mr. Mathew Oommen, Optical DataCom
- Dr. Karl Reid, Dean, OSU College of Engineering, Architecture, & Technology
- Dr. Jerri Schoats, CBA Graduate Program Advisor, OSU-Tulsa
- Dr. Keith Teague, Head, OSU Dept. of Electrical & Computer Engineering
- Dr. Gary Trennepohl, President, OSU-Tulsa
- Dr. Julie Weathers, Director, OSU College of Business Administration Office of Business Extension
- Dr. Mark Weiser, Director, MSTM

2. Advisory Committee Recommendations

- In fall 1999, the MSTM Industry Advisory Board (IAB) recommended the program office prepare a business plan to be sent with a letter addressed to former OSU President James Halligan urging immediate support for the MSTM program. Board members agreed to send individual letters to their state legislators.
- In 2000, the MSTM IAB recommended the formation of a subcommittee from the board membership led by Dr. Rick Wilson, former program director, responsible for developing a presentation for the State Board of Regents for Higher Education. The presentation should

detail the impact of the MSTM program on the telecommunications industry, the cost involved, the importance of the program's contribution, and a recommendation for a state and industry-matching fund to support the program. The board charged the IAB Program Review Committee with working with OSU faculty to recommend curriculum tracks for certificate programs in telecommunications management.

- In 2001, the IAB made numerous recommendations. Members were to identify industry members to co-develop cases with faculty. The board instructed the program to provide a plan for how to fund the long-term upgrade and maintenance of the Telecommunications Laboratory. Further, the board called for a long-term plan for lab operating, replacement, and other related costs; development of portable lab modules; the implementation of "mini remote labs" at corporate locations to be funded by user companies; the development of a virtual lab; and the continuous assessment of the lab for areas of improvement. The board called for MSTM student participation at the meetings, specifically the members of the student association and the top students in the program. Board members were asked to submit organization names to the program director and board chairman for IAB membership.
- In 2002, the board called for action in a variety of areas. Specifically, the board wanted a database of companies beneficial to the MSTM program. Memorandums to upper-level OSU administrators were to be written outlining the need for non-credit workshops and conferences in the telecommunications, information technology, and security areas. The board wanted a plan addressing the real needs of the industry for a telecommunications infrastructure to generate journal articles and material for presentations. To assist students in their intern and job searches, the board called for the establishment of an interview room with video conferencing capabilities, in cooperation with Educational Television Services on the OSU campus.
- In 2003, the board encouraged the program to move forward in the area of accreditation for telecommunications programs. The board recommended the development of curriculum tracks emphasizing specific areas such as security.

3. School Response to Recommendations

The growth of the MSTM program far exceeded the expectations of all parties involved in its development. Initially, the program projected enrollment in the first year to reach 30 students, total enrollment reached 86. Funding additional faculty positions and the telecommunications laboratory quickly became an issue as enrolled continued to climb. The University, however, was not able to react quickly in funding the program. Also, at this time, the program was not housed in any one college, so there was no one individual on the administrative level to champion the needs of the program.

Members of the IAB visited with the State Regents of Higher Education on funding issues. Several IAB members convinced their chief executive officers to write letters to the governor of Oklahoma and others. In addition, a team of industry executives met with the OSU Regents, only to find the Regents had similar objectives for the Brain Gain initiative. The College of Business Administration was provided with three faculty positions in the information technology area. One of these faculty positions was filled at OSU-Tulsa dedicated to the MSTM program.

The program has been able to fund the equipment upgrades for a laboratory in Stillwater and construct a new lab facility on the OSU-Tulsa campus. In Stillwater, the Student Technology fee provided sufficient funding for a facility-wide computer upgrade. The program also formed a partnership with Cisco that led to a substantial saving on an equipment purchase for the lab. In Tulsa, Williams Communications made a significant donation to OSU-Tulsa, which the campus

administration invested in the development of a telecommunications lab for the campus. The Regents matched the Williams donation, allowing for a \$750,000 investment. Portable labs are in place and work continues on the development of a virtual lab, which will allow students at remote locations to participate in lab exercises.

A database of over 1,000 telecommunications companies was developed, including location, financial, and contact information. An alternative to the interview room was developed at significant savings in funding and facilities. Using its expertise in video conferencing, the program can arrange a videoconference anywhere on campus, provided a network connection is available, allowing for greater flexibility for all concerned.

Dr. Mark Weiser, MSTM Director, will attend a meeting of other telecommunications and information technology programs in April 2004 to discuss the formation of an accreditation body. The program has developed plans for a certificate program in telecommunications management and short courses in wireless communications and systems security. The short classes are very popular with students in Stillwater and Tulsa. While the plans for a certificate program are ready, the program itself is currently not available.

4. Other Sources and Documents Indicating Demand

The program continues to see interest from international markets, particular from India, China, and increasingly Central and South America. In 2003, domestic student enrollment increased for the first time since 2001, and the program sees a slight increase in inquiries from prospective distance learning students.

B. Societal Needs for the Program

The definition of telecommunications varies from one person to another and, as such, so does the understanding of society's needs. Telecommunications continues to be the backbone for communications in the world. Telephone networks, both landline and cellular, depend on a vast infrastructure of cables, switches, towers, and technicians and managers. Our society has become accustomed to instant access to a dial tone and a reliable, clear connection.

While the Internet has existed in the military and through universities, the impact in the workplace, education, information dissemination, and entertainment is phenomenal considering its short public life. This vast computer network revolutionized American business and led one of the most successful economic periods in United States history. The bubble may have burst, but the workload required to support this expansion remains.

Regardless of the economy or the state of the telecommunications sector, telecommunications, however it is defined, plays an integral part in every day communications. The MSTM program continues to be a viable degree designed to manage telecommunications with telecommunications.

CRITERION VII

Program Duplication

A. Identify Other Degree Programs at OSU with Similar Titles or Functions

There is no program duplication of the M.S. in Telecommunications Management program at Oklahoma State University or within the State of Oklahoma. The MSTM program focuses on management of and management with telecommunications technology, so it is coded in the business and management category. None of the other programs in the category have content dealing with telecommunications. The MSTM degree requires two business courses, thus these two courses overlap with courses required by many of the graduate business disciplines.

In addition, an MSTM student may select all four of his/her electives from graduate-level business courses. The student, however, may also choose electives from Management and Information Systems, Computer Science, Electrical Engineering, or other business-related disciplines. Although the MSTM program may be coded under the business and management area, the program is truly interdisciplinary and will have some overlap with courses for other degrees in the academic areas noted.

B. Describe How Your Degree Program is Unique

The MSTM program was developed in response to industry's request for skilled and knowledgeable telecommunications managers. Structurally, MSTM is a 35 credit-hour interdisciplinary program that draws on the combined expertise of the College of Business Administration; the College of Engineering, Architecture, and Technology, and the College of Arts and Sciences. Students may choose electives from 9 different disciplines to achieve a depth of knowledge in an area best suited to fit their career aspirations. The MSTM curriculum is developed and revised through the input of an interdisciplinary academic program committee as well as the MSTM Industry Advisory Board.

Summary and Recommendations

A. Strengths

- State-of-the-art lab facilities in Stillwater and Tulsa, with partial funding in place for maintenance and upgrades.
- Input from Industry Advisory Board committed to the program and the telecommunications industry.
- Talented and dedicated group of faculty and staff.
- Strong leadership in using new technologies to deliver education to the students.
- Commitment to fulfilling the three-pronged mission of OSU as demonstrated in the program's instruction, research, and outreach.

B. Areas for Improvement

- Recruitment of companies for prospective students and increased placement opportunities.
- Maintaining closer ties to the program's graduates.
- Expansion of the telecommunications sector of the economy. Sadly, this is an area where we have no control.

C. Recommendations for Action

- Develop and execute plan for developing, or reestablishing, relationships with telecommunications companies within the region, as the industry continues.
- Roll out online evaluation ready for launch and use this system to develop networking opportunities for alumni.

D. Five-Year Goals for the Program

- Complete the Virtual Laboratory Project, which will make the extensive lab projects available at a distance.
- Complete planning and implementation for online journal with United States Telecommunications Association (USTA) and/or other national organizations.
- Increase network security component through improvement of the Center of Telecommunications and Network Security Management.
- Develop one of more emphases and/or certificates in telecommunications management.

Attachment A
Course Descriptions

Core Courses

TCOM 5113 Industry Overview and Telecommunications Applications (3 credit hours)

Provides overview of telecommunications industry, technology, environment, and current topics in telephone services (wireless and wire line), business data services, CATV, and Internet services and providers (including JAVA and HTML). Covers managerial and strategic aspects of telecommunications technologies. Above topics will be supported with guest speakers from the telecommunications industry.

ECEN 5553 Telecommunications Systems (3 credit hours)

Technical survey of the ways and means that voice, data, and video traffic are moved long distance. Topics covered include Data Networks (Ethernet and Token Ring Local Area Networks; FDDI and SMDS Metropolitan Networks; Internet, Frame Relay, and ATM Wide Area Networks); The Telephone System (POTs, Network Synchronization and Switching, ISDN, SONET, Cellular Telephone); and Video (NTSC, Switching and Timing, Compressed Video standards such as MPEG and Px64, HDTV).

TCOM 5123 Telecommunications Systems II (3 credit hours)

Prerequisite: ECEN 5553-Telecommunications Systems. Applied technical coverage of selected topics from the upper layers of the OSI model. The emphasis is on the Network and Transport layers, using TCP/IP, IPX/SPX, and Netbeui, as well as security issues and other multi-layer protocol suites. Other topics include flow control, RSVP, encryption, compression, and LAN/WAN applications.

TCOM 5143 Telecommunications Systems Analysis, Planning, and Design I (3 credit hours)

Prerequisite: ECEN 5553-Telecommunications Systems. Involves introduction to the basic system analysis tools and the procedures for conducting a system analysis. Topics include system requirements, the initial analysis, the general feasibility study, structured analysis, detailed analysis, logical design, and the general system proposal. Current system documentation through use of classical and structured tools and techniques for describing flows, data flows, data structures, file designs, input and output designs, and program specifications. The student will gain practical experience through a project.

MGMT 5113 Management and Organization Theory (3 credit hours)

Contemporary theories of organization. Structure and dynamics of organizational goals and environments.

Students will choose one of the following 6 MBA functional courses:

ACCT 5103 Financial Accounting and Analysis (3 credit hours)

Development of the ability to read and to analyze financial statements and to use this information along with other types of information in decision making.

ACCT 5113 Managerial Accounting (3 credit hours)

Prerequisite: ACCT 5103-Financial Accounting and Analysis. Interpretation of accounting data in planning, controlling, and decision making.

ECON 5113 Managerial Economics (3 credit hours)

Economic theory applied to business decision making. Concepts of microeconomics and macroeconomics related to understanding the economic system, analysis of policy, forecasting, and international economics.

FIN 5013 Business Finance (3 credit hours)

An introduction to the major areas of business finance: the financial environment in which business decisions are made and the institutions found therein, the financial management practices of a firm securing financing and allocating resources among competing alternatives, and the valuation of financial assets available to the firm and individuals.

FIN 5053 Theory and Practice of Financial Management (3 credit hours)

Prerequisite: ACCT 5103-Financial Accounting and Analysis. Concepts and theories applicable to the financial administration of a firm. Cases, problems and readings to illustrate various financial problems and techniques of solution.

MKTG 5133 Marketing Management (3 credit hours)

Consideration at an advanced level of the major elements of marketing from the point of view of the marketing executive. Emphasis on problem solving and decision-making, using an interdisciplinary approach. Development of an integrated, comprehensive marketing strategy.

TCOM 5012 Telecommunications Laboratory (2 credit hours)

Prerequisite: ECEN 5553-Telecommunications Systems, and TCOM 5123-Telecommunications Systems II, or concurrent enrollment in TCOM 5123 and instructor consent. This course will familiarize students with the hardware used to move voice, data, and video traffic. Data network experiments include hooking up and getting operational a small LAN, interconnecting these LANs via bridges or routers, and attaching voice and video modules to the LANs. Telephone Network experiments include installing small PBXs and interconnecting them to the campus phone system and then interconnecting the lab PBXs with crosspoint switches and fiber. Video experiments include interconnecting and getting operational a small 2-camera studio, then digitizing and transferring the video over the laboratory telephone system. Practical operating aspects and standards of distance transmission devices, switching equipment media for transmitting data, voice, and video signals. Handling information problems within selected environments.

TCOM 5163 Telecom Practicum (3 credit hours)

Application of knowledge and skills developed in core courses to an organizational environment to solve telecommunications management-related problems. Working within an organization allows students to integrate the concepts and experience the adaptation of theory to fit organizational reality. Emphasizes practical industry experience.

Computer Science Electives

CS 4273 Software Engineering (3 credit hours)

Lab 2. Prerequisites: CS 2133-Computer Science II, CS 3443-Computer Systems or ECEN 3213-Microcomputer Principles and Applications. Fundamental characteristics of the software life cycle. Tools, techniques, and management controls for development and maintenance of large software systems. Software metrics and models. Human factors and experimental design. Same course as ECEN 4273.

CS 4323 Design and Implementation of Operating Systems I (3 credit hours)

Prerequisites: CS 2133-Computer Science II, CS 3443-Computer Systems, or ECEN 3313-Electronic Devices and Applications. Process activation and process context block. Batch, multi-programmed, and timeshared operating system. Process management, memory management, and synchronization primitives. Deadlock prevention, avoidance, and detection.

CS 4343 Data Structures and Algorithm Analysis I (3 credit hours)

Prerequisite: CS 2133-Computer Science II. Storage, structures, data and information structures, list processing, trees and tree processing, graphs and graph processing, searching, sorting.

CS 5013 Linear Programming (3 credit hours)

Prerequisites: MATH 3013-Linear Algebra or INDEN 4014-Operations Research; FORTRAN. Simplex algorithm to solve deterministic linear optimization models considering maximization and minimization objectives; degeneracy, alternative optima, and no feasible solutions. Revised simplex procedures. Duality theory, economic interpretations, dual simplex, and complementary pivoting. Sensitivity analysis and parametric programming. Special cases of linear optimization problems and underlying mathematical foundations. Large-scale models including computational considerations. Same course as INDEN 5013.

CS 5070 Seminar and Special Problems (1-6 credit hours, maximum 6)

Object Oriented Programming and Visual C++ - Prerequisites: consent of instructor. Designed to allow students to study advanced topics not provided in existing courses. Common lecture with CS 4570-Special Topics in Computing. Common lecture with CS 3373-Object-Oriented Programming and Visual C++.

CS 5113 Computer Organization and Architecture (3 credit hours)

Prerequisite: CS 3443-Computer Systems. Computer architecture, computer control, microprogrammed control, addressing structures, memory hierarchies, hardware description languages, specific architecture, hardware simulation, emulation.

CS 5154 Computer Science Migration (4 credit hours)

Lab 2. Prerequisite: Graduate standing. A survey of computer science for students whose undergraduate major was not computer science. Programming in high-level languages, programming in assembly language, algorithm design and analysis, computer system fundamentals, fundamental data structures.

CS 5253 Digital Computer Design (3 credit hours)

Prerequisite: ECEN 3223-Digital Logic Design. Analysis and design of digital computers; arithmetic algorithms and the design of the arithmetic/logic unit (ALU); serial and parallel data processing, control and timing systems, microprogramming, memory organization alternatives, input/output interfaces. Same course as ECEN 5253.

CS 5273 Advanced Software Engineering (3 credit hours)

Lab 2. Prerequisites: CS 4273-Software Engineering. Continuation of CS 4273. Advanced theory and practice of software design methodology, large-scale design and implementation problems, experimental design for software engineering. Same course as ECEN 5273.

CS 5283 Computer Network Programming (3 credit hours)

Prerequisites: CS 4283-Computer Networks. Detailed technical concepts related to computer and telecommunications software development; client-server programming using various application program interfaces, including STREAMS, the Transport Layer Interface (TLI), and Berkeley Sockets; application development using TCP/IP protocols.

CS 5313 Formal Language Theory (3 credit hours)

Prerequisite: CS 3613-Theoretical Foundations of Computing. Formal language theory applied to procedure-oriented languages; application of finite state algorithms to lexical analysis; Chomsky hierarchy of languages; generation, recognition, and closure properties of languages.

CS 5323 Design and Implementation of Operating Systems II (3 credit hours)

Lab 2. Prerequisites: CS 4323-Design and Implementation of Operating Systems I, STAT 4013-Statistical Methods I. Task systems and concurrent programming, synchronization, and inter process communication; theoretical investigation of resource sharing and deadlock, memory management, strategies, and scheduling algorithms, queuing theory, distributed operating systems; system accounting, user services and utilities.

CS 5363 Advanced Organization of Programming Languages (3 credit hours)

Lab 2. Prerequisite: CS 3363-Organization of Programming Languages. Continuation of CS 3363, mathematical theory of computer language organization functional programming, parallelism in languages, mathematics of control structures and data structures, applicative languages, Symbolic languages.

CS 5413 Data Structures and Algorithm Analysis II (3 credit hours)

Prerequisites: CS 4343-Data Structures and Algorithm Analysis I. Data structures and their application in recursive and iterative algorithms, static and dynamic data structure representations and processing algorithms, dynamic and virtual storage management.

CS 5423 Information Organization and Retrieval (3 credit hours)

Prerequisites: CS 3423-File Structures, CS 4343-Data Structures and Algorithm Analysis I. An overview of database management systems, entity-relationship model, relational model, relational algebra, relational calculus,

structured query language, relational database design with normalization theorems, database integrity constraints, and object-oriented model.

CS 5433 Multi-Level Storage Processing for Data Bases (3 credit hours)

Prerequisites: CS 3423-File Structures, CS 4343-Data Structures and Algorithm Analysis I. Physical characteristics of memory devices, data organization methods, logical versus physical structure, performance analysis.

CS 5513 Numerical Analysis I (3 credit hours)

Prerequisite: CS 4513-Numerical Mathematics: Analysis or MATH 4513-Numerical Mathematics: Analysis. Algorithms and error analysis, solution of equations, interpolation and approximation theory.

CS 5543 Numerical Analysis for Differential Equations (3 credit hours)

Prerequisites: CS 4513-Numerical Mathematics: Analysis or MATH 4513-Numerical Mathematics: Analysis and MATH 4233-Intermediate Differential Equations. Advanced machine computing, algorithms, analysis of truncation and rounding errors, convergence and stability applied to discrete variable, finite element, and spectral methods in ordinary and partial differential equations. Same course as MATH 5543.

CS 5553 Numerical Analysis for Linear Algebra (3 credit hours)

Prerequisites: MATH 3013-Linear Algebra and CS 4513-Numerical Mathematics: Analysis or MATH 4513-Numerical Mathematics: Analysis. Advanced machine computing, algorithms; analysis of rounding errors, condition, convergence, and stability applied to direct and iterative solution of linear systems of equations; linear least squares problems, including LU and QR factorization, conjugate gradients, QR algorithm, and Lanczos method. Same course as MATH 5553.

CS 5653 Automata and Finite State Machines (3 credit hours)

Prerequisite: CS 5313-Formal Language Theory. Finite state model, state diagrams and flow tables, equivalent states and equivalent machines; formal grammars, context-free languages and their relation to automata; turing machines, computability, and recursive function. Same course as MATH 5653.

CS 5663 Computability and Decidability (3 credit hours)

Prerequisite: CS 5313-Formal Language Theory. Effectiveness, primitive recursivity, general recursibility, recursive functions, equivalence of computability, definitions, decidability, and recursive algorithms. Same course as MATH 5663.

CS 5793 Artificial Intelligence and Expert Systems (3 credit hours)

Prerequisite: CS 4793-Artificial Intelligence. Advanced knowledge representation and expert systems programming, including reasoning under uncertainty; applications to planning, intelligent agents, natural language processing robotics, and machine learning; development of an expert system or research report required. Common lectures with ECEN 5293, INDEN 5933, and MAE 5793.

Electrical Engineering Electives

ECEN 4273 Software Engineering (3 credit hours)

Lab 2. Prerequisites: CS 2133-Computer Science II, CS 3443-Computer Systems or ECEN 3213-Microcomputer Principles and Applications. Fundamental characteristics of the software life cycle; tools, techniques, and management controls for development and maintenance of large software systems; software metrics and models; human factors and experimental design. Same course as CS 4273.

ECEN 4523 Communication Theory (3 credit hours)

Prerequisite: ECEN 3513-Signal Analysis. Noise in modulation systems. Digital data transmission. Design of optimal receivers, introduction to information theory.

ECEN 4533 Data Communications (3 credit hours)

Prerequisite: ECEN 4503-Random Signals and Noise. Signal detection in noise, tradeoffs between bandwidth signal-to-noise ratio and rate of information transfer, transmission multiplexing and error handling, elements of

computer network design, data link protocols.

ECEN 5253 Digital Computer Design (3 credit hours)

Prerequisite: ECEN 3233-Digital Logic Design. Analysis and design of digital computers; arithmetic algorithms and the design of the arithmetic/logic unit (ALU); serial and parallel data processing, control and timing systems, micro-programming, memory organization alternatives, input/output interfaces. Same course as CS 5253.

ECEN 5263 VLSI Digital Systems Design (3 credit hours)

Prerequisite: ECEN 4303-Digital Electronics Circuit Design; recommended: ECEN 5253-Digital Computer Design. Design of very large-scale digital systems on a single chip; review of MOS technology; design rules imposed by fabrication techniques; systematic structures for control and data flow, system timing, highly concurrent systems. Experimental opportunities available.

ECEN 5273 Advanced Software Engineering (3 credit hours)

Lab 2. Prerequisites: CS 4273-Software Engineering. Continuation of CS 4273. Advanced theory and practice of software design methodology, large-scale design and implementation problems, experimental design for software engineering. Same course as CS 5273.

ECEN 5293 Artificial Intelligence and Expert Systems (3 credit hours)

Prerequisite: Graduate standing in electrical engineering. Fundamental concepts: search-oriented problem solving; knowledge representation; logical inference; building an expert system; artificial intelligence languages, specialized machine architectures; applications to planning, natural language processing, and robotics. Development of an expert system or research report required. Common lectures with CS 5793, IEM 5933 and MAE 5793.

ECEN 5533 Modern Communication Theory (3 credit hours)

Prerequisite: ECEN 5513-Stochastic Systems. Noise as a random process, analog and digital signal detection in the presence of noise, optimum receiver design using signal space concepts and introduction to information theory. Trade-offs between bandwidth, signal-to-noise ratio and the rate of information transfer. Example system designs include earth satellite, deep space and terrestrial communication systems, and computer communication networks.

ECEN 5543 Data Transportation and Protection (3 credit hours)

Data and its representation; finite field matrices, pseudorandom sequences; information protection; space division networks; synchronization; and channel and error control.

ECEN 5643 Wireless Communications (3 credit hours)

Prerequisites: ECEN 3613-Electromagnetic Fields, ECEN 4503-Random Signals and Noise. Aspects of radiowave propagation for fixed and mobile communication systems. Review of Maxwell's equations and plane wave propagation, antenna principles. Reflection, refraction, diffraction, fading and scintillation, attenuation, ducting, diversity. Propagation in a cellular environment. Satellite communications.

ECEN 5753 Digital Processing of Speech Signals (3 credit hours)

Prerequisite: ECEN 4763-Discrete-time Signals and Systems or ECEN 5763-Digital Signal Processing. Digital signal processing; speech production; digital modeling of speech; short time analysis and synthesis; the short time Fourier transform, linear predictive coding and solution of the normal equations; vocal tract spectrum calculation; speech coding; homomorphic processing; applications of speech processing. Introduction to more advanced topics as time permits.

ECEN 5763 Digital Signal Processing (3 credit hours)

Introduction to discrete linear systems; frequency-domain design of digital filters; quantization effects in digital filters; digital filter hardware discrete Fourier transforms; high-speed convolution and correlation with application to digital filtering; introduction to Walsh-Fourier theory.

ECEN 5793 Digital Image Processing (3 credit hours)

Prerequisite: ECEN 4763-Discrete-time Signals and Systems or ECEN 5763, Digital Signal Processing. Digital image processing including image acquisition and characterization, transforms, coding and compression,

enhancement, restoration and segmentation. Use of modern image processing software on Sun and IBM work stations.

ECEN 5833 Fiber-Optic Communication Systems (3 credit hours)

Five generations of fiber-optic communication systems described in detail. Technical advances and increased capability of each system. Historical framework of how technical capability at the time forced technical decisions. A systems engineering point of view, emphasizing optimization of all components of the optical fiber link. Other recommended Electrical Engineering Electives Specific aspects of communications systems:

Management Science and Information Systems Electives

MSIS 5123 Enterprise Resource Planning (3 credit hours)

Resource planning for today's global business organization. Emphasis on integrated data flows and computer software for enterprise resource planning. Integration of transactional analysis, fundamental accounting practice, financial planning, and supply chain analysis form the basis for study in this integrated approach to enterprise resource planning.

MSIS 5133 Advanced Info. Technology for E-Commerce

Most real-world e-commerce applications are surprisingly complex, from a system-builder's perspective. In addition, the number of technologies underlying e-commerce applications is substantial and new technologies and tools are growing rapidly. In this course, we will explore some of these key technologies and attempt to apply our learning to build e-commerce-related applications. Some of these technologies include client and server-side scripting, developing COM components, applets, servlets, and beans among others. In addition, we will learn about some of the advanced architectures and functionality necessary for e-commerce applications. Significant knowledge of Visual Basic and/or Java, object-oriented concepts and database design is a prerequisite.

MSIS 5223 Object Oriented Applications (3 credit hours)

Object-oriented programming concepts and applications for business in today's global environment. Implementation through an appropriate object-oriented programming language.

MSIS 5303 Quantitative Methods in Business (3 credit hours)

Prerequisite: Demonstrated calculus ability. Application of quantitative techniques to business problems. Linear programming, transportation and assignment models, goal programming, integer programming, and networks.

MSIS 5333 Advanced Decision Theory for Management (3 credit hours)

Case studies and examples involving decision analysis. Studies taken from current literature.

MSIS 5413 Advanced Management Science (3 credit hours)

Advanced management science methods, with computer applications. Mathematical programming, simulation, forecasting, queuing, Markov processes.

MSIS 5543 Advanced File and Data Management (3 credit hours)

A design perspective of business data storage methodologies, structures, and approaches; and of file management techniques for business enterprises.

MSIS 5613 Advanced Production and Operations Management (3 credit hours)

Prerequisite: MSIS 5313-Production Operations Management or equivalent. Production systems, including a synthesis of production and management techniques used by operations managers. A computerized management simulation game provides decision-making experience.

MSIS 5623 Advanced Management Information Systems (3 credit hours)

Advanced Management Information Systems. Prerequisites: MSIS 5313-Production Operations Management, BADM 5003-Computer Applications in Business, ACCT 5103-Financial Accounting and Analysis, STAT 3013-

Intermediate Statistical Analysis. Design and use of management information systems in businesses and other organizations. Model building, information resource management and decision support systems.

MSIS 5633 Decision Support and Expert Systems (3 credit hours)

Technical and managerial issues involved in the evaluation, acquisition, and implementation of advanced technologies, such as decision support systems, expert systems, artificial intelligence, executive information systems, neural networks and others.

MSIS 5643 Advanced Data Base Management (3 credit hours)

Advanced theoretical and practical foundations. Brief review of classical issues surrounding design, analysis, and implementation of data bases, both from a micro and a mainframe perspective. Current and emerging issues in the data base field. Analysis, design, and implementation of distributed data bases, the object oriented data model paradigm, the use and management of automated design and support tools (e.g., CASE) from a data base perspective, and data security.

MSIS 5653 Advanced Object Oriented Systems Development (3 credit hours)

Theory and applications for business systems development from an enterprise-wide perspective.

TCOM, Business Administration, and Other Electives

TCOM 5153 International Telecommunications Management (3 credit hours)

All levels of government regulate telecommunications, from the city that controls the placement of telephone wires up to the nation state which issues licenses to broadcast. Because of the nature of telecommunications and the importance of the information it carries, international politics are also heavily involved. The purpose of this course is to investigate the institutions that affect the use of telecommunications. Some time will be devoted to the various parts of the federal government that are involved in this endeavor, such as the Department of Commerce, the FCC, and the Department of State. The major thrust of the course will be toward the role of international institutions, including the ITU, UNESCO, and the various satellite organizations such as INTELSAT.

TCOM 5173 Global Telecommunications Regulation (3 credit hours)

Historical review of the classical "PPT (Post, Telephone and Telegraph) Model", and the development of new competitive environments. Overview of international telecommunications networks and how they are regulated nationally and internationally. Review of the World Trade Organization (WTO) and the telecommunications commitments made by members. Emphasis on the European Union as the largest single telecommunications market, along with analyses of regional emerging markets. Review of challenges for the future for both regulatory agencies and telecommunications operators/providers.

TCOM 5213 Telecommunications Systems Analysis, Planning, and Design II (3 credit hours)

Prerequisites: ECEN 5553-Telecommunications Systems, and TCOM 5143-Telecommunications Analysis, Planning, and Design. Covers technical as well as managerial aspects of developing an integrated communications network. While some technical issues are covered, the major emphasis is on systems analysis and design of the communications networks covering voice, data, and video. Managing such a network is also discussed.

TCOM 5223 Information Assurance Management (3 credit hours)

A broad investigation of the elements of information assurance and security with an emphasis on the management impact to corporations and businesses engaged in the information services and e-commerce. Students should come away from the course with the ability to advise management on the risks and mitigation for all types of threats to information and privacy.

TCOM 5233 Applied Information Systems Security (3 credit hours)

Prerequisites: TCOM 5123-Telecommunications Systems II. An investigation into the various technical aspects of attacking, and of guarding against attacks and failures in various types of information systems. Course content may vary but will generally include computer, network, and data protection technologies (e.g., firewalls, packet filters,

proxy servers, user authentication and validation techniques, encryption, backup methodologies, system and component redundancies, etc). Various threats and attack methods will be examined.

TCOM 5310 Advanced Topics in Telecommunications Management (3 credit hours)

This course covers advanced topics in the interdisciplinary field of telecommunications management such as legal and regulatory issues, electronic commerce, internet and intranet development among others.

TCOM 5350 Advanced Telecommunications Management Lab (3 credit hours)

Prerequisites: TCOM 5012-Telecommunications Laboratory and permission of MSTM Program Director.

Advanced state-of-the-art topics in voice, data, and video. Hands-on network experiments beyond coverage in the required TCOM lab (TCOM 5012).

TCOM 5990 Directed Studies in Telecommunications Management (3-6 credit hours)

Special advanced topics, projects, and independent study in telecommunications management.

BADM 5113 Entrepreneurship and Venture Management (3 credit hours)

Enterprise creation and problems faced by entrepreneurs in early growth stages of business ventures. An interdisciplinary problem-solving approach with emphasis on "live" case studies and plans for new business ventures. Emphasis is on entrepreneurship rather than problems faced by going concerns.

BADM 5713 Analysis of the Multinational Firm (3 credit hours)

Identification and analysis of the managerial, financial and market problems facing the multinational firm. Focus is empirical, and stressing application of ecological and quantitative tools to the study of the multidimensional nature of the international business environment.

FIN 5213 International Business Finance (3 credit hours)

Prerequisite: FIN 5053- Theory and Practice of Financial Management. Theories and financial management practices unique to business firms which operate in or are influenced by, an increasingly global economy.

FIN 5223 Investment Theory and Strategy (3 credit hours)

Prerequisite: FIN 5053-Theory and Practice of Financial Management. Selected investment topics and advanced portfolio management techniques.

FIN 5243 Financial Markets (3 credit hours)

Prerequisite: FIN 5053-Theory and Practice of Financial Management. An analysis of the structure of financial markets, the determination and behavior of interest rates, the functioning of and the flow of funds.

FIN 5613 Corporate Financial Planning (3 credit hours)

Prerequisite: FIN 5053-Theory and Practice of Financial Management. Financial planning in a systems framework. An integration of existing financial theory and practice. Financial planning systems allowing the manager to acquire an overview of the various functions of the firm; to examine alternative courses of action with speed and thoroughness; to reduce the response time in reacting to change in the environment and to improve future decisions by learning from feedback of previous decisions.

FIN 5763 Derivative Securities and the Management of Financial Price Risk (3 credit hours)

Prerequisite: FIN 5053- Theory and Practice of Financial Management. Differing amounts of financial price risk for individuals and corporations in volatile financial environment. The development of arbitrage-based models for the pricing of derivative securities, and the use of a full range of derivative securities to manage exposure to financial price risk.

IEM 5503 Financial and Advanced Capital Investment Analysis (3 credit hours)

Prerequisites: IEM 3503-Engineering Economic Analysis, IEM 4014-Operations Research, STAT 4033-Engineering Statistics. An understanding of financial concepts and markets, and an advanced treatment of proper methods of capital project selection under risk and uncertainty. Decision making under capital rationing. Financial environment and valuing securities, representing cash flows, selecting investments, avoiding common pitfalls,

evaluating timing consideration, depreciation and corporate taxation, replacement analysis, and incorporating risk and uncertainty.

IEM 5603 Project Management (3 credit hours)

Prerequisite: INDEN 4413-Industrial Organization Management or equivalent. A systems approach to planning, organizing, scheduling and controlling projects. The behavioral and quantitative aspects of project management. Importance of working with personnel as well as technology. Project management software utilized.

MGMT 5123 Organizational Design and Research (3 credit hours)

An analysis of research which integrates theory and design of organizations. Reviews empirical research findings and stresses methods of organizational analysis; design and modification of organizations.

MGMT 5213 Seminar in Organizational Behavior (3 credit hours)

Research on group behavior in organizations. Group processes and structural factors affecting the interaction process and intra- and intergroup performance characteristics. Laboratory simulations and team research projects used to pursue advanced topics.

MGMT 5513 Advanced Strategic Management and Business Policy (3 credit hours)

Prerequisites: MBA core courses. A terminal integrating course with emphasis on formulating and implementing basic policy decisions for business. An analytic approach to strategic decisions pursued through readings, cases and participation in a complex computer game.

MGMT 5553 Management of Technology and Innovation (3 credit hours)

Business applications of research, practice, and theory in the management of technology and innovation. To improve the effectiveness by which technologies are developed, implemented, and institutionalized. Emphasizes both management with advanced technologies and strategic management of technology.

MGMT 5713 Labor Relations and Collective Bargaining (3 credit hours)

A first course in labor relations. The industrial relations system, collective bargaining, labor legislation, the economic effects of unionization and other contemporary labor relations issues.

MKTG 5213 Services Marketing (3 credit hours)

Prerequisite: MKTG 5133-Marketing Management. Services and services marketing with emphasis on services research and services management.

MKTG 5220 Seminar in Marketing

(3-9 credit hours) Prerequisite: MKTG 5133-Marketing Management. Selected topics in marketing. Database marketing, electronic commerce, industrial marketing, product management, strategic marketing planning, international marketing, and services marketing.

MKTG 5313 Marketing Research Methodology (3 credit hours)

Prerequisite: MKTG 5133-Marketing Management. Research methodology applied to marketing problems. Measurement, survey research, experimentation, and statistical analysis of data.

MKTG 5553 International Marketing Strategy (3 credit hours)

Prerequisite: MKTG 5133-Marketing Management. An analysis of marketing in the global environment. Environmental effects on international marketing management and corporate strategy decisions.

MKTG 5613 Seminar in Consumer Behavior (3 credit hours)

Prerequisite: MKTG 5133-Marketing Management or consent of instructor. Psychological, sociological, and anthropological theories related to consumers' decision processes. Special emphasis on current empirical research in consumer behavior.

MKTG 5713 Seminar in Promotional Strategy (3 credit hours)

Prerequisite: MKTG 5133-Marketing Management. Promotional problems encountered by a firm and approaches to their solution.

MKTG 5813 Seminar in Channels of Distribution (3 credit hours)

Prerequisite: MKTG 5133- Marketing Management. Development structure and interrelationships among members of marketing channels involving customer service, physical distribution decisions, and operating policies.

MKTG 5983 Data Base Marketing (3 credit hours)

Prerequisite: MKTG 5133 or consent of instructor

Data base marketing is an information-driven process managed by database technology, that enables marketers to develop, test, implement, measure and adopt customized marketing programs and strategies. Thus, this course covers mechanisms to manage data (data base technology), techniques for converting data to information (interpretation and summarization) and tools to use data for decision making (statistical as well as artificial neural net based models to make forecasts and do "what-if" analyses). The focus is on "hands-on" application of each of the above tools.

MKTG 5993 Electronic Commerce and Interactive Marketing (3 credit hours)

Prerequisite: MKTG 5133 or consent of the instructor. Digital interactive tools changing the management of markets. The development and impact of electronic interactive marketing for building one-to-one relationships with customers.