SELF-STUDY QUESTIONNAIRE

Worcester Polytechnic Institute
COMPUTER SCIENCE DEPARTMENT

June 2008

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Please note that the appendices can be found at <http://web.cs.wpi.edu/CACvisit/>.

Self-Study Report
for the
COMPUTER SCIENCE DEPARTMENT, WPI

June 2008

Preface

As background to the self study, it is useful to provide some context regarding the educational system at WPI, which differs from that found at most universities.

The WPI Plan
The *WPI Plan*, adopted in 1970, replaced the traditional rigidly-prescribed curriculum with a flexible, outcomes-oriented curriculum in which undergraduate students were given responsibility for defining and realizing their educational goals.

Projects
The cornerstone of the Plan is project work. Almost all Computer Science courses include project work and teams. In addition, every WPI undergraduate must complete two significant projects, and a special Seminar/Practicum. The Major Qualifying Project (MQP) challenges students to solve problems typical of those to be encountered in their professional discipline. The Interactive Qualifying Project (IQP) examines the interaction of science, technology, and society. The Inquiry Seminar/Practicum, which may include projects elements, provides the capstone to a five-course selection of courses in the Humanities and Arts.

Major Qualifying Project
The Major Qualifying Project is a capstone project in which students typically conduct research, analysis, design, implementation, testing, and documentation activities within their major field of study. The projects are usually done in the 4th year by teams of 2-4 students working under a faculty project advisor from that major. The project may be initiated by students, a faculty member, or an outside sponsor. Whether it is done in one term or three, the overall effort is equivalent to 3 courses of work. A public oral presentation and a written final report are required.

Interactive Qualifying Project
Of all the components of the WPI Plan, the Interactive Qualifying Project stands out as unique. The IQP is an investigation into the *interaction* of science, technology, and society. For example, one might examine the impact of technological development on society, raise value questions about social/technological interactions, or design policies to cope with societal problems resulting from technological change. A student's IQP need not be related to the major field of study. Sample IQP areas are: technology and environment, safety analysis and liability, education in a technological society, and law and technology. IQP methodologies include: interviews, case studies, historical analysis, modeling, simulation, and statistical analysis. The

projects are usually done in teams of 2-4 students working under a faculty project advisor. The project may be initiated by students, a faculty member, or an outside sponsor. Whether it is done in one term or three, the overall effort is equivalent to 3 courses of work. An oral presentation may be required at the discretion of the project advisor. A written final report is required.

Humanities and Arts Requirement

The Humanities and Arts Requirement has until 2007 consisted of a set of 5 thematically related courses in the Humanities and Arts, capped off with an Independent Study Project called a Sufficiency. The course and project sequence must be sufficient to inform the student of how knowledge is obtained and expressed in a non-technical discipline. The body of work is approved by a faculty project advisor, who supervises the Independent Study Project. Sufficiency areas include: American Studies, European History, Drama, Music, and Philosophy.

From the Fall of 2007, the Humanities and Arts Requirement has been changed, and will no longer be referred to as the Sufficiency. The new requirement is essentially a set of 5 courses plus an *Inquiry Seminar/Practicum.* Students who entered prior to A term of 2007 may elect to follow either the old or the new requirements. Students who entered for A term, 2007 or later must follow the new requirements. During 2007-08, special rules apply as WPI makes the transition to the new requirements.

Distribution Requirements

Although much learning is aimed at providing preparation for projects, greater breadth is ensured by a set of *Distribution Requirements* for each major program. Requirements are specified by general topic area, not by specific courses, so that a student may demonstrate knowledge of a topic area by passing any course in that area. Consequently, WPI has no normal course order and no clear separation between required and elective courses. In keeping with the WPI philosophy of education, there are no enforced course prerequisites, only *recommended background* courses and topics. The Undergraduate Catalog, WPI and CS web pages, and academic advisors make clear which courses will achieve the desired objectives. Final responsibility for course selection rests with the student.

The Computer Science program identifies a set of *core courses* which all CS majors are expected to pass. However, this is not a requirement, and an occasional student will skip a core course to spend effort elsewhere. Nonetheless, students are responsible for knowledge of core material that is the recommended background for advanced courses. Such knowledge might also be gained through work experience or independent learning activities. Core courses are normally considered to be all 2nd and 3rd year courses, while *advanced courses* are considered to be 4th year courses.

Other WPI Degree Requirements

In addition to the Major Qualifying Project, the Interactive Qualifying Project, the Humanities and Arts Requirement, and the Distribution Requirement for the major, WPI also requires completion of two courses of work in the social sciences, and the accumulated equivalent of one course of Physical Education. In addition, at least the equivalent of 24 courses must be completed satisfactorily in residence at WPI, while the minimum academic credit required for

the Bachelor degree is the equivalent of 45 courses. Credit accumulated beyond the published distribution requirements is accomplished by the addition of "free elective" work.

Units of Academic Credit

The WPI academic year consists of Fall and Spring semesters, and an optional Summer term. The undergraduate program further divides each Fall and each Spring semester into two 7-week terms. The terms are labeled A, B, C and D, with E being the summer term.

Full-time undergraduate students are expected to take three courses (or the equivalent mix of courses and projects) each term. As a full-time load is considered to be 1 unit of work during each term, consequently each course is 1/3 unit. A full WPI course load is 4 units per year (i.e., 12 courses).

Students are expected to spend 17 hours of effort per week on each course. Most courses meet four times a week for lectures, and some also meet once a week for a lab or seminar session.

WPI's standard conversion of Units to traditional credit hours is as follows:

1 course = 3 credit hours;
1 unit = 9 credit hours.

Hence 1 year corresponds to 36 credit hours.

Grading System

The grading system is intended to be non-pejorative, recognizing only the grades of A, B, C, and NR (No Record). Plus and minus grades are not recognized. The NR grade comprises the grades of D, F, and Withdraw in a traditional grading system. The NR grade is only used internally and is not included on external documents such as grade reports and transcripts. Student work that would have earned a D elsewhere, and hence could have satisfied a degree requirement, will not do so at WPI.

Course Numbers

Each undergraduate course at WPI is designated by a two- to four-letter prefix identifying the subject area (e.g., CS) followed by a four-digit number. Three-digit numbers are used for graduate courses. The first digit indicates the approximate course level, from 1 for first-year students, to 4 for seniors and 5 for graduate students. However, students may take whatever courses for which they feel prepared, including graduate courses, regardless of designation. Thus, some undergraduate students satisfy Distribution Requirements by taking graduate courses, especially those enrolled in the BS/MS combined program.

Background Information

1. Degree Title

Give title(s) of all degrees awarded for the program under review, including options, etc., as specified in transcripts and/or diplomas, and describe as necessary.

The B.S. degree is in "Computer Science".

The department also offers a "Computers with Applications" degree, but we are not seeking accreditation for this degree, and there have been no recent graduates.

There are WPI Requirements and Computer Science Distribution Requirements for graduation. These requirements refer to types of courses, subsets of courses, or other criteria that allow the students to make a selection. The WPI degree requirements have already been described above. The additional "distribution requirements" for Computer Science (CS) majors are shown below (taken from the Catalog and the WPI Web pages). They are introduced at this point in the report as they are the basis for the success and high quality of the WPI CS program. They will be referred to often.

Program Distribution Requirements for the Computer Science Major

In addition to the WPI requirements applicable to all students, the requirements for mathematics, basic science, and related fields are as follows:

Computer Science	Minimum Units
1. Computer Science (including the MQP) (Notes 1, 2).	6
2. Mathematics (Notes 2, 3, 5).	7/3
3. Basic Science and/or Engineering Science (Notes 2, 4).	5/3

Notes:

1.
   a. Only CS 1101, CS 1102 and computer science courses at the 2000-level or higher will count towards the computer science requirement. CS 2118 will not count towards the computer science requirement.
   b. Must include at least 1/3 unit from each of the following areas: Systems (CS 3013, CS 4513, CS 4514, CS 4515), Theory and Languages (CS 3133, CS 4120, CS 4123, CS 4533, CS 4536), Design (CS 3041, CS 3431, CS 3733, CS 4233), and Social Implications of Computing (CS 3043, STS 2208, GOV/ID 2314). (If STS 2208 or GOV/ID 2314 is used to satisfy this requirement, it does not count as part of the 6 units of CS.)

c. At least 5/3 units of the Computer Science requirement must consist of 4000-level courses. These units can also be met by WPI graduate CS courses, with the exception of CS 501 and CS 507.
d. Only one of CS 1101 and CS 1102 may count towards the computer science requirement. Only one of CS 2301 and CS 2303 may count towards the computer science requirement.

2. A cross-listed course may be counted toward only one of areas 1, 2, 3, above.
3. Must include at least 1/3 unit from each of the following areas: Probability (MA 2621, MA 2631) and Statistics (MA 2611, MA 2612).
4. Courses satisfying the science requirement must come from the BB, BME, CE, CH, CHE, ECE, ES, GE, ME, PH disciplines. At least three courses must come from BB, CH, GE, PH, where at least two courses are from one of these disciplines.
5. At most four 1000-level Mathematics courses may be counted towards this requirement.

The CS Distribution Requirements are determined by vote of the CS Department Faculty in response to motions made the CS Education Committee. All changes passed by CS Department Faculty are sent to the WPI Committee on Academic Operations for review. Changes in Distribution Requirements need to be approved by a vote of the WPI Faculty. The CS Education Committee continually reviews the CS curriculum and responds to suggestions from the CS Faculty, the CS Department Head, and the CS Accreditation Coordination Committee. The students are informed of the CS Distribution Requirements via the Web, the Undergraduate Catalog, the advising process, pre-freshman literature, and email when significant changes are made. Note that on May 15, 2008 the addition of Robotics Engineering (RBE) to the first list in Note 4 was approved by the WPI faculty.

2. Program Modes

Indicate the modes, e.g., day, co-op, off-campus, on line, distance education, in which this program is offered and describe any differences in the information given for the computing unit as a whole in the Appendix.

All undergraduate CS courses are offered at WPI in the daytime. Some undergraduates may earn credit by taking graduate courses, and most of those are offered in the evening. Some junior and senior year projects (the IQP and MQP) are done off campus under faculty supervision.

3. Actions to Correct Previous Deficiencies, Weaknesses and/or Concerns

If specific program deficiencies, weaknesses and/or concerns were identified by the CAC during the most recent evaluation (visit or report), please refer to them and indicate the actions taken. Deficiencies, weaknesses and/or concerns that were addressed in the previous evaluation as being common to all computing programs should be addressed in each Self-Study Report.

The ABET Interim Report Evaluation (January 2005) expressed the following Concerns:

a) Class sizes are quite large in a significant number of computer science courses both in the

lower and upper divisions;

b) The curriculum does not include 12 semester hours of science.

c) Not all of the science course work beyond the required six-hour science sequence is in science courses that enhance the student's ability to apply the scientific method.

Concern a) has been partially addressed by the declining enrollments in CS, by more CS faculty, and by careful attention to scheduling in response to demand. However, this problem is still not entirely under control. Here are the CS course enrollment figures for AY 06-07 and 07-08.

	A06	B06	C07	D07	A07	B07	C08	D08
CS 1101.	175*		74		192*		116	
CS 1102.	49				58			
CS 2011.		29		67		40		92
CS 2022.	30		42	27	38		68	33**
CS 2102.		175		69		175		64
CS 2118.		29				48		
CS 2223.		65		41		55		76
CS 2301.		58				63		
CS 2303.	34		94		61		128	
CS 3013.	40		47		55		40	
CS 3041.		43		46	50		46	
CS 3043.	40			53		23		49
CS 3133.	33		53		39		35	
CS 3431.		42	36			53		45
CS 3733.		37		47		41		61
CS 4032.		11				10		
CS 4033.			6				2	
CS 4120.	15							
CS 4123.					32			
CS 4233.	47				47			
CS 4241.			54				55	
CS 4341.	41					46		
CS 4432.								27
CS 4445.		17						
CS 4513.				25				42
CS 4514.		34	25			32		
CS 4515.				67				
CS 4533.				32				
CS 4536.							40	
CS 4731.		46				36		
CS 4732.			16					

* Note that each of these two offerings of 1101 was split into two lecture sessions in order to reduce the student to faculty ratio.

** Note that these figures do not include MA 2201 enrollments: the equivalent course to CS 2022, but taught by the Math department.

This is clearly a concern that needs our continued attention. Allocation of CS faculty to teaching and development of both the Interactive Media and Game Development and the Robotics Engineering majors, coupled with the effects of those students taking CS courses, has somewhat diluted the gains in faculty numbers. While we would prefer that no course offering be larger than 30 students, we are currently working to try to keep totals below 50. For introductory courses, with a large service component, the size is compensated for by having multiple small lab sections that also meet apart from the main lecture.

Concern b) has been addressed by altering the Undergraduate Catalog wording and by increased stress on Science during advising sessions. As will be seen later in this report, the revisions to the ABET CAC criteria now allow this concern to be resolved.

Concern c) has been addressed by altering the Undergraduate Catalog wording and by increased stress on Science during advising sessions. As will be seen later in this report, the revisions to the ABET CAC criteria now allow this concern to be resolved.

4. Contact Information

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Accreditation Summary

A complete description of how the program satisfies all of the requirements for each criterion must be presented. It is suggested that the information presented for each criterion be as complete as possible such that the Program Evaluator(s) can determine if all of the requirements are being met without cross-referencing material provided under other criteria. This may require some duplication of material but it should aid the Program Evaluator(s). Reference to the material provided in the Appendix (found at the end of this document), and to other information provided by the institution, should be made as needed.

1. Students

Criterion

Students can complete the program in a reasonable amount of time. They have ample opportunity to interact with their instructors. Students are offered timely advising, by qualified individuals, about the program's requirements and their career alternatives. Students who graduate from the program meet all program requirements.

1.A. Frequency of Course Offerings

1.A.1. List below the course numbers, titles, semester hours and frequency of offerings for all courses required for the major that are offered less frequently than once per year.

There are no required courses at WPI. All undergraduate CS courses are 1/3 unit (3 cr. hrs.). Courses are classified into two categories depending on their frequency. Category I courses are offered at least once a year. Category II courses are offered every other year. Category II Computer Science courses that are in high demand may be offered more often. All 1000 level, all 2000 level and all 3000 level CS courses are Category I. In addition, some 4000 level courses are as well. Many of those Category I courses, especially the lower level ones, are offered more than once a year. The ordering of those courses in the year is chosen to fit with the order suggested by the "Recommended background" for the course as described in the course descriptions in the catalog.

The Category II courses are:

CS 4120 - Analysis of Algorithms.

CS 4123 - Theory of Computation.

CS 4233 - Object-Oriented Analysis and Design.

CS 4432 - Database Systems II.

CS 4445 - Data Mining and Knowledge Discovery in Databases.

CS 4515 - Computer Architecture.

CS 4533 - Techniques of Programming Language Translation.

CS 4536 - Programming Languages.

CS 4732 - Computer Animation.

1.A.2. Explain how it is determined when each required course will be offered, e.g., rotation, odd-numbered years, etc

Most Category II courses follow an alternate year pattern that is published in the catalog, is available on the WPI Web, and is reinforced by the advising system. For example, the 2008-2009 catalog description for CS 4732, Computer Animation, says, "This course will be offered in 2008-09 and in alternating years thereafter." High demand category II courses are scheduled about 6 months ahead, by the department head and associate head. Additional sections of any course may be added at a later date if there is sufficient demand as indicated by registration statistics.

Table 1: Category II Course Offerings for Past 2 Years plus Next Year

	A06	B06	C07	D07	A07	B07	C08	D08	A08	B08	C09	D09
CS 4120	y								y			
CS 4123					y							
CS 4233 *	y				y				y			
CS 4432								y				
CS 4445		y							y			
CS 4515				y							y	
CS 4533				y							y	
CS 4536							y					
CS 4732			y									y

* Note that due to high demand CS 4233 (Object-Oriented Analysis and Design) was offered in 06-07, and 07-08, with a planned offering in 08-09.

1.A.3. List below the course numbers, titles, and semester hours of courses allowed for the major but not required (i.e., electives within the major), and explain how it is determined when they will be offered.

There are no required courses at WPI. Students may take any WPI course, including CS courses, to act as their "free electives" (i.e., those courses that are not being used to satisfy distribution requirements). The WPI and CS distribution requirements have been described above. Choices provided within the major's distribution requirements are described as part of those requirements (see above). For example, the Design area may be satisfied by any one of CS 3041, CS 3431, CS 3733, or CS 4233. Those courses follow the rules for category I and category II course

frequency, as well as the department's response to demand, both historical and from registration figures.

1.B. Interaction with Faculty

1.B1. Describe how you achieve effective interaction between students and faculty.

The fluctuating growth in enrollment for CS programs in the best universities has challenged all of us to find ways to provide high quality education despite varying numbers of majors. The CS program is also affected by growth in the Interactive Media and Game Development major and the Robotics Engineering major, as they take many CS courses as part of their curriculum. In addition to what's been described below, we are working to increase the number of faculty—making sure we get new faculty with a unique blend of strong teaching ability and high quality scholarship.

Undergraduate classes vary in size from about 15 to about 120. Senior level classes in more specialized subjects, and those about less 'popular', or more advanced topics, tend to be smaller, while introductory courses, which are also taken by students from other majors, are the largest.

We try to provide students with lots of additional assistance. Large classes break out into smaller groups (up to 7 in one case) for seminar sessions with graduate teaching assistants (TAs) and undergraduate Senior Assistants (SAs), and sometimes with faculty. Office hours, and perhaps also help sessions, are provided for every course. Both faculty and teaching assistants are available during regular office hours to provide help to anyone from the course who stops by. Help is also available for all courses by email from the course instructor and the TAs, and via information posted on the web. Some courses also use web-based discussion boards.

We are also working hard to provide more sections of every 2000-, 3000- and 4000-level course. In recent years we have doubled—and sometimes tripled—the number of times our core courses are offered each year, as well as increasing the offerings of the most popular 4000 level (advanced) courses. This keeps the class sizes smaller, and interaction more convenient. For example, CS 2022 and CS 3043 will be offered three times in AY 08-09, and many 2000 and 3000 level courses will be offered twice.

In addition to the regular instructors, an extra faculty member, Glynis Hamel, is specifically assigned to the introductory courses. Her job includes providing extra assistance for the students, and helping with the coordination of the courses, as well as to taking care of SA/TA assignment, management and evaluation.

We continue to experiment with appropriate ways to use Teaching Assistants (graduate students), Graders, Senior Assistants, and Peer Learning Assistants. These all help to allow faculty to provide more time to help students.

There are no special mechanisms for dealing with large upper level courses, other than what has already been described.

1.C. Student Advising

1.C.1. Describe your system of advisement for students on how to complete the program. Indicate how you ensure that such advisement is available to all students.

- **Student Admissions**

  Completion of the program starts with Admissions. Students are admitted into WPI as a whole, not into a major. Students first officially declare a major in December of the first year and then can transfer to an academic advisor in that major. Students may change majors and advisors at any time. WPI does not have an upper division or a separate "engineering educational unit" or "science educational unit".

  WPI recruits and seeks to enroll the appropriate number (usually between 800 and 810) of well-qualified undergraduate students each year, with Fall'08 figures currently at 950+. As well as recruiting students for our academic departments, specific outreach is performed for women, multicultural students, international students, high-ability students, and transfers. The undergraduate Admissions Office directs a comprehensive campaign of direct mail, electronic mail, staff travel, on-campus programming and alumni activity toward students who have expressed an interest in WPI. The faculty and the Department of Physical Education and Athletics provide additional support for Admissions Office efforts.

  Professional members of the admissions staff review applications each fall and winter. During the selection process, the Admissions Office pays close attention to course selection, trends in grades on the high school transcript, overall grade point average, rank in class, courses taken and grades earned in the senior year of high school (especially in mathematics and the sciences), recommendations from counselors and high school faculty, and a required personal statement by the applicant. Students are required to have a sequence of mathematics courses that includes pre-calculus. Note that two laboratory science courses are required, usually physics and chemistry. For the class entering in August 2007 more than 5,600 applications for admissions were reviewed.

  Beginning with applicants for fall 2008 entrance, SAT and ACT scores are optional. Students may submit scores from the Scholastic Aptitude Test (SAT) or the American College Test (ACT) or may choose to submit alternative materials, such as research papers, project work, or design concepts in lieu of standardized test scores. For those students submitting test scores, the Admissions Office will use the best critical reading, writing, and math scores a student submits for the SAT. If a student submits both the SAT and ACT, the office will use whichever scores are higher. The class entering in the fall of 2007 had a combined SAT score (math and critical reading) of 1283.

- **Evaluating Student Performance**

  1. University Policies and Procedures

  Please note that the WPI Undergraduate curriculum is organized with two seven-week terms in the fall (A and B), two in the spring (C and D), and one (optional) in the summer, term E.

Students normally take nine credit hours of course or project work per term, which is equivalent in the WPI system to one unit of work. That is, three credit hours equals 1/3 unit in the WPI system.

Satisfactory Academic Progress

In order to assist students, parents and the academic advisor in determining whether a student is making academic progress, WPI has adopted both of the following guidelines, effective Term A, 1989:

1. The student must complete at least 4/3 units of work in two successive terms, including [if applicable] Military Science, Physical Education and Consortium courses.
2. The student must complete at least 8/3 units of work in four successive terms, including [if applicable] Military Science, Physical Education and Consortium courses.
   Note: Term E (Summer School) will be included if the student is registered full time.

Academic Warning

Each student's academic record will be reviewed at the conclusion of terms B and D according to the guidelines above by the Registrar's Office. If a student's performance falls short of either guideline 1 or 2, the student, parent and academic advisor will be notified that the student is not making satisfactory progress. The notification will place the student on Academic Warning. At this time, the student is urged, with the help of his/her academic advisor, to identify the nature of the academic difficulty and to formulate a course of action for overcoming the difficulty.

Academic Probation

During the next review of academic progress, should the student fail, once again, to maintain satisfactory academic progress, the student, parent and academic advisor will be notified. This notification will place the student on Academic Probation for two terms. Academic Probation will prevent the student from receiving financial aid, will result in loss of eligibility for team sports, will prevent the student from obtaining undergraduate employment in the Co-op Program and will prevent participation in the Global Perspective Program.

Students who obtain no academic credit (exclusive of Physical Education or ROTC-related courses) in either Term A or Term C shall be e-mailed by the Director of Academic Advising informing them of the following change of academic status if they earn no academic credit for the next term for which they are registered. In the e-mail, the students are also urged to seek academic support services through the Academic Advising Office.

Students who fail to obtain credit for two consecutive terms shall:

1. Be placed on Academic Probation if currently they are classified as making satisfactory progress, or
2. Be placed on Academic Suspension if currently they are on the list of students on Academic Warning or on Academic Probation

Subsequent academic review shall follow the rules for all students.

Academic Suspension

Should a student on Academic Probation fail to make satisfactory academic progress during the next review period, the student will be suspended from WPI. The notification will prevent the student from enrolling as a full-time student or a special student for at least the next two terms. Subsequent readmission is subject to approval (with possible conditions) of a petition through the Registrar to the Committee on Academic Operations (CAO). As a general rule, a student readmitted after suspension will be placed on an Academic Probation status.

New students (first year or transfer) who fail to obtain academic credit for the first two terms shall be placed on Academic Suspension and not allowed to enroll for the following terms. Readmission is subject to approval by the Committee on Academic Operations.

Improvement in Status

Students on Academic Warning or Academic Probation have the opportunity to improve their status by progressing through the levels in reverse order. If a student on Academic Probation satisfactorily meets the guidelines at the end of the next review period, he or she will be moved to the list of students on Academic Warning. A student on Academic Warning would be moved back to Satisfactory Academic Progress status.

Term E (Summer Session) Review Period

An exception to the guidelines stated above can occur when a student registers full time for Term E. At the conclusion of Term E, a review will be conducted which will include the previous five terms. If the student has completed 10/3 units acceptable work, the student's academic progress status will improve. Thus, a student on Warning status after the Term D review will start terms A and B on Satisfactory Academic Progress. A student placed on Academic Probation after the Term D review will be on Warning status for terms A and B. A student on Suspension status after the Term D review will be able to register for terms A and B on Academic Probation.

Summer Bridge Program

Students who finish the academic year on Academic Warning or Academic Probation status, but who have passed at least 2 units of academic work during the previous four terms, are eligible to participate in the Summer Bridge Program. Students who participate in the program enroll in Term E for two courses and also take a four-week study skills program. Successful completion of the courses and the study skills program will result in the academic status rising one level (Academic Probation to Academic Warning, or Academic Warning to Satisfactory Academic Progress). The Office of Academic Advising coordinates the Summer Bridge Program.

Once the academic review is conducted, academic status is updated immediately in banner web and a letter is sent to the student from the Registrar's Office notifying them of the status change. Additionally, a letter from the Provost's Office is sent to the parent with a copy of the letter sent to the student. This letter outlines the academic support available to the student upon their return.

2. Student and Advisor Review of Academic Performance

Fours days after the conclusion of every term, students are able to view their grades which are posted on their unofficial transcript online through the WPI Web Information System. Only those courses for which the student earned a grade of "C" or better will be displayed on the transcript. Grades are mailed home to parents at the end of B and D term. Grades are not mailed home to parents of those students who been able to legally establish "independent status."

The Registrar conducts an official review of each student's academic progress at the end of B term and D term. Those students, whose academic status changed (Academic Warning, Academic Probation or Suspension) as a result of this review, receive written notification of the change. The student's academic status is also annotated on the unofficial transcript. In addition, parents also are mailed a copy of the notification of change in academic status if it results in the student being placed on Academic Warning, Probation or Suspension.

Academic Advisors are also included in this process. Students who have had a change in their academic status are flagged on the advisee list in the electronic advising folder so advisors can easily identify those students who need their attention. Advisors can also view all their advisees' grades through the online transcript in advising folder and both students and advisors can monitor students' progress to graduation through an online degree evaluation.

A list of students who are on Academic Warning, Probation or Suspension is sent to the Academic Advising Office. Additionally, the Advising Office also receives a list from the registrar's office of those students who do not earn any credit in A and C term. The Advising Staff then contacts all of these students by both mail and e-mail strongly urging them to come in for a consultation regarding academic support services.

- **Advising Students**

The WPI Plan results in educational experiences that are usually different for each student. Advising must be specifically tailored for the individual, which adds a new level of complexity and responsibility for the advisor. To assist in the advising process, WPI's faculty formally endorsed in 1993 the following statement on the goals of academic advising and the responsibilities of academic advisors:

WPI Advising Guidelines

The primary purposes of WPI's academic advising program are to:

1. Assist students in the development of meaningful educational plans, which are compatible with their life goals
2. Help students accept responsibility for their own education
3. Aid in students' professional development by providing guidance in curricular and professional choices.

An academic advisor's responsibilities include:

1. Helping the student to design a program of study, interpret catalogs and degree requirement audits, and choose among academic alternatives
2. Monitoring academic progress and recommending appropriate resources to answer questions or solve problems related to academic, career, and personal matters.

The Office of Academic Advising <www.wpi.edu/Admin/OAA/> reports to the Dean of Undergraduate Studies and is responsible for coordinating the undergraduate advising program. The advising staff provides training and support to all the academic advisors and is a resource for students.

Insight Program/First Year Advising (pre-declaration of major)

The advising process begins after a student has been admitted to WPI in early May. A website known as "Designs" <www.wpi.edu/Admin/OAA/Designs/> provides incoming first-year students with guidance on course selections and the registration process. Students are asked to review the advice for selecting courses for the fall semester and register for their courses by the end of June. Additionally, those students who would prefer to meet with an advisor may elect to attend an Advising Open House during the month of June. These open houses afford students (both first-year and transfer) the opportunity to learn more about WPI's academic requirements and meet with faculty in their intended major for course selection advice prior to registering for their courses online. Transfer students, who can not attend one of the June advising open houses, are advised on an individual basis by scheduling a meeting with the Advising Office during the month of July. This office also works with the Registrar's Office and the Scheduling Office to develop appropriate schedules.

During New Student Orientation, the four-day period before the academic year begins, students have the opportunity to review their schedule with their academic advisor. The goal is to help students develop an academic schedule that is oriented toward the students' goals and interests. Further modifications to the schedule can be made up to the end of the fourth day of classes.

WPI's first-year advising system for A and B Term is known as the Insight Program. Instead of assigning academic advisors to students based on what is often a tentative indication of major field of study, new students are assigned to one of 36 faculty advisors who are willing to make a modest but real commitment to working with a group of 25 to 30 first-year students who are housed together on one of the residence halls floors. These faculty members recognize that first-year advising is much more about mentoring students and much less about course scheduling. The advisors represent almost all the departments at WPI, and in many cases are the senior faculty members and the most experienced advisors. The faculty advisors are paired with student leaders, known as community advisors, and together they work with the resident advisors to help the first-year students make a successful transition from high school to college. At the end of the first semester in December, the students officially declare their majors and are assigned an advisor in the department of their declared major.

Advising of Majors

Academic advising at WPI is decentralized in that each department is responsible for advising their respective majors. The Office of Academic Advising assigns advisees to advisors in their major, with advising spread reasonably evenly among the faculty in the major. New faculty are given a reduced advising load. To make the advising process as efficient as possible a variety of online tools are available to both the advisors and students. Electronic advising folders have been created to help advisors track student performance and progress toward completion of their degree requirements. Advisors can also view student schedules and proposed schedules and post comments to their advisees in the folder. An "Academic Advisors Handbook" is also able to all advisors both as a Web document <www.wpi.edu/Admin/OAA/Handbook/>.

Each year, the students and their advisors are asked to make plans for the upcoming academic year. This process starts with Academic Advising Day in February. No classes are scheduled for this day in order to give students and advisors time to meet and discuss the student's progress toward meeting the degree requirements. Additional meetings are scheduled as needed until the final master schedule is developed. In early April, students are then asked to register for their classes and projects for the following year.

- **Transfer Students and Transfer Course Policies**

The WPI Admissions Office evaluates full-time and part-time transfer candidates using the following required credentials (in addition to the WPI transfer application):

1. Submission of all prior college transcripts (high school transcripts must be included if the applicant has been enrolled in college for three semesters or less)
2. Two recommendations (one must be academic; the other may be either academic, from the military or from an employer)
3. Autobiographical statement or resume outlining all academic and work activity from date of high school graduation to date of application to WPI
4. Essay on transfer goals.

Fifty to sixty-five percent of our transfers enter WPI from accredited four-year colleges and the remaining transfers enroll from accredited two-year colleges. As of the fall of 2007, WPI has articulation agreements with Quinsigamond and Bristol Community College. Only the agreement, with Quinsigamond Community College (QCC) in Worcester, is active, since QCC has a two-year basic engineering program that is ABET approved for engineering technology. WPI accepts graduates of this program provided the student has a grade point average of 3.0. The same process described above for all other transfer credit applied to the courses approved as transfer credit from QCC. The advising office conducts a yearly review of the articulation agreement and the agreement is updated as needed.

Transfer decisions are made primarily by Michael Smith (for domestic transfers) or by Ed Connor (for international students/permanent residents) in the WPI undergraduate Admissions Office. In certain cases, applicants may be brought to a Transfer Committee

including the Director of Admissions. WPI typically enrolls between 20-30 transfer students for the spring semester and 60-70 transfer students for the fall semester.

Students who submit satisfactory credentials with a transcript of a 2.8 GPA or higher (2.5 GPA or higher if transferring from a competitive institution) and have completed at least calculus are usually offered admission. The Admissions Office recommends completion of calculus prior to entering WPI and will work with appropriate students to assist them in taking pre-requisite coursework.

Evaluation of Transfer Credit

Any course considered for transfer credit must be relevant to WPI's educational mission. The following kinds of courses/programs are not recognized for transfer credit: Vocational, correspondence, pre-college, remedial, review, noncredit CEU, adult enrichment or refresher courses, and CLEP examinations.

The decision to award transfer credit is determined by the WPI department offering comparable courses. Elective credit, either free elective or department elective credit, may be awarded for courses with no WPI equivalent if deemed relevant to WPI's program. Courses taken at regionally accredited post-secondary institutions that are comparable to courses offered at WPI will be reviewed for course content and level by the WPI department offering the comparable course. Only those courses in which the transfer student received a grade of C or better will be evaluated for possible transfer credit.

The Office of Academic Advising and the Projects and Registrar's Office coordinate transfer credit evaluation. The appropriate faculty members in the respective departments make all decisions regarding transfer credit. Staff members make no transfer credit decisions.

Current WPI students who wish to take courses at a regionally accredited post-secondary institution must obtain a WPI Transfer Credit Authorization form from the Projects and Registrar's Office. This form and the course description must be taken to the WPI department head or designated representative and academic advisor for approval before the course is taken. On the form, the department head may specify a minimum grade higher than C for transfer. This minimum grade depends on the institution at which the course is taken and the criticality of the course to the department. Courses that have not been pre-approved may not receive transfer credit.

Transfer students are subject to the same academic review process as any other WPI student. This review and monitoring process indicates that transfer students perform as well as other WPI students and their retention graduation rates are about the same as other students.

- **Graduation Requirements**

A Program Review Committee is established in each department. These committees review the degree audit for each student during the final year of study to ensure that each graduating student will satisfy both WPI and ABET requirements. It is important to note that the

development of a program of study and the satisfaction of degree requirements are the responsibility of each student. Each Academic Advisor helps the student design a program that meets each student's individual goals as well as the degree program's requirements. During the last semester, both the Registrar and the Program Review Committee will notify students if degree requirements are missing. Thus the students have the opportunity to adjust the schedule before the completion of the academic year. The final review to ensure that all requirements have been met is the responsibility of the Registrar.

- **Enrollment and Graduation Trends**

  See Table 5 in Appendix C for a summary of the enrollment and graduation trends for the past five years.

1.C.2. When students need to make career choices, what is their procedure for obtaining advising? How do they have adequate access to qualified professionals when necessary?

For career choices students may consult their academic advisors, or other CS faculty, and they may also take advantage of services offered by the Career Development Center (CDC) (see Appendix F).

The CDC team assists students and alumni in developing, evaluating, and effectively initiating and implementing relevant and satisfying career plans. The team promotes a greater awareness of the world of work and its trend within the academic and business communities. CDC programs: foster self-knowledge, career awareness and planning; promote experiential education; support optimal employment or further professional preparation; build relationships and market WPI. General programming activities of the CDC include: self assessment; career counseling; career exploration; career decision making; coop; summer internships; on-campus recruiting; job listings; company visits; collaborative programs. The CDC also arranges regular career fairs on campus and provides connections to off campus events that include industry and graduate school representatives.

The Career Development Center organizes the Major Selection Program for students who are undecided about their major. The mission of the Major Selection Program (MSP) is to assist students in the selection of a major that meets their interests and aptitudes. The MSP program is designed for first-year students; however, it is open to any student who wishes to explore academic and career options. To accomplish this process, MSP offers a variety of services including:

1. Career and academic counseling
2. Self assessment instruments
3. A Career Resource Center with printed and computer accessed materials on majors and professions
4. Individual meetings with peer/career advisors, upper-class students, faculty, alumni or employers who provide insights into various majors and careers
5. Corporate tours and job shadowing opportunities.

A non-credit seminar is typically offered during B term. The seminar is marketed to first-year students participating in the Insights program and to other undecided students on-campus.

In addition, the Career Development Center meets individually with students who do not participate in the Major Selection Program and want some guidance regarding major selection or career information. It provides one-on-one counseling appointments, administration and interpretation of self assessment instruments, and job shadowing.

1.C.3. Advising must be done by qualified individuals. Discuss the system by which advisors become qualified.

WPI's Office of Academic Advising is staffed by experienced and qualified individuals. Additional advising is done by the department's faculty, as every student is assigned a faculty advisor. Preparation for advising starts at the New Faculty Orientation which is held yearly before the start of A term for all new faculty members. A detailed description of WPI requirements is given, as well as practical advising information given by experienced faculty and Academic Advising staff. In addition, all new faculty members can participate in the WPI Center for Educational Development & Assessment's (CEDA) Mentoring Program For New Faculty, where a new faculty member is paired with an experienced faculty member from a different department for regular mentoring meetings. Both the CEDA and the WPI Interdisciplinary and Global Studies Division (IGSD) run regular lunch-time seminars where presentations are given about advising, teaching, and new programs/thrusts at WPI. The CS Department maintains an advising web page <web.cs.wpi.edu/~dcb/advising-aids.html> which has been in place for about 10 years. This is used by advisors during Academic Advising Day and at other times. It acts as pointer to the rich variety of information that is available via WPI's web pages, including the WPI Academic Advising Handbook <www.wpi.edu/Admin/OAA/Handbook/>. Finally, advising issues are discussed at CS Department meetings, person to person, as well as via email.

1.D. Meeting the Requirements

Describe your standards and procedures for ensuring that graduates meet all of the requirements of the program.

A Program Review Committee (PRC) is established in each department. The CS PRC, consisting of 3 faculty members, reviews the degree audit for each CS student during the final year of study to ensure that each graduating student will satisfy CS, WPI, and ABET requirements. It is important to note that the development of a program of study and the satisfaction of degree requirements are the responsibility of each student. Each Academic Advisor helps the student design a program that meets each student's individual goals as well as the WPI and CS degree requirements. During the last semester, both the Registrar and the PRC will notify students if degree requirements are missing. Thus the students have the opportunity to adjust the schedule before the completion of the academic year. The final review to ensure that all requirements have been met is the responsibility of the Registrar.

The WPI Web Information System allows the academic advisor, the student, the Registrar and the Program Review Committee to obtain audits of the student's progress towards meeting all requirements. An example of such an audit is shown below. These audits are consulted during Advising Appointment Day (in February), when every WPI student meets with his/her academic advisor to review progress and plan courses for the following year.

A partial and a completed student audit are included in Appendix I.

1.E. CS Department Data Collection, Analysis and Evaluation Mechanisms

Based on the Department's Goals, Objectives and Outcomes (described below) the WPI Computer Science department uses a variety of methods of measurement to collect data. We analyze it, evaluate it, present it to the department faculty, discuss it, and try to make adjustments that reduce perceived weaknesses while maintaining perceived strengths. Some methods generate little analyzable data, but instead provide an opportunity for reflection about the state of the department. We present them all here as it is important to note the variety of approaches used, before we present particular applications of them. It is also important to note that some of the approaches cannot easily be associated with a particular objective or outcome. However, as these too are very useful for the Department, it would be inappropriate to leave them out of this overall examination of the CS Department.

The methods, in no particular order, are presented below.

- **CS Alumni Survey**

  The CS department alumni who graduated with BS degrees 5, 10 and 15 years previously are surveyed every year to establish how important they feel each Objective is (I: Importance), and how well WPI CS prepared them relative to each Objective (P: Preparation). Postcards are sent to all CS alumni from the selected years, and they provide their evaluations via a web form. Data is available for graduation years 1989 to 2003. The data has been plotted to show changes in I, changes in P, and I versus P. The graphs are inspected for significant changes in I and in P, and also for significant differences between important objectives and the department's performance of those objectives. Selected graphs are included in this report and their salient features are discussed.

- **MQP Review Report**

  At regular intervals determined by the WPI Administration the CS department undertakes a significant review of the content and quality of that year's MQPs. Many of the outcomes are assessed, as well as the correlation between perceived quality and grade assigned. The results are usually published as a technical report, and are discussed by the department faculty. The most recent studies were done in 2001 and 2006. The most recent MQP Review report is included in Appendix E of this report. At the time of writing, a review is being planned for summer 2008.

- **MQP Presentation Evaluations**

  In April every year all graduating students present their MQPs to their departments during Project Presentation Day <www.wpi.edu/News/PPD/>. The CS department also has an opportunity for this in December for those projects that are completed during the Fall semester. The CS faculty evaluates every presentation using a form. The resulting data is

mostly used to evaluate presentation skills, although some additional data relate to other selected Outcomes. The data has been plotted and selected graphs are included in this report.

- **Advisor's Evaluation of MQP**

  Every MQP has at least one faculty advisor. One of the CS advisors for each project provides an evaluation of that completed MQP via a web form, based on the CS Outcomes. The resulting data is used to provide a view of how well MQPs are supporting Outcomes. The data covers the years 2002 to 2008. The data has been plotted and selected graphs are included in this report. Results are shared with the department faculty. As the MQP is equivalent to 3 courses of work, these projects contribute significantly towards the department's, and individual student's, achievement of outcomes.

- **Transcripts of Seniors**

  Transcripts of students applying for graduation are checked by the Registrar's Office using a computer program that checks that WPI and departmental requirements are being met. In addition their records are reviewed by the CS Program Review Committee to indicate specific problems to the student if there are any, or to indicate approval. This ensures that all students graduating meet WPI and the department's course distribution requirements.

- **Transcripts of Graduates**

  Occasionally, transcripts of recent graduates are reviewed to monitor trends. For example, it is possible to determine what percentages of majors are taking which courses. For example, the courses taken by the 2007 graduating CS class have been analyzed, and we expect to also do this for the 2008 graduating class.

- **Course Enrollments**

  Course enrollments are monitored regularly to detect enrollment trends, to ensure that enough sections of courses are offered so that majors can graduate on time, and so that student/faculty ratios are kept to reasonable levels. The bulk of this responsibility falls on the Associate Department Head.

- **Advisory Board Reports**

  Regular CS Advisory Board meetings are presented with the state of the department, ongoing changes and plans. They provide feedback to the department head, and offer suggestions about improvements and important future directions.

- **CDC Reports**

  The Career Development Center provides an annual report summarizing internships, post-graduation employment, and attendance at graduate school. This provides a way to assess the quality and appropriateness of the preparation we are providing our graduates.

- **NSSE**

  WPI participates in the National Survey of Student Engagement. These results are shared with the faculty, although the data is not major-specific. It mainly helps WPI administration adjust its support services for the students.

- **EBI**

  WPI participates in the EBI Survey of exiting seniors. We have included CS Majors in the survey, even though the survey is directed towards engineering students. A selection of the results from last year is included in this report. However, we decided that the survey was so biased towards engineering majors that the results for CS majors were being colored in inappropriate ways. As a consequence the EBI Survey was not given to CS majors this year. We will continue to evaluate its suitability for CS.

- **Student Evaluation of Instructor**

  At the end of every term students evaluate the course and instructor for every course in which they are registered. Every faculty member gets an electronic report of their evaluation. The department head also gets information about every evaluation. This allows teaching quality to be monitored across all instructors and courses. In addition, the data and the specific comments written by students allow individual instructors to improve their courses.

- **Course to Outcomes mapping**

  Every course has a mapping of intended educational outcomes for the course to the CS department's outcomes, associated with the methods for measuring whether that outcome was achieved—typically by projects, examinations, homework, presentations, etc. This mapping should be included in the web pages for the course.

- **Faculty Retreat**

  The department holds a faculty retreat every year or two, with the goals of reviewing recent self-assessment data, evaluating current strengths and weaknesses, and proposing solutions to problems. Typically the list of action items is addressed by appropriate departmental committees during the following year(s). The most recent retreat was held in August 2007. Some of the topics discussed will be presented in this report.

- **Department Meetings**

  CS Department meetings for the CS faculty are held every three weeks during the academic year. Many issues are discussed, including staffing, new courses, changes to regulations, and assessment. In addition the department head reports on the progress of any ongoing activities, such as recruiting, and any upcoming events (such as advising or teaching information sessions). Major changes to the CS curriculum or the department regulations are introduced as motions, discussed and voted on.

- **Education Committee Meetings**

  The CS Education Committee continually reviews the CS curriculum and responds to suggestions from the CS Faculty, the CS Department Head, and the CS Assessment Coordination Committee. Proposed revisions to regulations, proposed new courses, or any other important issues are raised at CS Department meetings. Those presented as motions are discussed and may result in changes to the CS regulations or curriculum, once they have been approved by the WPI faculty.

- **TA Evaluations**

  Most undergraduate courses are run with the help of Teaching Assistants. At the end of every class the faculty instructor provides an evaluation of the TAs for that course. The TA Coordinator uses this data to provide better assignments of TAs for each course, in order to ensure the best support for the faculty and the undergraduate students. In addition, TAs that are not doing an acceptable job are informed, and may be replaced if their performance does not improve.

- **Faculty Evaluations**

  Every year each faculty member prepares an activity report about research, teaching and service for that year. They deliver it to the Department Head, and subsequently the Provost, for their evaluation. The Department Head provides an evaluation of the faculty member, and discusses strengths, weaknesses and future plans with them.

- **Annual Report**

  The department's annual report provides an opportunity to reflect on and summarize the state of the department, including the Undergraduate and Graduate programs, facilities, funding, research, and staffing.

- **Student Reported Workload**

  In the Student evaluations of courses they report how much time they spent working on the course. This data was summarized and profiled for discussion at the 2007 CS Department Faculty Retreat. It provides a way of determining whether the 1000, 2000, 3000 and 4000 level courses are hard enough (or too hard) for their category. For each class, WPI expects an average of 17 hours of work per week, including class and laboratory time. These data are included in this report.

- **Percentage of Students Taking Courses**

  Periodically, data is collected about what percentages of our majors take each course. As we provide distribution requirements, which allow students choice, this provides feedback about the impact of Advising and the Undergraduate Catalog on student course selection. It also helps the department to plan the appropriate number of offerings of each course each year.

- **IQP Review Report**

  At regular intervals determined by the WPI Administration (usually yearly) an evaluation is done of a large sample of the IQPs done at WPI. A document reporting on the latest IQP evaluation is included in Appendix G of this report.

2. Program Educational Objectives

Criterion

The program has documented measurable program educational objectives that are based on the needs of the program's constituencies.

2.1. Provide the institution's mission statement. Include any other mission statements that are relevant.

The Mission of WPI

WPI educates talented men and women in engineering, science, management, and humanities in preparation for careers of professional practice, civic contribution, and leadership, facilitated by active lifelong learning. This educational process is true to the founders' directive to create, to discover, and to convey knowledge at the frontiers of academic inquiry for the betterment of society. Knowledge is created and discovered in the scholarly activities of faculty and students ranging across educational methodology, professional practice, and basic research. Knowledge is conveyed through scholarly publication and instruction.

A Statement of Values for Undergraduate Education at WPI

1. WPI's programs shall emphasize fundamental concepts, knowledge, and skill, and ensure that students are able to apply them within the context of their major disciplines.
2. WPI's programs shall emphasize the development of students as effective thinkers and communicators, able to use evidence to present their ideas with logic, clarity, and persuasion.
3. Programmatic breadth in general, and balance between technical and humanistic components in particular, are the hallmarks of a WPI undergraduate education. In addition to educating students in their major discipline, WPI's programs shall provide students with a broad preparation for fulfilling lives as responsible professionals and informed citizens.
4. Grounded in project and course experiences, a WPI education shall provide a firm foundation for life-long learning in a variety of fields. WPI programs shall emphasize inquiry-based learning and open-ended problem solving. Students shall bear a considerable responsibility for learning outside of the classroom.
5. WPI's programs shall be sufficiently flexible so as to allow students significant choice in and responsibility for planning their courses of study. Faculty, via the central teaching tasks of project and academic advising, shall ensure that student learning experiences encourage critical reflection, decision making, and personal growth.
6. WPI's programs shall emphasize the scientific, technical, societal, and humanistic contexts in which knowledge is applied and constructed. Education activities shall challenge students to make connections between disciplines, to consider multiple viewpoints, and to appreciate the consequences of their actions. The curriculum shall prominently feature integrative and interdisciplinary activities.

7. WPI's learning environment and educational activities shall balance personal responsibility and individual accountability with cooperation, collaboration and mutual respect. Members of the community shall be encouraged to value academic integrity, and to become conscious of the value that such integrity confers to themselves and to the community.
8. WPI shall be committed to assessment and improvement of student learning.

CS Department Mission Statement

The mission of the Computer Science Department at WPI is to provide outstanding education to its undergraduate and graduate students in accordance with the principles of the WPI mission, to advance scholarship in key domains of the computing sciences, and to engage in activities that improve the welfare of society and enhance the reputation of WPI. The Department aims to maintain an environment that promotes innovative thinking; values mutual respect and diversity; encourages and supports scholarship; instills ethical behavior; and engenders life-long learning.

2.2 List the program's educational objectives. Explain how and where they are documented outside of this Self-Study.

CS Department Goals

The goals of the WPI Computer Science undergraduate program are to:

G1. Prepare students to function professionally as computer scientists and software engineers.

G2. Prepare students for graduate studies in computer science and related disciplines.

G3. Develop students' critical thinking and problem-solving skills.

G4. Prepare students to assume responsible positions in society.

G5. Prepare students for life-long learning.

G6. Foster in students a sense of ethical behavior and respect for diversity.

CS Department Objectives

The objectives established by the WPI Computer Science undergraduate program in support of its *Goals* and *Mission* are to graduate students with a Computer Science major who:

1. Are prepared technically for computer science and software engineering practice.
2. Understand the basic principles of computer science and software engineering.
3. Understand appropriate mathematical concepts and are able to apply them to computational problems.
4. Have knowledge of computer hardware and architecture.
5. Understand and follow software engineering processes.
6. Are prepared to design and implement software systems.
7. Are prepared to analyze and evaluate software systems.
8. Understand fundamental scientific principles and the scientific method.

9. Can function effectively in diverse teams and situations.
10. Can communicate effectively in speech and in writing.
11. Are able to learn independently and find relevant resources.
12. Are prepared for future changes in computer science and software engineering.
13. Are prepared to uphold professional and ethical standards.
14. Understand and appreciate the role of computer science and software engineering in a societal context.
15. Are aware of career and further educational opportunities.
16. Have a mature understanding of themselves and others.

The department's Goals and Objectives are publicly available in the published (print & web) Undergraduate Catalog and also on the web via <www.cs.wpi.edu/About/>.

The department's Goals relate to the Objectives in the following manner:

Table 1: Relationship between goals and objectives

Goals / Objectives	1. Profession	2. Graduate	3. Critical	4. Responsible	5. Learning	6. Ethical
1.Technical preparedness	X	X	X		X	
2. Basic principles	X	X	X		X	
3. Mathematics	X	X	X		X	
4. Hardware	X	X				
5. SE Process	X		X		X	
6. Design & Impl.	X	X	X			
7. Analyze & evaluate	X	X	X			
8. Scientific method	X	X	X		X	
9. Teams & diversity	X	X		X		X
10. Communicate	X	X		X	X	
11. Learn & find	X	X	X	X	X	
12. Future changes	X	X	X		X	
13. Uphold standards	X	X		X		X
14. Societal context	X	X		X	X	X
15. Opportunities	X	X		X	X	
16. Maturity	X	X		X	X	

2.3 Describe how your program's educational objectives align with your institution's mission.

The Computer Science program's objectives are well aligned with WPI's mission. The program's mission statement was based on WPI's mission statement. As the department's objectives stem from its mission statement, they are highly compatible with WPI's mission: preparation for professional practice, responsible participation in society, technical and personal leadership, and independent learning.

2.4 Explain how the program's educational objectives align with the needs of its constituencies, and include a list of the stakeholders. Also describe the role the constituencies played in formulating the educational objectives.

The CS department's annual alumni survey provides the alumni an opportunity to comment on the objectives, but there have been none. While CS faculty members have recently mentioned the need to reconsider our Outcomes, there have been no comments about the Objectives. Faculty and alumni were involved in the original formulation of both the Outcomes and Objectives. Current students have access to both via the Undergraduate Catalog and the CS Web pages, but there have been no comments about them.

2.5 For each program educational objective, indicate the mechanism(s) used to measure it.

The only mechanism that produces results directly in terms of Objectives is the annual CS Alumni Survey. The survey directly addresses all of the Objectives. Other mechanisms contribute to the evaluation of satisfaction of Objectives by the mapping from Outcomes.

3. Program Outcomes

Criterion

The program has documented measurable outcomes that are based on the needs of the program's constituencies.

The program enables students to achieve, by the time of graduation:

- *(a) An ability to apply knowledge of computing and mathematics appropriate to the discipline;*
- *(b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution;*
- *(c) An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs;*
- *(d) An ability to function effectively on teams to accomplish a common goal;*
- *(e) An understanding of professional, ethical, legal, security, and social issues and responsibilities;*
- *(f) An ability to communicate effectively with a range of audiences;*
- *(g) An ability to analyze the local and global impact of computing on individuals, organizations and society;*
- *(h) Recognition of the need for, and an ability to engage in, continuing professional development;*
- *(i) An ability to use current techniques, skills, and tools necessary for computing practices.*

For computer science programs:

- *(j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices;*
- *(k) An ability to apply design and development principles in the construction of software systems of varying complexity.*

3.1 List the program's outcomes. Discuss how and where they are documented outside of this Self-Study.

CS Department Outcomes

Based on the Objectives, the specific outcomes to be achieved for the WPI Computer Science undergraduate program are that:

1. All students will demonstrate an understanding of programming language concepts.
2. All students will demonstrate knowledge of computer organization.
3. All students will demonstrate an ability to analyze the behavior of computational systems.
4. All students will demonstrate knowledge of computer operating systems.
5. All students will demonstrate an understanding of the foundations of computer science.
6. All students will demonstrate an understanding of software engineering principles and the ability to apply them to software design.
7. A majority of students will demonstrate an understanding of human-computer interaction.

8. All students will complete a large software project.
9. All students will demonstrate advanced knowledge of computer science topics.
10. All students will demonstrate an understanding of the mathematical foundations of computer science.
11. All students will demonstrate knowledge of probability or statistics.
12. All students will demonstrate an understanding of scientific principles.
13. A majority of students will demonstrate the ability to design experiments and interpret experimental data.
14. All students will demonstrate independent learning.
15. All students will demonstrate the ability to locate and use technical information from multiple sources.
16. All students will demonstrate an understanding of professional ethics.
17. All students will demonstrate an understanding of the links between technology and society.
18. A majority of students will belong to at least one professional organization, including IEEE, ACM, and UPE.
19. All students will participate in a class or project team.
20. All students will demonstrate the ability to communicate effectively in speech.
21. All students will demonstrate the ability to communicate effectively in writing.

The department's Outcomes are publicly available in the published (print & web) Undergraduate Catalog and also on the web via <www.cs.wpi.edu/About/>.

The mapping of Objectives to Outcomes is provided in Table 2 below.

3.2 For each program outcome, indicate the mechanism(s) used to measure it.

Before listing for each Outcome the mechanism(s) used for evaluation, we will list the Outcomes addressed by each mechanism.

MECHANISM	**OUTCOMES**
CS Alumni Survey	all indirectly, via mapping from Objectives.
MQP Review Report	Main: 21 Writing also: 8 Large project 9 Advanced CS 10 Math 11 Probability or Statistics 14 Independent Learning 15 Locate & Use 16 Ethics 19 Team
MQP Presentation Evaluations	Main: 20 Speech also: 3 Analyze 9 Advanced CS

	12 Scientific principles 14 Independent Learning
Advisor's Evaluation of MQP	all outcomes.
Transcripts of Seniors	all outcomes, via WPI's and the department's distribution requirements.
Transcripts of Graduates	all outcomes.
Course Enrollments	all outcomes.
Advisory Board Report	all outcomes.
CDC Reports	all outcomes.
NSSE	mapping unclear.
EBI	some connection to many outcomes.
Student evaluations of courses	all outcomes.
Course to Outcomes mapping	all outcomes.
Faculty Retreats	selected outcomes, depending on current issues.
Department meetings	selected outcomes, depending on current issues.
Education Committee meetings	selected outcomes, depending on current issues.
TA Evaluations	some connection to all outcomes
Faculty Evaluations	some connection to all outcomes
Annual Report	selected outcomes, depending on current issues.
Student reported workload	some connection to all outcomes.
% of students taking courses	all outcomes.
IQP Review Report	Main: 14 Independent Learning 15 Locate & Use 16 Ethics 17 Technology and society 21 Writing Possibly also: 11 Probability or Statistics. 12 Scientific principles 13 Experiments 19 Team

Next, for each program outcome, we indicate the key mechanism(s) used to measure it. Where the use of the mechanism varies or is hard to specify exactly it has not been included.

***Outcome*: 1. All students will demonstrate an understanding of programming language concepts.**

Mechanisms: Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **2. All students will demonstrate knowledge of computer organization.**

Mechanisms: Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **3. All students will demonstrate an ability to analyze the behavior of computational systems.**

Mechanisms: MQP Presentation Evaluations; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **4. All students will demonstrate knowledge of computer operating systems.**

Mechanisms: Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **5. All students will demonstrate an understanding of the foundations of computer Science.**

Mechanisms: Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **6. All students will demonstrate an understanding of software engineering principles and the ability to apply them to software design.**

Mechanisms: Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 7. A majority of students will demonstrate an understanding of human-computer interaction.**

Mechanisms: Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 8. All students will complete a large software project.**

Mechanisms: MQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 9. All students will demonstrate advanced knowledge of computer science topics.**

Mechanisms: MQP Review Report; MQP Presentation Evaluations; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 10. All students will demonstrate an understanding of the mathematical foundations of computer science.**

Mechanisms: MQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 11. All students will demonstrate knowledge of probability or statistics.**

Mechanisms: MQP Review Report ; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 12. All students will demonstrate an understanding of scientific principles.**

Mechanisms: MQP Presentation Evaluations; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **13. A majority of students will demonstrate the ability to design experiments and interpret experimental data.**

Mechanisms: IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **14. All students will demonstrate independent learning.**

Mechanisms: MQP Review Report; MQP Presentation Evaluations; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **15. All students will demonstrate the ability to locate and use technical information from multiple sources.**

Mechanisms: MQP Review Report; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **16. All students will demonstrate an understanding of professional ethics.**

Mechanisms: MQP Review Report; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **17. All students will demonstrate an understanding of the links between technology and society.**

Mechanisms: IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

Outcome: **18. A majority of students will belong to at least one professional organization, including IEEE, ACM, and UPE.**

Mechanisms: CS Alumni Survey; Course to Outcomes Mapping;

***Outcome:* 19. All students will participate in a class or project team.**

Mechanisms: MQP Review Report ; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 20. All students will demonstrate the ability to communicate effectively in speech.**

Mechanisms: MQP Presentation Evaluations; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

***Outcome:* 21. All students will demonstrate the ability to communicate effectively in writing.**

Mechanisms: MQP Review Report; IQP Review Report; Advisor's Evaluation of MQP; Transcripts of Seniors; Transcripts of Graduates; Course Enrollments; Advisory Board Report; CDC Report; Student Evaluations of Courses; Course to Outcomes Mapping; % of Students Taking Courses;

3.3 Explain the relationship between the outcomes and the needs of the program's constituencies. Also explain the role played by the various constituencies in formulating the program outcomes.

The CS department's annual alumni survey provides the alumni an opportunity to comment on the objectives and, by implication the outcomes, but there have been no comments. CS faculty members have recently mentioned the need to reconsider our Outcomes. CS Faculty and alumni were involved in the original formulation of both the Outcomes and Objectives. Current students have access to both via the Undergraduate Catalog and the CS Web pages, but there have been no comments about them.

3.4 Indicate how your program outcomes map to your program educational objectives.

Table 2: Mapping Outcomes to Objectives

Outcomes \ Objectives	1. Technical	2. Principles	3. Mathematics	4. Hardware	5. SE	6. Design	7. Analyze	8. Scientific	9. Teams	10. Communicate	11. Learn	12. Changes	13. Standards	14. Context	15. Opportunities	16. Maturity
1. PL Concepts	X	X				X										
2. Comp Org	X	X		X												
3. Analysis	X	X	X				X	X								
4. OS	X	X		X		X										
5. Theory	X	X	X									X				
6. SE	X	X			X	X	X									
7. HCI	X	X				X								X		
8. Large SW	X	X			X	X										
9. Adv CS	X	X	X		X	X	X					X				
10. Math	X	X	X									X				
11. Prob & Stat	X		X				X	X								
12. Science	X							X				X				
13. Experiment	X		X		X		X	X								
14. Indep Learning											X	X				
15. Locate Info											X	X				
16. Ethics													X	X		
17. Society														X		
18. Prof orgs											X	X	X	X	X	X
19. Teams									X							X
20. Speech										X						
21. Writing										X						

3.5 Explain how completion of your program enables (a-i) of the general criteria, as well as enables the corresponding additions from the relevant program criteria (j-k).

The applicable ABET general criteria are:

a) An ability to apply knowledge of computing and mathematics appropriate to the discipline;
b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution;
c) An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs;
d) An ability to function effectively on teams to accomplish a common goal;
e) An understanding of professional, ethical, legal, security, and social issues and responsibilities;
f) An ability to communicate effectively with a range of audiences;
g) An ability to analyze the local and global impact of computing on individuals, organizations and society;
h) Recognition of the need for, and an ability to engage in, continuing professional development;
i) An ability to use current techniques, skills, and tools necessary for computing practices.
j) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices;
k) An ability to apply design and development principles in the construction of software systems of varying complexity.

The mapping of CS Educational Outcomes to these General Criteria is approximate, and is shown in the following table:

Table 3: Outcomes to General Criteria

Criteria / Outcomes	a	b	c	d	e	f	g	h	i	j	k
1.PL Concepts	X		X								
2.Comp Org	X		X								
3.Analysis	X	X	X							X	
4.OS	X		X								
5.Theory	X	X	X							X	
6.SE	X	X	X						X	X	X
7.HCI	X	X	X								X
8.Large SW	X	X	X								X
9.Adv CS	X	X	X						X		X
10.Math	X	X	X							X	
11.Prob & Stat	X		X							X	
12.Science			X								
13.Experiment			X							X	
14.Indep Learning			X					X	X		
15.Locate Info			X						X		
16.Ethics					X						
17.Society					X		X				
18.Prof Orgs					X			X			
19.Teams				X							
20.Speech						X					
21.Writing						X					

4. Continuous Improvement

Criterion

The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met. The results of the evaluations are documented and used to effect continuous improvement of the program through a documented plan.

4.1 Describe your procedure for periodically assessing the extent to which each of the program educational objectives is being met by your program. Include:

- Frequency and timing of assessments.
- What data are collected (should include information on initial student placement and subsequent professional development).
- How data are collected.
- From whom data are collected (should include students and computing professionals).
- How assessment results are used and by whom.

Apart from the impact of our evaluation of Outcomes on the evaluation of Objectives—as all are coupled, many tightly—we have one key mechanism for evaluating whether our students meet the Objectives, and that is the CS Alumni Survey. The CS department Alumni who graduated with BS degrees 5, 10 and 15 years previously are surveyed every year to establish how important they feel each Objective is (I: Importance), and how well WPI CS prepared them relative to each Objective (P: Preparation). We believe that this 5 year delay gives alumni time to assess the impact of their WPI CS education on their ability to function successfully in their new situations in industry or academia. Postcards are sent to all CS alumni from the selected years, and they provide their evaluations via a web form. Data is available for graduation years 1989 to 2003. The data has been plotted to show changes in I, changes in P, and I versus P. The graphs are inspected for significant changes in I and in P, and also for significant differences between objectives indicated as important and the department's performance of those objectives. The graphs, and a discussion of their evaluation, are shared with the CS faculty (see Appendix K).

4.2 Describe your procedure for periodically assessing the extent to which each of the program outcomes is being met by your program. Include:

- Frequency and timing of assessments.
- What data are collected (should include information on initial student placement and subsequent professional development).
- How data are collected.
- From whom data are collected (should include students and computing professionals).
- How assessment results are used and by whom.

The form and frequency of the mechanisms we use to evaluate outcomes have already been described. More details of the use of the mechanisms and their impact are given in section 4.5.2 below.

4.3 If you have an assessment plan or similar document that provides the information in (1) and (2) above, include it as an appendix and reference the appendix here.

Most of the mechanisms we use are an integral part of the functioning of the CS department, and their interactions complex enough that a diagram would not clearly represent them, as we hope is clear from our descriptions so far. The Accreditation Coordination Committee maintains a web-based Departmental Calendar (in a restricted area) that lists all actions that need to be carried out on a regular, yearly basis in the CS department. These include data collection, analysis and evaluation activities. The Calendar is included in Appendix N.

4.4 Attach as an appendix copies of the actual documentation that was used by your data collection and assessment process since the last accreditation visit or for the past three years if this is the first visit. Include survey instruments, data summaries, analysis results, etc. Indicate the appendix reference here.

Copies of the various forms used are available in Appendix H.

Graphs of key results are available in Appendices K, L, and M.

The latest CS Department MQP Review Report can be found in Appendix E.

Other documents and data are mentioned below.

4.5 Describe your use of the results of the program's assessments to identify program improvements and modifications to program educational objectives and program outcomes. Include:

- Any program changes within the last six years based on assessments.
- Any significant future program improvement plans based upon recent assessments, including timelines.
- Any changes in program educational objectives or program outcomes within the last 6 years.
- How this information has been documented.

4.5.1 Program Changes within the Last Six Years

The following changes have been recorded in the minutes of the regular CS Department meetings. Some changes are just internal to the department. However, many of these changes have resulted in updates to the WPI Undergraduate Catalog, both in print and on the WPI web pages, as well as updates to the CS Department web pages. In addition some information was conveyed to CS majors via emails from the department.

March 2003: the following new CS courses were approved:

- CS 1101: Introduction to Program Design
- CS 1102: Accelerated Introduction to Program Design
- CS 2102: Object-Oriented Design Concepts
- CS 2303: Systems Programming Concepts

- CS 2301: Systems Programming for Non-Majors
- CS 4536: Programming Languages

In addition, courses 1001, 1005, 1006, 2005, 2135 and 2136 were removed, effective starting in AY 04-05, as these courses were replaced by the new courses. In addition the CS Distribution Requirements were changed to reflect these changes, and also to allow only CS 1101, CS 1102, and computer science courses at the 2000-level or higher to count towards the computer science distribution requirement. A modification was also made to only allow one of CS 2301 and 2303 to count towards the computer science distribution requirement.

Because of these course changes, many of the Recommended Background statements in the catalog course descriptions were changed to refer to the new courses.

An additional motion was passed concerning our handling of Advanced Placement credit in computer science. Up to 2/3 unit of credit for the generic CS 1000 can be earned.

April 2003: The CS department's formal response to the Accreditation report was discussed and approved.

January 2004: The proposal to convert an experimental course to permanent status was approved. The new course is CS 4445, Data Mining and Knowledge Discovery in Databases, and is Category II. Its Recommended Background is CS 4341, Introduction to Artificial Intelligence; MA 2611, Applied Statistics I; and CS 3431, Database Systems I.

December 2004: CS 4536, Programming Languages, and CS 4120, Analysis of Algorithms, were added to the theory and languages area of the Undergraduate distribution requirements.

September 2006: The department discussed the new ABET accreditation requirements, in particular the "one year of mathematics and science", as this had been an issue of concern during the last visit. The opinion of the department was that we were in compliance with this new requirement.

December 2007: The department approved a motion from the Education Committee to change the Computer Science degree requirements by adding Robotics Engineering (RBE) to the list of disciplines that satisfy the Basic Science/Engineering Science Distribution Requirements. Note this was approved by the WPI Faculty on May 15, 2008.

February 2008: The department discussed the introduction of an experimental course called "Software Security Engineering". While the majority of the department approved, some additional details still need to be worked out.

April 2008: The department discussed and approved a motion from the Education Committee to introduce a new 3000-level Computer Networks course that takes some of the material from CS 4514. As a consequence, CS 4514, *Computer Networks: Architecture and Implementation*, would move to Category II and would include more current advanced topics (such as wireless

networks) that could not be covered before. Some implementation details of this change still need to be worked out.

4.5.2 Significant Future Program Improvement Plans

A number of issues are being discussed. We will address each separately, even though some are currently only recognized weaknesses with no fully developed plan at present. Most of the discussion is organized around the data collection and evaluation mechanisms already presented.

Space allocation:

There is ongoing planning to re-allocate space in Fuller Labs. This will affect faculty office space and lab space, with positive effects on the undergraduate program. Fuller Labs was originally designed to house the anticipated much larger CS Department than we were at the time of building. Much of the space that we didn't initially occupy was used by other groups, and, although we have been growing steadily, the other groups' inertia has been difficult to overcome.

New Courses:

In section 4.5.1 above we described the department's approval of two new courses that, pending WPI faculty approval, will be offered in the future.

CS Alumni Survey:

Appendix K shows some graphs of this data. The graphs refer to Objectives. The two main graphs are "Alumni feedback on WPI CS Preparation" and "Alumni feedback on Preparation compared to Importance".

This 2008 survey was sent to graduates of our BS program from 1993, 1998, and 2003. The survey asks about the importance (I) of each Objective, and our performance (P): how well their WPI education satisfied each Objective.

The 1993 alumni were negative about our performance in 10 (Speech & Writing) as well as 15 (Career & Education), but neutral about 7 (Analyze & Evaluate) and 16 (Mature Understanding). Apart from those the largest difference between I and P was for 6 (Software Systems).

None of the 1998 performance data was negative. The largest differences between I and P were for 5 (Software Engineering), 6 (Design & Implement), 7 (Analyze & Evaluate), 10 (Speech & Writing), and 15 (Career).

Once again this features Software Engineering. The department's focus on Software Engineering has increased a huge amount since 1998, the courses in that area have been completely revised, and strong instructors are in place. We are monitoring this situation and anticipate that 2004 and later graduates should rate performance in this and related areas more highly.

The weakness in Speech and Writing is a common finding across the campus—WPI expects high performance, and provides lots of opportunities to practice both, but we aren't seen as providing enough formal help so that the students can meet our expectations. This is a difficult issue.

The 2003 data shows improved Performance pretty much across the board, with the weakest being 10 (Speech & Writing). The other large difference between I and P is for 7 (Analyze & Evaluate). We are aware that this is a problem for CS. We have started addressing it by having

MQP advisors stress that in their projects. However, we need to move more analysis and evaluation into our courses.

The good news from the class of 2003 is that 9 (Teams) gets a perfect score, while 1 (Prepared Technically), 2 (Basic Principles), 11 (Learn Independently) and 12 (Prepared for Future) are at about 80% approval.

For 2003, with regard to Importance, 7 (Analyze & Evaluate) has risen to 100%, and 6 (Design & Implement) has fallen slightly. However, 14 (Society) has made the largest gain over the three sampled years.

With regard to Performance changes, 4 (Computer Hardware), 12 (Prepared for Future) and 15 (Career & Education) are strong isolated gains, with the increase in 9 (Teams) being the strongest trend. There slight gains for 6 (Design & Implement) and 7 (Analyze & Evaluate) over previous years, but they are still not high enough, so there's more to do there.

MQP Review Report:

The 2001 Computer Science Department MQP Review made the following recommendations:

a) Students need to better document type and level of mathematics;

b) Students need to better describe the types of work encompassed by the project;

c) Advisors need to increase student team size and avoid single-student projects;

d) Advisors need to emphasize the testing and evaluation phase;

e) Advisors need to emphasize the need for students to indicate why the project was a good learning experience;

f) Advisors need to strive to have projects build on one another.

Recommendations c) and f) were responding to the large numbers of graduating students at that time. All these recommendations were addressed by project advising.

The 2006 Computer Science Department MQP Review (available online as WPI-CS-TR-06-15 at <www.cs.wpi.edu/Resources/techreports.html>) examined 44 final year projects accounting for 85 students.

The recommendations of that report were to:

a) Increase student team size and avoid single-student projects when possible. Better mechanisms for bringing project groups together earlier need to be investigated. Working in project groups improves cooperative and communication skills of the students. Larger MQP teams offer more efficient use of a faculty member’s time.

b) Ensure that project reports are complete and encompass all aspects of a project including proper background research. A decrease in the quality of the project report

was a negative result of this MQP review and needs to be a point-of-emphasis moving forward.

c) Emphasize the testing and evaluation phase. Lack of adequate evaluation by external sources was a problem with many of the design and implementation projects. Serious analysis of projects is a general weakness in department MQPs. More formal analysis would also increase the level of mathematics and statistics displayed by the projects.

d) Emphasize the need for students to indicate why the MQP was a good experience, what was difficult about the project and what experiences/courses the MQP builds upon. It was difficult with some projects for the reviewers to understand the significance of the work and upon which prior student work the project built.

e) Strive to have MQPs build on previous MQPs and projects. In industry, our graduates will have to learn how to work with old code from old projects, and one way we can address this is through building upon previous MQPs and theses. This approach makes faculty more efficient and creates a pipeline of projects so the students can see the larger objective for their individual project.

f) Continue to work with external companies and organizations to sponsor MQPs. Externally-sponsored projects are both beneficial for students and generally lead to better quality projects.

The department is aware of these findings, and they are being addressed by academic advising and project advising.

MQP Presentation Evaluations:

Graphs of the 06-07 and 07-08 data are available in Appendix L. Overall, there are 10-20% gains in the "Strongly Agree" category for all the evaluation criteria in 07-08, which is excellent. The criterion "Demonstrated use of the Scientific Method" was added for 07-08 in an attempt to obtain data in response to CAC's critique that it did not appear that our students had enough preparation in this area. While we are confident that the Basic Science/Engineering Science Distribution Requirement provides enough Science to cover CAC's criteria, we are still uncomfortable with the poor showing in the MQP Presentation data. However, most of the projects do not do experiments to try to verify hypotheses. We have noted that the "Results Analyzed and Evaluated" criterion data is too low. Unfortunately, this is consistent with other evaluations, as noted elsewhere in this report. As most of the criteria in this mechanism concern Oral presentation, and as most are in the range of 70-90% for Agree + Strongly Agree, we are quite happy with the overall quality demonstrated by our students. The department is aware of these findings.

Advisor's Evaluation of MQP:

This evaluation is in terms of Outcomes. So for Outcome 1, for example, advisors responded to "Based on the contents of this MQP we can claim that the student or students: Demonstrated an understanding of programming language concepts." Graphs of the data from 2002 to 2008 can

be found in Appendix M. The key graphs are "02-08 MQP Advisor Evaluation Summaries" and "02-08 MQP Advisor Evaluations Averaged".

There were drops in 3 (Analyze systems), 12 (Scientific Principles), and 13 (Experiments), which all seems somewhat related to existing problems with data collection, analysis and evaluation.

Outcomes rated by advisors on average as at least "Well" on the evaluation scale over those seven years are 6 (Software Engineering), 8 (Large Project), 9 (Advanced CS), 14 (Independent Learning), 15 (Locate/use Information), 19 (Teamwork), 20 (Spoken Communication) and 21 (Written Communication). Note that Independent Learning had highest value.

Those outcomes rated on average close to "Somewhat" are 5 (Foundations), 10 (Math Foundations) and 18 (Member of Professional Org.). These are all quite hard to address in MQPs. The department is aware of these findings.

Transcripts of Seniors:

This process appears to be working well for monitoring seniors. For advisor checking of student progress prior to the senior year, the WPI Web Information System has recently been augmented (January 2008), in response to faculty feedback, to introduce "Electronic Advising Folders". A faculty member's advisees are grouped by year and "Performance Indicators" are listed for each student, showing important information including which degree requirements have been satisfied and whether an advisee is overloading (or under loading). From this list an advisor can bring up an "Electronic Folder" for individual students to review their progress and registered activity for the year. Private comments can be entered for the advisor's own use. These changes were instituted by WPI's Committee on Advising and Student Life (CASL), working with the Registrar, the Director of Academic Advising, and the Academic Technology Center.

Transcripts of Graduates:

A full evaluation of recent transcripts will be done this summer. An analysis for the class of 2007 to determine what percentage of them took each CS course is provided below under "Percentage of Students Taking Courses".

Course Enrollments:

Course enrollments have been discussed elsewhere in this report.

Advisory Board Report:

This mechanism appears to be working well. The Advisory Board has been changed over the last 5 years in order to strengthen external relationships and provide strategic advice to the department. However, this de-emphasizes its role as an external evaluator.

CDC Report:

The Career Development Center 2007 Report is included in Appendix F. The 2006 report is also available upon request. Our graduates are in demand, get jobs with excellent companies, are being offered good salaries, and go to good graduate schools.

Average starting salaries of CS undergraduate students registered with the CDC were $62,860 in 2007, $57,805 in 2006, $51,176 in 2005, and $48,696 in 2004. Areas of employment in 2007

include Aerospace & Defense, Business Services, Computer Hardware, Computer Services, Computer Software, Education, Electronics, Energy & Utilities, Financial Services, Government/Federal, and Leisure. Of those registered with the CDC in 2007, 63% were hired, 18% went to Graduate School, with the rest unknown.

The top hiring companies for 2007-2005 were EMC, Fidelity, Raytheon, RSA Security, MIT Lincoln Labs, IBM, MEDITECH and Bloomberg. Students were also hired by BBN, eBay and Microsoft. Graduate schools included WPI, Brown, CMU, Suffolk Law School, Sydney University of Technology, USC, Georgia Tech, and the University of Potsdam.

NSSE:

This mechanism appears to be working well. The National Survey of Student Engagement (NSSE) online edition of 2007 Annual Report "Experiences That Matter: Enhancing Student Learning and Success" can be found at <nsse.iub.edu/NSSE_2007_Annual_Report/>.

One of their "Promising Findings" is that "Students who took part in one or more 'high-impact' practice such as a learning community, research with faculty, study abroad, and culminating senior experience reported greater levels of deep learning and greater gains in learning and personal development." As all WPI students take part in two faculty-directed projects, one of which is a culminating senior experience, and over 50% do at least one project overseas, this is good news for WPI.

In their "Disappointing Findings" (DF) they include the fact that "The number of hours full-time students spend studying per week has remained constant since 2001 at about 13-14 hours, only about half what many faculty say is necessary to do well in their classes". This is consistent with our findings. Another DF is that "About one in ten students never met with their advisor during the current academic year." Given the advising structure at WPI we would expect that all students would see their advisors regularly. A final DF is that "In their last year of college, half of all seniors did not write a paper or report longer than 20 pages; one in ten (9%) did not write a paper longer than 5 pages." At WPI every senior writes an MQP report and those reports are usually 50-100 pages.

The Undergraduate Outcomes Assessment Committee Assessment Plan for Institutional Learning Outcomes at WPI can be found in Appendix O. It is based on 2006 NSSE data and compared to data from the Association of Independent Technical Universities Consortium (AITU). The most surprising result, from a CS department perspective, is that WPI students scored lower than AITU students on "Worked with other students on projects during class**".** Many of the department's classes include some form of group activity.

EBI:

Due to concerns about the applicability of this survey to CS students, with correspondingly strange results in 2006, we decided not to use this mechanism after that. The EBI survey is aimed at engineering departments. Many sections in the survey include questions that explicitly say "Engineering", possibly leading to confusion and poor responses from CS students. The

Computing Resources category is an example were results were nonsensical.

Forms were distributed at Project Presentation Day (April 18, 2006) and from the department office (seniors were alerted by email). The standard form can be found in Appendix H. There were 43 responses. Two interesting results were the percentage of CS students who were at WPI while also holding an outside job, and the number of hours the claimed to study per week on average.

```
Outside job:   None     12.2%
               1-10 hrs 29.3%
              11-20 hrs 36.6%
              21-30 hrs 17.1%
              31-40 hrs  2.4%
                >40 hrs  2.4%


Hours of study: 0-5 hrs 17.1%
                6-10 hrs  9.8%
               11-15 hrs 29.3%
               16-20 hrs 19.5%
               21-25 hrs  2.4%
               26-30 hrs  4.9%
                 >30 hrs 17.1%
```

Clearly, with WPI's expected workload of 17 hours a week per class, and a normal load of three classes per term, they should be studying about 50 hours a week (i.e., about 7 hours a day). Anyone who is working 20 or more hours a week is going to find that very challenging. In addition, it's clear that most students are not studying hard enough (also note the Student Reported Workload section below). These figures are worrying.

Student Evaluations of Courses:

This mechanism appears to be working well.

Course to Outcomes mapping:

The course to outcomes mapping is presented in section 5.b.5 below. It shows which courses have outcomes that map to the CS Outcomes. The number of times each outcome is contributed to by a course is then totaled. These totals are as follows, with the total first and then text that indicates to which outcome it refers, with a minimum of zero and a maximum of twenty.

0 belong to at least one professional organization *
2 human-computer interaction *
3 computer organization *
3 links between technology and society *
4 computer operating systems *
5 professional ethics *
6 foundations of computer science
6 probability or statistics
6 scientific principles

7 design experiments and interpret experimental data
7 communicate effectively in speech
9 analyze the behavior of computational systems
9 mathematical foundations
9 locate and use technical information
13 programming language concepts
13 large software project
14 advanced knowledge of computer science topics
15 class or project team
16 independent learning
16 software engineering principles
20 communicate effectively in writing

While students take their own paths through the courses, these figures do reflect the amount of opportunity each student has to address each outcome. Of concern are those outcomes marked with an asterisk. The lack of opportunity for courses to directly affect membership in "at least one professional organization, including IEEE, ACM, and UPE" is hard to address, but the department tries to compensate for this by encouraging ACM and UPE activities and membership. Both student branches of these organizations have faculty advisors, and are currently active. Human-computer interaction, computer organization, links between technology and society (and ethics) as well as computer operating systems are all well served by popular courses that most students take.

Faculty Retreat:

The last CS faculty retreat was held in August 2007. A significant amount of the data and evaluation presented in this report was shared and discussed there. The "executive summary" is that there was:

a) significant enthusiasm for revitalizing the old "threads" effort that tracked how concepts are reinforced across curriculum;

b) very strong interest in finding ways to improve students' communication skills, partly as reflected in MQP presentations; and

c) strong interest in improving coverage of modern issues in systems-building, in adding more opportunities for top-performing students, and in reviewing and revising the social implications aspect of our curriculum.

Initial consideration of these desires mostly falls to the Education Committee to address. At this point the issue of 'threads' (interconnecting and repeating technical concepts) has been addressed for the introductory courses only, but has not yet been documented or discussed by the department.

Department meetings:

This mechanism appears to be working very well.

Education Committee meetings:

This mechanism appears to be working very well.

TA Evaluations:

This mechanism appears to be working very well.

Faculty Evaluations:

This mechanism appears to be working very well.

Annual Report:

There have been difficulties in producing the report regularly, but we hope these problems can be overcome. Production of the report is an opportunity for additional evaluation of and reflection about the state of the CS department, and therefore serves as a valuable mechanism. The next annual report is due in July 2008.

Student Reported Workload:

In the Student Evaluation of Courses form there is a place to indicate how hard the student feels that they are working on the course. The Student Reported Workload data from the 2007 forms was gathered and averaged. A graph of this data is provided in Appendix P. It is clear that CS 1101, CS 2022, CS 3043, and CS 3133 are not making the students work hard enough, while CS 4445 is probably doing the opposite. This data has been shared with the faculty, and some corrections have been applied by individual instructors (e.g., in CS 2102, CS 2303 and CS 3041).

Percentage of Students Taking Courses:

An analysis of the transcripts of the 48 CS majors from the class of 2007 is shown in the following table. The figures should be taken as approximate.

CS Course	Percentage
CS 1000	23
CS 1005	63
CS 1102	31
CS 1101	8
CS 1006	19
CS 2005	85
CS 2011	94
CS 2022/MA 2201	94
CS 2102	48
CS 2135	52
CS 2136	38
CS 2223	91
CS 2303	33
CS 3013	98
CS 3041	71
CS 3043	98
CS 3133	100
CS 3431	77

CS 3733	90
CS 4032	10
CS 4033	6
CS 4120	17
CS 4123	19
CS 4233	67
CS 4241	77
CS 4341	52
CS 4432	33
CS 4445	15
CS 4513	54
CS 4514	83
CS 4515	52
CS 4533	31
CS 4536	6
CS 4731	46
CS 4732	23
CS 502	2
CS 503	2
CS 509	10
CS 513	2
CS 521	4
CS 524	4
CS 525	2
CS 530	4
CS 536	2
CS 549	4
CS 577	2
CS 578	2

Courses taken by over 90% of the graduating class are:

- CS 2011, *Introduction to Machine Organization and Assembly Language.*
- CS 2022, *Discrete Mathematics.*
- CS 2223, *Algorithms.*
- CS 3013, *Operating Systems.*
- CS 3043, *Social Implications of Information Processing.*
- CS 3133, *Foundations of Computer Science.*
- CS 3733, *Software Engineering.*

These courses play a significant role in our outcomes. It is encouraging to see figures of 70% and higher for all the 3000-level courses. Note that there are 20 occurrences of students taking graduate courses (500). Courses at the 4000-level taken by more than 50% of students are:

- CS 4233, *Object-Oriented Analysis and Design;*
- CS 4241, *WebWare: Computational Technology for Network Information Systems;*
- CS 4341, *Introduction to Artificial Intelligence;*
- CS 4513, *Distributed Computing Systems;*
- CS 4514, *Computer Networks: Architecture and Implementation;*
- CS 4515, *Computer Architecture;*

with CS 4731, *Computer Graphics,* being close to 50%. This provides an illuminating view of the interests of our students.

IQP Review Report:

The school's IQPs are regularly sampled and reviewed for content and quality. The latest report was produced in November 2007, and can be found in Appendix G. The report evaluates the projects and their reports in terms of ABET Learning Outcomes for engineering programs, and mostly concerns Juniors.

Major findings were: that about 50% were able to analyze their data, but over 50% showed lack of ability to draw persuasive conclusions; that the average team size needs to be increased; that about two thirds do not show enough attention to ethical issues; that about 80% produced writing rated as acceptable or better; and that projects were mostly well-balanced between social and technical aspects, but fewer than expected did a good job of evaluating the impact of the technology on society. One of the difficulties that the review observed was that much of the data was qualitative, leading to difficulties with analysis. This is also a problem for departments doing ABET self assessment.

4.5.3 Changes in program educational objectives or program outcomes

There have been no changes to the Objectives or Outcomes. Some discussion about the Outcomes has been requested, and this will take place during this coming academic year.

5. Curriculum

Criterion

The program's requirements are consistent with its educational objectives and are designed in such a way that each of the program outcomes can be achieved. The curriculum combines technical and professional requirements with general education requirements and electives to prepare students for a professional career and further study in the computing discipline associated with the program, and for functioning in modern society. The technical and professional requirements include at least one year of up-to-date coverage of basic and advanced topics in the computing discipline associated with the program. In addition, the program includes mathematics appropriate to the discipline beyond the pre-calculus level. For each course in the major required of all students, its content, expected performance criteria, and place in the overall program of study are published.

For Computer Science Programs:

Students have the following amounts of course work or equivalent educational experience.

a. *Computer science: One and one-third years that includes:*
    1. *coverage of the fundamentals of algorithms, data structures, software design, concepts of programming languages and computer organization and architecture. [CS]*
    2. *an exposure to a variety of programming languages and systems. [CS]*
    3. *proficiency in at least one higher-level language. [CS]*
    4. *advanced course work that builds on the fundamental course work to provide depth. [CS]*
b. *One year of science and mathematics:*
    1. *Mathematics: At least one half year that must include discrete mathematics. The additional mathematics might consist of courses in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, geometry or symbolic logic. [CS]*
    2. *Science: A science component that develops an understanding of the scientific method and provides students with an opportunity to experience this mode of inquiry in courses for science and engineering majors that provide some exposure to laboratory work. [CS]*

Credit Hour Definition

One semester or quarter hour normally means one hour of lecture or three hours of laboratory per week. One academic year normally represents from twenty-eight to thirty weeks of classes, exclusive of final examinations. Please describe below if your definitions differ from these.

Full-time undergraduate students are expected to take three courses (or the equivalent mix of courses and projects) each term. Each of the four terms is 7 weeks long: i.e., a year is 28 weeks. A full-time load is considered to be 1 unit of work during each term. A full WPI course load is 4 units per year (i.e., 12 courses). Most courses meet four times a week for lectures, and some also

meet once a week for a lab or seminar session. WPI's standard conversion of Units to traditional credit hours is as follows: 1 course = 3 credit hours; 1 unit = 9 credit hours. Hence 1 year corresponds to 28 weeks and 36 credit hours.

5.A. Prerequisite Flow Chart

5.A.1 Attach a flow chart showing the prerequisite structure of the program's courses required or allowed towards the major.

WPI students are free to take courses in any order. A partial order of CS courses is provided to the students by the advising process, by the Recommended Background that appears in course descriptions in the catalog, and Computer Science Course Flow Chart (See p.54 of the 2008-09 Undergraduate Catalog). The flow chart is included in Appendix J of this report.

5.B. Course Requirements of Curriculum

5.B.1. Required and elective courses. In the tables on the following pages, list the courses in the order in which they are normally taken in the curriculum, classified in the appropriate categories. The data should clearly indicate how the program meets the Curriculum Category of the *Criteria for Accrediting Computing Programs.* These tables are designed for a semester calendar; they may be easily altered for a quarter calendar.

Note that WPI has no required courses. The suggested course order based on recommended background can be found in the flowchart already referred to in section 5.A.1 above. Below we provide a prototypical schedule and then the schedules of two randomly selected graduates of the class of 2007 that represent an excellent student and an average one.

A sample, prototypical course schedule looks something like this:

Year	***A term***	***B term***	***C term***	***D term***
Freshman:	MA HU CS	MA HU CS	MA HU Sci/Eng	MA HU Sci/Eng
Sophomore:	MA HU CS	MA Suff/Inquiry CS	MA SS CS	CS SS CS
Junior:	IQP CS Sci/Eng	IQP CS Sci/Eng	IQP CS Sci/Eng	EL CS CS

Senior:	MQP CS EL	MQP CS EL	MQP CS EL	CS CS EL

Notes:

EL = free elective (i.e., student's choice)
Sci/Eng = Science/Engineering
Suff/Inquiry = Sufficiency/Inquiry Seminar
SS = Social Science
HU = Humanities
CS = Computer Science
MA = Mathematics
Off campus single term IQPs or MQPs will alter this schedule.

Sample Student 1:

Year	***A term***	***B term***	***C term***	***D term***
Freshman	EN2221	CS2005	CS2135	CS2136
03-04	MA1023	MA1024	CS3013	EN2233
	PH1015	PH1121	MA2071	MA2611
Sophomore	CS2022	CS2223	CS3133	CS2011
04-05	GN1511	CS3041	CS3431	CS3733
	MA2621	GN1512	GN2511	GN2512
Junior	CS4233	CS4513	ECE2801	IQP
05-06	CS4241	GN3512	ID2050	IQP
	GN3511	SS1120	ME1800	IQP
Senior	MQP	CS4514	BB1045	CS3043
06-07	MQP	PQP	PQP	CS4515
	MQP	**	**	CS4533

Notes: GN = German
Advanced placement credit for MA1021, MA1022
IQP was in Boston
ID2050, off-campus IQP preparation, counts as an SS course.
PQP is a pre/post qualifying project.

This student graduated with High Distinction.
PE courses are not shown.
** represents slots that were either NRs or, more likely for this student, were left open deliberately to ensure that all project work could be satisfactorily completed. As projects are officially 1 unit long (three courses), PQPs are usually used to complete any remaining work.

Sample Student 2:

Year	***A term***	***B term***	***C term***	***D term***
Freshman	GN1511	CS2005	CS2135	GN2512
03-04	MA1021	GN1512	GN2511	MA1024
	PH1110	MA1022	MA1023	PH1120
Sophomore	CH1010	CS2102	CS3013	CS3041
04-05	CS2022	CS2223	MA2071	CS3733
	GN3511	GN3512	MA2621	MA2611
Junior	ECE3601	CS3431	CS3133	CS3043
05-06	SS1120	SS1110	CS4514	CS4432
	IQP	IQP	IQP	PQP
Senior	CS4233	BB1001	CS4241	ECE2022
06-07	***	CS4731	CS4732	IMGD4000
	MQP	MQP	MQP	PQP

Notes: Advanced placement credit for CS1005.
Quite by chance this student also used German for their Humanities study.
PE courses are not shown.
This schedule represents a more typical B average level student.
*** this marks a slot that probably represents a course with an NR grade.

The MQP:
The senior year project, the MQP, is a vital part of WPI's educational program, and has for many years been one of our key methods for assessing outcomes. The quality and scope of our MQPs are hard to appreciate without looking at examples—many have resulted in workshop or conference papers, and even on occasion journal articles. Consequently, we will select four sample project reports for your study. While in the past we have submitted them with this report (about 300 extra pages), this year we will be more considerate and just provide some basic

information here, making the reports themselves available during the visit. The four projects will be selected from the following that were presented in April 2008:

Neal Orman
"GPU Optimization of an Existing Free-Viewpoint Video System"
Advisor: R.W. Lindeman (CS)
Project Center: Kyoto, Japan
Sponsor: ATR International.

Katherine Levinson
"Lunar Micro Rover"
Advisor: C.E. Wills (CS)
Sponsor: NASA Ames Research Center.

Elijah Forbes-Summers and Michael Zhang
"Meta-Reasoning Diagnosis Agent"
Advisor: D.C. Brown (CS)
In cooperation with Walt Truzkowski, NASA Goddard Space Flight Center.

Niva Shrestha
"Vernal Pool Database"
Advisors: M. Mani (CS) and S.M. Selkow (CS)

Christopher Bass, James Roumeliotis, and Bart Shappee
"Scalable Multi Query Processing of GMTI Data Streams"
Advisor: E.A. Rundensteiner (CS)
Sponsor: MITRE Corporation

Kenneth Breeman and Eric Griffel
Webfoot Realtime Collaborator
Advisor: G.F. Pollice (CS)

5.B.2. Individual courses may be split between or among curriculum areas if the course content justifies the split. For example, a discrete mathematics course may have some of its semester hours under mathematics and some under computer science. In such cases, assign semester hours to categories in multiples of one-half semester hour.

See below.

5.B.3. Required courses. List courses by department/subject abbreviation (Math, Chem, IS, etc.), number, and title. Apportion the semester hours for each course by category.

Not applicable. The WPI and CS Distribution Requirements were presented at the start of this report.

5.B.4. Elective courses. Designate these courses "elective." If an elective is restricted to a particular category, then tabulate the semester hours in that category and indicate the category in the listing, e.g. "elective—science." In addition, be sure that you have supplied information elsewhere in this document indicating how you ensure that students take the course in the specified category (e.g., advisement, graduation check sheets, etc.). For free electives (i.e., those not restricted to a particular category), list the semester hours under the heading "Other". Use footnotes for any listings that require further elaboration.

The WPI and CS Distribution Requirements were presented at the start of this report. The 15 units (45 courses) of minimum academic credit are made up of the courses that satisfy those requirements plus any other WPI courses the student wishes to take.

In direct response to the Criterion, we address each aspect in turn. First, a reminder that 1 course = 3 credit hours, 1 unit = 9 credit hours, and 1 year corresponds to 36 credit hours. Note once again that WPI has no required courses, but uses distribution requirements at both the school and program levels, as well as a strong advising system.

a. One and one-third years of Computer Science.

The CS program's distribution requirements require 6 units of CS study, including the MQP. This corresponds to 54 credit hours. As one and one-third years corresponds to 48 credit hours, the amount of CS required by the WPI CS program exceeds this part of the Criterion.

a.1. Coverage of the fundamentals of algorithms, data structures, software design, concepts of programming languages and computer organization and architecture.

The CS program's distribution requirements require at least one course from each of the following areas: Systems; Theory & Languages; Design; and Social Implications of Computing. The courses that can be used to satisfy these areas are all at the 3000 or 4000 level. In addition at least five advanced courses (at the 4000 level) are required. All these courses have recommended background (i.e., 1000-, 2000- and 3000-level courses). Finally, students are advised that the core courses are all of the 1000, 2000 and 3000 courses. All these together allow students to gain the coverage of the topics mentioned above. The MQP also contributes to coverage of these areas. Hence the WPI CS program meets this part of the Criterion.

a.2. An exposure to a variety of programming languages and systems.

The CS program's distribution requirements require at least one course from each of the following areas: Systems; Theory & Languages; Design; and Social Implications of Computing. The courses that can be used to satisfy these areas are all at the 3000 or 4000 level. In addition at least five advanced courses (at the 4000 level) are required. All these courses have recommended background (i.e., 1000-, 2000- and 3000-level courses). Finally, students are advised that the core courses are all of the 1000, 2000 and 3000 courses. All these together allow students to gain the coverage of the topics mentioned above. Graduating students have typically used Assembly Language, Scheme, Java and C/C++, while others have also used Visual Basic.NET, LISP, and various WWW and scripting languages. Hence the WPI CS program meets this part of the Criterion.

a.3. Proficiency in at least one higher-level language.
The CS program's distribution requirements require one course from the Systems area, of which the lowest level course is CS 3013. The recommended background for majors is CS 2303 and CS 2011. CS 2303 is taught in C++ and C. CS 3013 has programming assignments in C. Other course sequences focus on Java. For example, CS 3733, Software Engineering, is taught in Java, with CS 2102 as its recommended background. CS Majors also tend to select one of those languages for the implementation in their MQP. Hence the WPI CS program meets this part of the Criterion.

a.4. Advanced course work that builds on the fundamental course work to provide depth.
The CS program's distribution requirements require at least five courses at the 4000 level. These are advanced courses. Hence the WPI CS program meets this part of the Criterion.

b. One year of science and mathematics.
The CS program's distribution requirements require seven courses in Mathematics, and five courses in Basic Science and/or Engineering Science. The total of 12 courses is equivalent to 36 credit hours, which is equivalent to one year. Hence the WPI CS program meets this part of the Criterion.

b.1. Mathematics: At least one half year that must include discrete mathematics. The additional mathematics might consist of courses in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, geometry or symbolic logic.
The CS program's distribution requirements require seven courses in Mathematics. That is a total of 21 credit hours, which is more than the 18 credit hours that corresponds to half a year. At least one of those seven courses must be a Statistics course, and at least one other must be a Probability course. Students are advised to take the four-course sequence of Calculus courses. The students are also advised that the core CS courses are all of the 1000, 2000 and 3000 courses. This includes CS 2022, Discrete Mathematics. In addition, the lowest level course in the Theory and Languages distribution requirements area is CS 3133, Foundations of Computer Science. The recommended background for that course includes CS 2022, Discrete Mathematics. Hence the WPI CS program meets this part of the Criterion.

b.2. Science: A science component that develops an understanding of the scientific method and provides students with an opportunity to experience this mode of inquiry in courses for science and engineering majors that provide some exposure to laboratory work.

The CS program's distribution requirements require five courses in Basic Science and/or Engineering Science. Courses satisfying the science requirement must come from the BB, BME, CE, CH, CHE, ECE, ES, GE, ME, PH disciplines. At least three courses must come from the laboratory sciences, BB, CH, GE, PH, and at least two courses are from one of these disciplines, ensuring some depth in at least one of these sciences. Hence the WPI CS program meets this part of the Criterion.

5.B.5 Explain how the curriculum addresses the program outcomes. Include a table showing how each course contributes to the program outcomes.

Every CS course contributes to one or more Outcomes. An estimate of the course to Outcomes mapping is provided in the table below. The mapping for each course was provided by course instructors.

Course	Outcomes																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1101	1	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	19	.	21
1102	1	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	19	.	21
2011	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21
2022	.	.	.	.	5	.	.	.	.	10	11	.	.	.	.	.	.	.	.	.	21
2102	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19	.	.
(2118																					)**
2223	.	.	3	.	5	.	.	.	.	10	11	.	13	.	.	.	.	.	.	.	.
2301	1	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21
2303	1	.	3	.	.	6	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.
3013	.	.	.	4	.	6	.	8	9	.	.	.	.	14	.	.	.	.	19	.	.
3041	.	.	.	.	.	6	7	.	.	.	11	12	13	14	15	16	17	.	19	20	21
3043	.	.	.	.	.	.	.	.	.	.	.	.	.	14	15	16	17	.	19	20	21
3133	1	.	3	.	5	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.
3431	.	.	.	.	.	.	.	8	.	.	.	.	.	14	.	.	.	.	19	.	21
3733	1	.	.	.	.	6	.	8	.	.	.	.	.	.	.	.	.	.	19	.	.
4032	.	.	3	.	.	.	.	.	9	.	.	12	.	14	.	.	.	.	.	.	21
4033	.	.	3	.	.	.	.	.	9	.	.	12	.	14	.	.	.	.	19	.	21
4120	.	.	3	.	5	.	.	.	9	10	11	.	13	.	15	.	.	.	.	.	21
4123	.	.	3	.	5	.	.	.	9	10	.	.	.	.	.	.	.	.	.	.	21
4233	1	.	.	.	.	6	.	8	.	.	.	.	.	14	15	16	.	.	19	20	21
4241	1	.	.	.	.	6	7	8	9	.	.	.	.	14	15	16	.	.	19	20	21
4341	.	.	3	.	.	.	.	8	9	10	.	.	13	14	15	.	.	.	.	.	21
4432	.	.	.	4	.	6	.	8	9	10	.	.	.	14	15	.	.	.	.	20	21
4445	1	.	3	.	.	.	.	.	9	.	11	12	13	14	.	16	17	.	.	20	21
4513	.	.	.	4	.	6	.	8	9	.	.	.	13	14	.	.	.	.	19	.	.
4514	.	.	.	4	.	6	.	8	9	.	11	12	13	14	15	.	.	.	19	20	.
4515	.	2	.	.	.	.	.	8	.	.	.	.	.	14	15	.	.	.	19	.	21
4533	1	2	.	.	5	6	.	8	9	.	.	.	.	.	.	.	.	.	.	.	.
4536	1	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21
4731	.	.	.	.	.	6	.	.	9	10	.	.	.	14	.	.	.	.	.	.	.
4732	.	.	.	.	.	6	.	8	9	10	.	12	.	14	.	.	.	.	19	.	21
Total=	13	3	9	4	6	16	2	13	14	9	6	6	7	16	9	5	3	0	15	7	20

** CS Majors cannot count this course for CS credit.

For computer science programs

The following areas must be stressed within the program's curriculum. Indicate the course numbers and titles of courses embodying a *significant portion* of these areas:

Area	Courses
Algorithms	*CS 2223. Algorithms.* *CS 4120. Analysis of Algorithms.* *CS 4123. Theory of Computation.*
Data structures	*CS 1101. Introduction to Program Design. (and CS 1102)* *CS 2102. Object-Oriented Design Concepts.* *CS 2223. Algorithms.* *CS 2303. Systems Programming Concepts.* *CS 3431. Database Systems I.* *CS 4432. Database Systems II.*
Software design	*CS 1101. Introduction to Program Design. (and CS 1102)* *CS 2102. Object-Oriented Design Concepts.* *CS 2303. Systems Programming Concepts.* *CS 3013. Operating Systems.* *CS 3733. Software Engineering.* *CS 4233. Object-Oriented Analysis and Design.*
Programming language concepts	*CS 1101. Introduction to Program Design. (and CS 1102)* *CS 2102. Object-Oriented Design Concepts.* *CS 2303. Systems Programming Concepts.* *CS 3133. Foundations of Computer Science.* *CS 4533. Techniques of Programming Language Translation.* *CS 4536. Programming Languages.*
Computer organization and architecture	*CS 2011. Introduction to Machine Organization and Assembly Language.* *CS 2303. Systems Programming Concepts.* *CS 3013. Operating Systems.* *CS 4515. Computer Architecture.*
Exposure to variety of languages and systems	*CS 1101. Introduction to Program Design. (and CS 1102)* *CS 2011. Introduction to Machine Organization and Assembly Language.* *CS 2102. Object-Oriented Design Concepts.* *CS 2303. Systems Programming Concepts.* *CS 3013. Operating Systems.* *CS 3041. Human-Computer Interaction.* *CS 4241. WebWare: Computational Technology for Network Information Systems.*
Proficiency in at least one higher level language	*CS 1101. Introduction to Program Design. (and CS 1102)* *CS 2102. Object-Oriented Design Concepts.* *CS 2303. Systems Programming Concepts.*

Advanced course work that builds on the fundamental course work to provide depth	*All 4000-level CS courses.* *Note that the MQP can contribute to this area as well as any of the others.*
Discrete mathematics	*CS 2022/MA 2201. Discrete Mathematics.* *CS 2223. Algorithms.* *CS 3133. Foundations of Computer Science.* *CS 4120. Analysis of Algorithms.* *CS 4123. Theory of Computation.*
Science component	*All Science and Engineering courses, as specified in the CS program's degree requirements.*

5.C. Course Descriptions

For each required or elective course in the program that can be counted in the curriculum being reviewed for accreditation, include a two-page or three-page course outline, as indicated below, at this point in the Self-Study Report. If your documentation does not exactly follow this format, be sure that all of the requested information (if applicable) is present, and please in any case adhere to a common format for all course descriptions. If some of this documentation is on-line (e. g., in an instructor's web site), please give here the URLs for accessing any such materials. These URLs should be made accessible to the visiting team as soon as the Self-Study is sent to them.

The collected course descriptions for the following courses can be found in Appendix A. Note that course web sites are available via <www.cs.wpi.edu/Undergraduate/coursepages.html>.

CS 1101. INTRODUCTION TO PROGRAM DESIGN.
CS 1102. ACCELERATED INTRODUCTION TO PROGRAM DESIGN.

CS 2011. INTRODUCTION TO MACHINE ORGANIZATION AND ASSEMBLY LANGUAGE.
CS 2022. DISCRETE MATHEMATICS.
CS 2102. OBJECT-ORIENTED DESIGN CONCEPTS.
CS 2118. OBJECT-ORIENTED DESIGN CONCEPTS FOR BUSINESS APPLICATIONS.
CS 2223. ALGORITHMS.
CS 2301. SYSTEMS PROGRAMMING FOR NON-MAJORS.
CS 2303. SYSTEMS PROGRAMMING CONCEPTS.

CS 3013. OPERATING SYSTEMS.
CS 3041. HUMAN-COMPUTER INTERACTION.
CS 3043. SOCIAL IMPLICATIONS OF INFORMATION PROCESSING.
CS 3133. FOUNDATIONS OF COMPUTER SCIENCE.
CS 3431. DATABASE SYSTEMS I.
CS 3733. SOFTWARE ENGINEERING.

CS 4032. NUMERICAL METHODS FOR LINEAR AND NONLINEAR SYSTEMS.
CS 4033. NUMERICAL METHODS FOR CALCULUS AND DIFFERENTIAL EQUATIONS.
CS 4120. ANALYSIS OF ALGORITHMS.
CS 4123. THEORY OF COMPUTATION.
CS 4233. OBJECT-ORIENTED ANALYSIS AND DESIGN.
CS 4241. WEBWARE
CS 4341. INTRODUCTION TO ARTIFICIAL INTELLIGENCE.
CS 4432. DATABASE SYSTEMS II.
CS 4445. DATA MINING AND KNOWLEDGE DISCOVERY IN DATABASES.
CS 4513. DISTRIBUTED COMPUTING SYSTEMS.
CS 4514. COMPUTER NETWORKS: ARCHITECTURE AND IMPLEMENTATION.
CS 4515. COMPUTER ARCHITECTURE.
CS 4533. TECHNIQUES OF PROGRAMMING LANGUAGE TRANSLATION.
CS 4536. PROGRAMMING LANGUAGES.
CS 4731. COMPUTER GRAPHICS.
CS 4732. COMPUTER ANIMATION.

6. Faculty

Criterion Part A: Faculty Qualifications

Faculty members teaching in the program are current and active in the associated computing discipline. They each have the educational background or expertise consistent with their expected contributions to the program. Each has a level of competence that normally would be obtained through graduate work in the discipline, relevant experience, or relevant scholarship. Collectively, they have the technical breadth and depth necessary to support the program

For Computer Science Programs:
Some full time faculty members have a Ph.D. in computer science.

Criterion Part B: Faculty Size and Workload

There are enough full time faculty members to provide continuity, oversight and stability, to cover the curriculum reasonably, and to allow an appropriate mix of teaching, professional development, scholarly activities and service for each faculty member. The faculty assigned to the program has appropriate authority for the creation, delivery, evaluation and modification of the program, and the responsibility for the consistency and quality of its courses.

6.A. Faculty Profile

1. Please complete the following table for each faculty member who regularly teaches courses in the program.

Note: Faculty based in Computer Science, but whose principal teaching duties are in the Interactive Media and Game Development program, are indicated by "(IMGD)" after their name.

Faculty Name	*Rank*	*FT/PT*	*Degree*	*Research Areas*	*# Adv.*
Emmanuel Agu	Associate	FT	PhD/CS	Computer Graphics; Mobile Computing.	14
David Brown	Professor	FT	PhD/CS	AI in Design.	20
Michael Ciaraldi	Prof. of Practice	FT	MS/CS	Software Engineering; networking.	19
Mark Claypool (IMGD)	Associate	FT	PhD/CS	Distributed systems; networking; multimedia.	2 *[1]
Daniel Dougherty	Professor	FT	PhD/CS	Programming languages; Logic.	13

David Finkel (IMGD)	Professor	FT	PhD/MA	Computer system performance evaluation.	18 *[2]
Kathi Fisler	Associate	FT	PhD/CS	Formal verification of hardware and software systems.	9
Michael Gennert	Associate	FT	ScD/CS	Image processing & understanding; theoretical computer science.	4
Glynis Hamel	Instructor	FT	MS/CS	Computer organization; data structures.	0
Neil Heffernan	Associate	FT	PhD/CS	Intelligent tutoring systems.	12
George Heineman	Associate	FT	PhD/CS	Adaptation of software components; component-based systems.	35
Micha Hofri	Prof	FT	DSc/CS	Analysis of algorithms	8
Robert Kinicki	Prof	FT	PhD/CS	Computer networking performance; wireless networks.	9
Hugh Lauer	Adjunct Instructor	PT	PhD/CS	Real-Time Visualization	0
Jeff LeBlanc	Adjunct Instructor	PT	MS/CS	Human Computer Interaction.	0
Karen Lemone	Associate	FT	PhD/CS	Electronic documents	7
Robert Lindeman (IMGD)	Assistant	FT	ScD/CS	Virtual Reality; Computer Graphics.	0 *[3]
Murali Mani	Assistant	FT	PhD/CS	Databases & XML technologies.	19
Lisa O'Connor	Adjunct Instructor	PT	MM/Mgt	Instructional Design; Multimedia.	0
Gary Pollice	Prof. of Practice	FT	MS/CS	Software Engineering.	16
Keith Pray	Adjunct Instructor	PT	MS/CS	Data mining.	0
Charles Rich (IMGD)	Professor	FT	PhD/CS	Intelligent user interfaces; human-robot interaction.	0 *[4]
Carolina Ruiz	Associate	FT	PhD/CS	Knowledge discovery & data mining.	13

Elke Rundensteiner	Professor	FT	PhD/CS	Database & information systems.	22
Gabor Sarkozy	Affiliated Associate Professor	PT	PhD/CS	Combinatorics; graph theory.	0
Stanley Selkow	Professor	FT	PhD/MA	Graph Theory; combinatorics.	9
Matthew Ward	Professor	FT	PhD/CS	Data & information visualization.	1 *[5]
Craig Wills	Associate	FT	PhD/CS	User interfaces; distributed systems.	13

Notes:

*1 Prof. Claypool is currently (AY 07-08) on sabbatical leave.

*2 Prof. Finkel has a complicated mix of CS and IMGD advisees. Included here are CS single or double majors.

*3 Prof. Lindeman only advises IMGD students.

*4 Prof. Rich only advises IMGD students.

*5 Prof. Ward is currently (AY 07-08) on sabbatical leave.

6.B. Information Regarding Faculty Members

On separate pages, please furnish the following information for all faculty members who teach courses allowed for the major, including those who have administrative positions in the department (chair, associate chair, etc.). Use the form given below as guidance. This form need not be followed exactly, but all requested information should be supplied. Use a common format for all faculty members. Limit information to no more than three pages per person, providing only the most recent information if needed to limit space. Place the form(s) for administrators first, followed by the others in alphabetical order.

The collected faculty profiles for the following individuals can be found in Appendix B.

Michael Gennert (Head)
David Finkel (Associate Head)
Emmanuel Agu
David Brown
Michael Ciaraldi
Mark Claypool
Dan Dougherty
Kathi Fisler
Glynis Hamel

Neil Heffernan
George Heineman
Micha Hofri
Robert Kinicki
Hugh Lauer
Karen Lemone
Robert Lindeman
Murali Mani
Lisa O'Connor
Gary Pollice
Keith Pray
Carolina Ruiz
Elke Rundensteiner
Gabor Sarkozy
Stanley Selkow
Matthew Ward
Craig Wills

6.C. Faculty Size

The purpose of this section is to determine whether you have a sufficient number of faculty members to provide overall continuity and stability for the program. The Faculty Profile table in 6.A relates to this concept.

Explain (if applicable) any difficulties you have offering required or optional courses frequently enough, particularly as they might be affected by faculty size.

The CS department's courses are certainly offered often enough for students to complete the program in a timely manner, although the class sizes are often larger than the faculty would like. Part-time instructors and adjuncts are used to supplement the full-time faculty. For example, in AY 07-08 there were 41 offerings of our courses with 5 taught by Adjunct Instructors. Some courses that are jointly listed with the Mathematics department are often taught by their faculty.

6.D. Faculty Workload

Describe the means for ensuring that all full-time faculty members have sufficient time for professional development and scholarly activities. For those faculty members having significant extra duties (e.g., large number of advisees, manage or maintain computing resources, director of undergraduate or graduate programs, etc.), explain how these components of the faculty workload are recognized.

The WPI CS Department expects the following "average" full-time tenure-track teaching load to be carried by faculty:

- Three courses, normally a mix of undergraduate and graduate per year;
- Up to 10 project or thesis students per year;
- Up to 30 undergraduate academic advisees;

- Miscellaneous service contributions to faculty governance and department committees and to institute development.

Recognizing that tenure-track faculty distribute their efforts between teaching and scholarship in different ways, the CS department uses a flexible course load system. “Teaching-centric” faculty members (3 individuals) teach 4 courses per year, and “research-centric” faculty members teach 2 courses per year. Most faculty members (16 individuals) are considered “balanced” and teach 3 courses per year.

WPI maintains a listing of the teaching, project advising, program advising and other responsibilities for each individual faculty member conducted during the course of the academic year. This information can be made available to the ABET visiting team at the time of the visit on request.

The course load of 3 classes in 4 terms, depending on how they are distributed, may allow for one term without any courses or at least some terms with lower load than others. This allows for more concentrated research periods. In addition, there are no undergraduate classes on Wednesdays, although students may be in laboratories led by Teaching Assistants. Having Wednesdays free of classes also allows some time to concentrate on research. In addition, there are no summer classes as a part of the normal faculty load.

6.E. Program Development and Delivery

Describe the roles of the program’s faculty and other offices on the campus in creating, evaluating and modifying the program.

The faculty of the CS department has the primary responsibility for creating, evaluating and modifying the program. New courses, changes to the regulations, and all proposals relating to the undergraduate program are discussed at CS faculty meetings, often after preliminary examination and discussion by the Education committee. Once approved by the department, the proposed change is sent to the WPI Committee on Academic Operations for review, to ensure that it meets all WPI regulations and that all potential side-effects are considered. Changes in Distribution Requirements need to be approved by a vote of the WPI Faculty. Sometimes changes are suggested or co-developed with other departments, especially if it involves a course likely to be taken by non-majors, or if it falls into areas of mutual interest (such as Networks with ECE).

6.F. Course Oversight

Full-time faculty members have the responsibility for the consistency and quality of major courses. That means they must either teach all sections of a course or be responsible for coordinating the instruction of sections not taught by full-time faculty members. Describe how this oversight and coordination is performed.

This process is currently under review by the department’s Education Committee. The last departmental retreat raised the issue of maintaining consistency across course offerings while allowing some variation (as expected by academic freedom), especially to take advantage of

particular faculty expertise. Twice in the past the department has done a concept by concept evaluation of the material in our undergraduate courses, in particular to ensure that important concepts (threads) are introduced early and reinforced later, and also to make sure that our Recommended Background dependencies are correct. The sense of the department is that it is now time for another similar study. The overall concern does not just apply to sections taught by part-time faculty members, although that issue is clearly important.

Faculty members who share a common course routinely share course material, and, as every course is expected to have web pages, that too is a key method for ensuring consistency across courses. During the two years before accreditation visits official course coordinators are appointed to help produce the course description and help monitor the collection of student material. In other years this only exists in an informal fashion, with certain faculty member being recognized as the “keeper” of particular courses—usually due to having taught them most of the time.

7. Facilities

Criterion

Institutional facilities including the library, other electronic information retrieval systems, computer networks, classrooms, and offices are adequate to support the educational objectives and outcomes of the program.

Computing resources are available, accessible, systematically maintained and upgraded, and otherwise adequately supported to enable students to achieve the program's outcomes and to support faculty teaching needs and scholarly activities. Students and faculty receive appropriate guidance regarding the computing resources and laboratories available to the program.

7.A. Library Staffing

Assess the staffing of the library (or libraries) that serves the program, including both size and qualifications.

WPI's Gordon Library continues to be the prime resource for research, scholarship, teaching and learning, but with an increasing focus on the electronic environment. However, it will continue to purchase and provide access to print in the foreseeable future. This facility is becoming a hub for information retrieval and expert assistance in using technology to locate and evaluate all forms of knowledge, as well as a center for the creation of multimedia information.

The library has 18 full-time staff, and 5 part-time staff, providing service for over 225,000 building visits per year, and almost 4 million home page accesses per year. The staffing of the library seems entirely adequate. When students complain about issues that need improvement, the library is never one of them. The library staff is helpful and knowledgeable.

7.B. Library Technical Collection

Assess the adequacy of the library's technical collection relative to the needs of the program and the faculty. Describe and assess the adequacy of the process by which faculty may request the library to order books or subscriptions.

The library is entirely adequate for the undergraduate program.

In the last several years the library has added a large number of electronic resources, notably the entire Digital Libraries of the ACM and the IEEE, as well as collections of journals from several publishers and other professional societies, plus indices and citation services. There are 41,515+ Web-based full text e-journals, 40,000+ Web-based full text e-books, 150+ Web-based electronic databases, and 570+ Electronic Theses & Dissertations.

Requests from CS faculty for purchasing books and subscribing to journals are funneled through the faculty member that serves as the department's Library Liaison, and we find the response times, and the budget, adequate.

In addition, one of the conference rooms in Fuller Labs is called the CS Library. It has several journals and trade magazines that the CS Department subscribes to on display. Examples include: PC Magazine, Linux World, Dr. Dobb's Journal, Wired, Information Week and several general publications, such as Scientific American, New Scientist, Chronicle of Higher Education and Issues in Science and Technology. It also houses a complete collection of CS theses and dissertations up to the point that their submission became electronic.

7.C. Library Electronic Access

Assess the library's systems for locating and obtaining electronic information.

The electronic information access systems are completely adequate.

7.D. Classroom Equipment

Describe the equipment typically available in classrooms where you teach your courses. Assess its adequacy for the purpose.

The rooms we use for instruction typically have an overhead projector, a VCR, a DVD player, a PC with internet access, and one or two ceiling installed video projectors that can be used to display from any source. Some rooms also have a video-based overhead projector. This meets the faculty needs. Other resources, such as per-student internet connection, microphones, web-cams, voting systems, and specialized software, are also available from the WPI Academic Technology Center <www.wpi.edu/Academics/ATC/>.

7.E. Faculty Offices

Discuss and assess the adequacy of faculty offices.

All full-time faculty members have personal offices, though several lack windows, and are considered non-faculty grade for that reason. We are currently working on moving faculty to other offices, and are involved in planning to re-allocate space in Fuller Labs in order to address this issue. Current faculty offices are typically 150 square-ft in size, with standard furniture and equipment, including an internet drop. The faculty appear to be satisfied with their offices. Since the offices are not convenient for meeting with more than two or three students, several small conference rooms exist for meeting somewhat larger groups, for projects, grading sessions, etc.

7.F. Computing Facilities

7.F.1 Describe the computing hardware, software and networks used for instruction. Specify any limitations that impact the quality of the educational experience.

Institutional and college computing facilities:

The Computing and Communications Center (CCC, previously referred to as the College Computer Center) provides campus-wide IT support and facilities and is described elsewhere in this document.

Undergraduate courses use PC Labs which are supported by the CCC. There are presently 13 PC labs (providing more than 300 machines) available for student use on campus, all of which are available from 7AM to midnight during the academic year. Some of these labs are available 24 x 7 with entry by card-reader and student-ID.

All academic buildings, and dorms are wired for high speed network access, and most interior locations are covered by secure wireless network access.

Undergraduate students use these facilities (as well as using their own computer hardware) for the majority of their coursework, but it is not uncommon for the department to provide departmental computer access or even a custom built system, should a special undergraduate need present itself.

Departmental computing facilities:

As previously noted most undergraduate computer work happens in the plentiful CCC labs. Facilities provided by the department serve the full spectrum of work done by the faculty, staff, and students of WPI Computer Science—email, software development, collaboration.

In summary, the key features of the department's computing services are: Centralized, integrated file service to Unix, Windows and Mac clients; Nightly backups with off-site monthly archiving; Departmental email backed up hourly; New 16-processor 64-bit high-performance research computing server; Faculty, staff, and TA desktop PCs are on a 3-year replacement cycle; Gigabit Ethernet to all servers, with redundant fiber-optic uplinks; Automated environmental and security monitoring of server room; Redundant power and backup cooling systems in server room; Upgraded mains power to server room to meet future needs.

The department does have a specialized lab for instruction in Operating Systems and networking, the FOSSIL lab, upgraded with all new computer hardware during the summer of 2007. This lab consists of 30 Linux workstations and a central fileserver used for hands-on operating systems experimentation and instruction. Fuller Labs is wired for gigabit or fast-Ethernet depending on need, and has 11 Wireless Access points, for very good wireless coverage.

The department also provides a 16-core Opteron server (32Gb memory, 6Tb of local storage) built specifically for the hosting of Virtual Machines for student and faculty projects and allowing small projects to be assembled quickly without the delays associated with a purchase.

All Faculty, Staff and Grad students have a desktop PC which allows access to the departmental infrastructure. All major software is available through departmental and/or campus-wide licensing agreements and money is allocated towards software purchasing should a special research or instructional need arise.

File storage is provided by a Linux fileserver built specifically for the purpose and providing adequate capacity. The storage capacity is being expanded this summer (2008). Every user has access to safe fileserver storage (see below) from their UNIX account and/or from their desktop PC.

Other computing facilities:

Other than those mentioned above, there is nothing specific other than the hardware and software used on an everyday basis by students, faculty and staff. Hardware and software is updated frequently, and both hardware and software budgets exist should some limitation present itself.

Individual research labs frequently contain special equipment for use by MQP teams as well.

7.F.2. Describe the laboratory equipment planning, acquisition, and maintenance processes and their adequacy. Include discussion of these topics for university-wide computing resources available to all students (if used by your majors), your own laboratories and equipment (if applicable), and computing resources controlled by other departments and/or schools (if used by your majors). Discuss the adequacy and effectiveness of these processes and how they are assessed. Please attach documentation (e.g., inventories, equipment replacement plans, etc.) to this report.

The only specialized laboratory equipment used by our students are computers. Large computer labs, their network and power are maintained by CCC and WPI's Facilities department. Lab computers are replaced on a regular 3 year basis.

The department's replacement policy on Graduate Student computers is a three-year cycle, although the rate of speed increase in PC hardware has decreased and we may shift to a four year cycle to prevent unnecessary replacement of still-functional machines.

Faculty and Staff machines are provided by the CCC on a three year replacement basis. If a special need is demonstrated, CCC is responsive.

Other than this, there is no algorithm for replacement of departmental software and hardware; it is done on an as-needed basis with the support and direction of the department's Facilities Committee. Hardware and software support is provided by a system-staff of two, who design systems and procedures and advise faculty in technical matters.

Maintenance and backup of departmental computing hardware is done by the Computer Science system staff. Email and user files on our fileserver, on many dedicated research group machines, and on certain faculty PCs, and are backed up on a nightly basis for safe keeping.

7.F.3. What support personnel are available to install, maintain, and manage departmental/college hardware, software, and networks used for instruction in the program? Describe the adequacy and limitations of the level of support. Include discussions at the university, college and departmental levels as appropriate.

CCC has a large staff of personnel to maintain the large computer labs on campus. The WPI CS system staff does the bulk of installation, maintenance, and management of departmental computer hardware and software. CCC provides us with networking and other essential infrastructure. This level of WPI CS and CCC support is very good.

7.G. Student Access

State the hours the various facilities are open. State whether students have access from dormitories or off campus by direct access, modem, etc., and describe this access quantitatively.

CCC labs are available for the most part from 7am to midnight during the academic year, with some labs open 24 hours. Almost all late-night computing happens from networked student dorm rooms now, explaining the lack of universal 24 x 7 lab operation. Dormitories and fraternity/sorority houses are all wired for high-speed internet access.

Staff, Grad Students, and Faculty have 24 x 7 access to departmental computing facilities, via keys to the building and to their offices, or via remote access. Teaching and Research Assistants, and other funded Graduate Students have offices and dedicated machines, and have access to printers, and all the hardware a normal office would provide.

All WPI CS systems are directly accessible 24 hours a day via Secure Shell (SSH) from the global internet, with students and faculty regularly connecting from other continents to read mail or do work.

Users in locations without SSH access, or where such access is restricted, may still reach email via a secure web-mail interface. Remote file access can be done via WPI's Virtual Private Network (VPN), although over large distances network speed reduces the practicality of this. Remote access to Windows PCs is also possible via Remote Desktop, but as with file access, the practicality of this over inter-continental distances is questionable.

7.H. Faculty Access

Describe the computing facilities available to faculty for class preparation and for scholarly activities and research. Include specifics regarding resources in faculty offices.

Faculty access to Campus and Departmental resources is at least as good as that described above for students. Every faculty member has a dedicated workstation in their office (typically a PC, but some prefer laptop computers, Macintoshes or other types of Workstations) running an operating system of the faculty members' choice.

There are also several research laboratories with specialized equipment for use by faculty and research groups.

The CS department’s system staff, the Computing and Communications Center (CCC) staff, and the Academic Technology Center (ATC) staff are all available to help faculty realize their potential and by helping them, help our students.

8. Support

Criterion

The institution's support for the program and the financial resources available to the program are sufficient to attract and retain qualified faculty, administer the program effectively, acquire and maintain computing resources and laboratories, and otherwise provide an environment in which the program can achieve its educational objectives and outcomes. Support and resources are sufficient to provide assurance that the program will retain its strength throughout the period of accreditation.

8.A. Faculty Stability

8.A.1 Evidence of the long-term continuity and stability of a program is provided by its ability to both attract and retain high quality faculty. Describe how your program attracts and retains high quality faculty. Some topics the description might address are sabbatical and other leave programs, salaries, benefits, teaching loads, support for and recognition of scholarly activity (including financial support for attendance at professional meetings), departmental and institutional ambiance, etc.

Attracting Faculty:

The CS department takes recruiting seriously and makes every effort to hire faculty who can meet our high expectations in both teaching and scholarship. We start by advertising in select venues, including Computing Research News, Communications of the ACM, IEEE publications as appropriate, and our website. Our ads emphasize our unique programs and collegial atmosphere. Faculty candidates are made to feel at home during their campus visits, which includes opportunities to meet with most CS faculty members, key administrators, and both undergraduate and graduate students. We emphasize several points to candidates: high yet balanced expectations for teaching and scholarship, faculty collegiality, student quality, close student-faculty interaction, the uniqueness of the WPI Plan and our commitment to project-based learning, increasing research funding, and an excellent quality of life. Faculty salaries and start-up packages are competitive with all but the most elite universities. The CS department has been very successful in recruiting and usually hires its first or second choice.

Retaining faculty:

Teaching assignments support faculty development. Most faculty members teach three courses per year. Newly hired faculty members teach two courses in the first year, one of which is often a graduate seminar. We avoid assigning courses to new faculty in the first term to allow them time to adjust to WPI. For all faculty members, course assignments are carried out as equitably as possible, with special consideration given to junior faculty. Junior faculty members are often given highly desirable courses, such as advanced graduate and special topics courses.

Newly hired faculty members are offered the opportunity to be assigned a mentor by the university (usually in another department), and also an in-department mentor.

There is much help available for developing faculty scholarship. New faculty start-up packages generally include RA and faculty summer support for up to two years plus funds for equipment. The Office of Research Administration runs workshops on grant-writing and the proposal process. The CS department encourages proposal preparation and provides feedback during proposal development. Travel funds are available to visit funding agencies. The faculty is highly collaborative; research teams form within and across departments as appropriate.

Untenured faculty members are reviewed yearly by the departmental Tenure Committee and are given a formal letter of evaluation, including suggestions and advice. The tenure process itself is well-defined and transparent. Tenure candidates are reviewed during their sixth year at WPI by a Joint Tenure Committee comprising members of the at-large Committee on Tenure and Academic Freedom and the departmental Tenure Committee. Joint Tenure Committee recommendations are acted on by the Provost, President, and Board of Trustees. Approximately 85-90% of faculty members who undergo Joint Tenure Committee review receive tenure.

WPI encourages faculty to take sabbatical leaves. Faculty members become eligible for sabbatical leave every seven years. Sabbaticals may be either for a half-year at full salary or a full year at half salary, which can be supplemented from external sources.

Faculty members are encouraged to attend professional conferences, workshops, and developmental activities. Support for travel includes sponsored research funds, professional development funds, department funds, and the Provost's Office. The CS department is highly supportive of faculty travel needs, including non-tenure track faculty.

Many faculty members are deeply engaged in off-campus Project Center advising and enjoy the intellectual stimulation and experience afforded by these activities. The CS department is highly supportive of faculty undertaking off-campus advising and treats such assignments as equivalent to a course, so that faculty members are not overly burdened for undertaking Project Center work.

Ambiance:

The CS department maintains a highly collegial atmosphere through many activities:

- Department meetings, held 12 times per year, which which all full-time and select part-time faculty participate,
- Weekly Computer Science Colloquia, usually with outside speakers,
- Regular research group meetings,
- ACM Fall and Spring BBQs,
- Winter Holiday Social,
- ACM Coffee House,
- Pizza and Bowling with faculty, staff, and graduate students,
- CS Faculty Retreats,
- Other events scheduled on an ad hoc basis.

WPI engages in many activities to provide a collegial atmosphere:

- Monthly faculty meetings, at which all tenure-track faculty members have voting privileges and many non-faculty staff participate,
- Town Hall meetings, at which senior administrators and staff engage in dialog with the WPI community, sometimes on particular issues, other times on a range of topics,
- Events for all employees, including a Winter Holiday Luncheon and Fall Picnic,
- Organized social events, such as trips to ball games, beaches, etc., and

A range of workshops and training opportunities are open to all employees.

8.A.2 Give counts of the total number of full-time faculty and the number of resignations, retirements, and new hires for each of the last five years. Indicate whether there are significant problems attracting and retaining faculty, and if so, the causes.

Year	Total Faculty	Resignations	Non-renewals	Retirements	New Hires
2003-2004	21				Murali Mani; Gary Pollice.
2004-2005	21				
2005-2006	22				Robert Lindeman.
2006-2007	22				
2007-2008	23				Charles Rich.

8.B. Faculty Professional Activities

Summarize the support mechanisms for professional activities of your faculty, such as attendance at meetings, research, etc. Highlight important faculty accomplishments that have resulted from this support.

Faculty members are encouraged to attend professional conferences, workshops, and developmental activities. Support for travel includes sponsored research funds, professional development funds, department funds, and the Provost's Office funds. The CS department is highly supportive of faculty travel needs, including non-tenure track faculty.

Faculty members are also encouraged to host workshops and seminars on campus as a means of increasing their professional visibility. The CS Department provides funds for such events when there is no external support available. We also provide office staff, lab staff and work-study student support as needed. Recently, we hosted the New England Programming Languages and Systems Symposium (October 2007), the WPI Robotics Symposium: "Engineering the Revolution" (October 2007) and are preparing to host an ACM Workshop on Network and Systems Support for Games (NetGames) in October 2008.

8.C. Administration Effectiveness

Describe the effectiveness of the administration of the program.

The program appears to be effectively administered. The program is managed by a Department Head, supported by an Associate Department Head. Both receive course releases for administrative duties.

Department Head duties include:

- Recruit faculty,
- Tenure and promotion of faculty,
- Interviewing and hiring adjunct faculty,
- Review faculty teaching effectiveness,
- Nominate, and in some cases, decide, student awards,
- Nominate faculty members for awards,
- Handle cases of academic dishonesty,
- Handle complaints from students, staff, and faculty,
- Provide a supporting environment for faculty,
- Hire and oversee office and laboratory staff,
- Conduct performance evaluations and salary recommendations for faculty and staff,
- Recruit and work with the CS Advisory Board,
- Schedule and set agendas for staff meetings,
- Schedule, set agendas for, and chair CS Department meetings,
- Host events for faculty, staff, students, and alumni,
- Attend WPI Department Heads Meetings,
- Represent the CS Department at a variety of events, on- and off-campus, for alumni, corporations and foundations, potential donors, funding agencies, etc.
- Represent the CS Department in inter-disciplinary programs, including Interactive Media & Game Development and Robotics Engineering. Contribute to planning for these programs and others currently under development, such as Bioinformatics and Learning Sciences,
- Prepare annual budgets and quarterly budget reviews,
- Verify and sign off on all department expenditures, including vouchers, check requests, invoices, and reimbursements,

- Verify and sign off on all personnel actions, including hiring, dismissal, and change-of-status of graduate student RAs and TAs, fellows, undergraduate SAs, graders, workstudies, and other student and professional help,
- Write CS Department Annual Report,
- Assign faculty members to committees,
- Schedule faculty for open houses and information sessions,
- Oversee and speak at Admissions Open House events,
- Oversee and prepare as needed external communications for admissions, publicity, undergraduate and graduate catalogs, and CS Department newsletters,
- Communicate with prospective, admitted, and confirmed students as part of the admissions process,
- Prepare and revise department policies,
- Administer department policies,
- Allocate space,
- Develop short- and long-range space plans,
- Develop CS Department strategic plans, and
- Oversee and contribute to ABET and NEASC accreditation activities.

Associate Department Head duties include:

- Develop course schedules and assignments for CS, IMGD, and RBE,
- Interface with Corporate Education,
- Assist in hiring adjunct faculty,
- Oversee updates to the Undergraduate and Graduate Catalogs for CS, Undergraduate Catalog for IMGD
- Coordinate CS MQPs,
- Represent the CS Department Head when he is unavailable,
- Plan various department events, and
- Nominate students and faculty for various awards.

Many departmental operations are delegated to committees. Faculty members are assigned to committees by the Department Head, taking into consideration their preferences, experience, seniority, university and professional committee commitments, off-campus duties, and other obligations. Most faculty members are assigned their top preferences. Departmental committees are:

- Graduate and Research: Promote research, including graduate student recruiting and enrollment, work with Research Groups on funding opportunities, coordinate department-wide grant efforts, and coordinate all graduate examinations.
- Education: Undergraduate and graduate academic and curricular issues, including new and revised courses, degree requirements, AP and transfer credit, TA allocation, academic petitions, review of the Undergraduate and Graduate Catalogs, and "Designs" for incoming 1st-year students.
- Facilities: Allocate office and laboratory space, equipment needs, including hardware and software, work with the lab manager.
- Faculty Recruiting: Review, screen, and invite faculty candidates.
- Graduate Admissions: Review graduate applications, recommend applicants for admission and financial support.
- Program Review: Review undergraduate degree candidates, responsible for administering CS minor.
- Assessment Coordinating: Oversight of assessment and accreditation activities.
- Public Relations: Public relations, publish Significant Bits, work with campus media.
- Undergraduate & Graduate Council: Address issues of concern to undergraduate & graduate students.
- Library Liaison: Interface with library, order books.
- Colloquium: Schedule colloquium speakers.
- Technical Reports Coordinator: Track TRs, assign TR numbers.

In addition, the CS Department has two committees with members elected from the department faculty that have specific, clearly defined roles:

- Tenure Committee,
- Promotion Committee.

Office staff comprises an Administrative Assistant, Graduate Secretary, and Receptionist. The Administrative Assistant duties are:

- Provide administrative support and train departmental office staff in WPI and CS Department policies and procedures.
- Be responsible for budget formation; prepare and oversee preparation of budgets; maintain departmental budget records; oversee petty cash.
- Provide administrative support for all confidential matters.
- Relieve supervisor of handling numerous routine contacts, answer questions, gather information requiring discretion/sensitivity and provide a wide variety/depth of knowledge of office operations and procedures.

- Maintain and oversee complex administrative/academic records (e.g., financial, student, and budgetary) requiring an in-depth knowledge of procedures and methods, with a high level of initiative and discretion.
- Assist and contribute to setting policies and procedures, research, planning and development activities.
- Use a variety of business or technical programs (spreadsheets, word processing, graphics, file management packages, communication software) to complete information management or production tasks.
- Assist in marketing the department (WWW pages, brochures, etc.).
- Coordinate CS events, including: Open Houses, Colloquia and Distinguished Lecture Series, workshops and conferences, social events, etc.
- Coordinate CS faculty recruiting.
- Provide administrative support to CS Department and committees; record department meeting minutes and serve on committees as appropriate.
- Perform other duties as assigned.

The Graduate Secretary duties are:

- Maintain computerized and paper records of the graduate student population and program.
- Manage correspondence with the students and WPI offices, including Graduate Admissions.
- Prepare reports and statistics as needed.
- Manage the mailing of graduate program applications and catalogs and correspondence with the applicants.
- Prepare and maintain graduate applicants' files for review by the graduate committee.
- Prepare and maintain graduate students' folders.
- Assign advisors and maintain records; type authorizations for TA's and RA's; assign building keys and maintain records for such.
- Assist with graduate examinations, colloquia, visitors.
- Act as liaison between graduate committee/chair and students.
- Provide a variety of office services such as photocopying, maintaining office supplies inventory, preparing and distributing U.S. and campus mail for the Department; preparing student timesheets, ordering textbooks for faculty, and serving as receptionist.
- Perform other duties as assigned.

The Receptionist duties are:

- Serve as receptionist and provide clerical support for the department including correspondence preparation, room reservations, answering telephone inquiries, mail distribution, faxing, and distribution of student keys and computer accounts.
- Guide department work study students in the performance of their daily assignments.
- Arrange potential student/faculty meetings at the request of the Office of Admissions.
- Maintain the C.S. Department News and Announcement web pages.
- Organize the department colloquia under the direction of the colloquia coordinator. The duties include posting announcements to the department web pages, providing equipment for the speakers, arranging luncheons and meetings with faculty, preparing refreshments and acting as colloquia host.
- Edit department publications and brochures under the direction of the C. S. Department Public Relations Committee. This activity includes research, creation of brochures, printing, and distribution.
- Support faculty conference activity through the phases of planning and realization as needed.
- Perform other duties as assigned.

Laboratory staff comprises two Laboratory Managers; with an additional 0.5 FTE position approved starting FY 09.

The Laboratory Manager II responsibilities are:

- Anticipate Departmental facilities needs; provide for these needs when they arise. Anticipation of problems before they happen is an important aspect of the job.
- Responsible for planning and purchasing decisions, installation and maintenance of computer hardware and software.
- Interaction with WPI students, faculty and staff entities outside of WPI, in support of the above items.
- Sit on the department's Facilities Committee and serve as a resource for the Facilities Committee chair.
- Supervises a staff assistant and student assistants.
- Other facilities-related duties as necessary.

The Laboratory Manager I duties are:

- Handle integration of PC and UNIX systems and services.
- Handle PC hardware and software-related issues, and support availability of all PC services.
- Setup, maintenance and trouble shooting of PC and UNIX hardware and software.

- Writes specifications and makes recommendations for purchases of new hardware, software and services.
- Management of part-time assistant staff.

8.D. Adequacy of Resources

Describe the adequacy of the resources available to the program, including those to acquire and maintain laboratory facilities, relative to the ability of the program to achieve its educational objectives and outcomes. Include information on how the institution determines the adequacy of these resources.

Resources for the program come from several sources:

- Operating Budget. The funding cycle for each fiscal year begins in the preceding spring, when all departments are asked to provide budgets for the upcoming year. The overall budget is set by the administration based on faculty size and student enrollment; department heads allocate funds within the various accounting lines. The CS Department has several lines that support laboratory facilities, including Computer Supplies, Computer Hardware, Computer Software, Service Contracts, Equipment, Equipment Repair & Maintenance, Computer Hardware Maintenance, and Maintenance Contracts. During FY 2008, these lines amounted to over $53,000.
- IT Capital Budget. Separate from the Operating Budget, there is a separate funding process for IT projects, including regular replacement of computing laboratory equipment. The IT Capital cycle begins almost a year in advance of each fiscal year as requests are developed in early fall, submitted in October, and reviewed and prioritized by the administration for development of the IT Division budget in the spring. There is no fixed IT Capital funding amount set aside for CS, however, it is fair to say that all departmental needs are being met adequately. In recent years, IT Capital has funded teaching laboratory development and upgrades, faculty and staff desktop and laptop computers, departmental file and compute servers, and additional disk and memory for existing machines.
- Grants: We have extremely close relations with a number of vendors and have benefited from their equipment donations. Recently, Intel and Sun have made sizable contributions to the department infrastructure.

In effect, the IT Capital Budget provides the basis for medium- to long-term departmental planning. When long-range needs can be anticipated, such as the complete replacement of a laboratory's equipment due to obsolescence, alerting the IT Division years in advance allows them to plan appropriately and essentially guarantees that the funds will be available when needed.

Overall, the university provides adequate resources for the operation of the program supplemented by resources made available from external funds as noted above.

8.E. Continuity of Institutional Support

Discuss and show evidence of continuity of institutional support for the program in the past, and problems that have existed or are anticipated in this area, if any.

The Department enjoys the clear support of the WPI administration. This support has been hard-won by the department faculty, who have reached new levels of success in every area:

- Teaching. As evidence of the teaching quality of the department, note that the CS Department has 3 WPI Technology Teaching fellows and two Romeo Moruzzi Young Faculty Awards for Innovation in Undergraduate Education.
- Scholarship. The CS Department attracted the most external funding of any department in two of the last three years. While not in itself indicative of research quality, this suggests that the department is doing something right. Furthermore, in 2006 the department, with the support of the WPI administration, set a goal of attracting $10M/year in external funding by 2016, the so-called "10 in 10" plan.
- Service. The CS faculty is highly visible in campus governance and professional activities.
- Innovation. The CS faculty has shown itself to be innovative in the development of new programs, bringing high value to the university. It is also innovative in the way it teaches, and in its research.

At a time of tight budgets, there are several positive developments for the CS department indicative of strong institutional support.

- Faculty Hiring. Since 2002 the CS department been given permission to expand significantly. We have hired seven full-time faculty members (Profs. Agu, Dougherty, Heffernan, Lindeman, Mani, Pollice, Rich), while losing two (Profs. Becker, Hachem). This growth has occurred despite decreasing enrollment in Computer Science nationally and at WPI, however, this is offset by recent increases n CS course enrollment from the IMGD and RBE majors.
- Staff. An office receptionist position that had been frozen since 2004 was restored in 2008, bringing the office staff back to full strength with three people. An additional 0.5 FTE lab manager position has been authorized starting Fiscal Year 2008. This will mark the first time the CS department has had more than 2.0 FTE lab managers.
- Office Space. The steady increase in CS faculty size over time has led to space pressures within the department. However, the pressure is about to be relieved. An additional seven faculty offices have been allocated for the CS department effective the start of A Term 2008.

While not necessarily problem areas, there remain issues of concern.

- Faculty. Despite the recent increases in faculty size, the needs of new programs in IMGD and RBE have resulted in fewer faculty FTEs allocated strictly to core Computer Science. While still manageable, this stress impedes the department's ability to further innovate new programs without additional faculty resources.

- Research Space. Achieving $10M/year in external funding by 2016 will require additional research space. Additional space has been verbally agreed to for 2009, however, that is not definitive at this time.
- Teaching Laboratories. The conversion of an open computing laboratory to IMGD teaching space for A Term 2008 will alleviate pressure on IMGD, however, the CS department remains short of teaching laboratory space for its own needs. At present, the Free/Open Source Laboratory (FOSSIL Lab) is the only teaching laboratory devoted solely to the Computer Science department.

Ending on a positive note, the upcoming Capital Campaign provides additional opportunities for support for the Computer Science Department. Among the items under discussion are chaired professorships and major facilities upgrades/expansions. While these items are not certain, the WPI administration is on record as saying that "The needs and opportunities presented by the CS department will occupy a prominent place in the upcoming Capital Campaign…". Thus, given our successes to date and strong university backing, we have every reason to expect institutional support to continue in the foreseeable future.