I. Introduction

The APR team consisting of Chris Fauerbrauch, Michael Lam, Ronald Lancaster, Richard Mathieu and James Sochacki were very pleased overall with the undergraduate program in Computer Science (CS) at JMU. We believe that the CS department provides a unique computer science major to the state of Virginia that is academically rigorous. The CS department has strong leadership and a faculty that are able to work well with limited resources. With this in mind, we also encourage the CS department to have a plan to stay abreast with technology, assessment, classroom usage, laboratory space, recruitment and retention of students and faculty. Our findings are presented in this document with suggestions for growth and improvement.

II. Strengths

A. The Major

The CS undergraduate program is in conformance with ACM program recommendations and offers a variety of courses that are in agreement with ACM and ABET. The undergraduate major provided by the CS department is distinctive with a strong liberal arts emphasis. The following list contains some of the highlights of the major.

- **Technical Communication** - Students are required to take WRTC 210 - Introduction to Technical and Scientific Communication. Technical writing and public presentation are a major component of all upper level courses in the CS undergraduate major.

- **Applied Professional Emphasis** - Faculty in the CS department have professional experience in using computers in industry and require students to follow professional computer science guidelines in courses.

- **Student Projects** - Courses require students to turn in projects with deadlines and formats.

- **Group Work** - Students are required to be team members on projects assigned by instructors.

- **Course Content** - Course descriptions align with state of the art computer technology. Instructors are teaching current and relevant material.

B. The Faculty

The department faculty is excellent. The senior faculty members bring years of valuable industry or academic experience to the program, and the younger faculty members bring an energy and creativity that will serve the program very well in the years to come. All of the faculty members (both junior and senior) have demonstrated an admirable level of friendliness and approachability; all students who were interviewed agreed on this point. In our opinion this is one of the strongest attractors of the program. Having a faculty body that is uniformly approachable for undergraduates is a unique draw to this department that is unfortunately lacking in many similar institutions.
We also want to commend the department on its effective and productive search processes. We were very impressed with the recent selections that were made for both department head and faculty positions.

C. Outreach

The CS department has a good relationship with other departments and programs at JMU. They have a long history of working with the Department of Mathematics and Statistics, including currently working on cross listed courses and a double major. A similar relationship exists with the ISAT program. The CS department has been a part of the High Performance Computing Center and High-Resolution Animation Group housed in Burruss 132. These relationships need to be continued and more like these relationships should be made with other departments. The current Robotics Minor being designed with Engineering, ISAT, Mathematics and Physics is a great example.

The CS department now has a working partnership with the corporation SAIC. More of these partnerships need to be developed. These relationships can develop internship programs, increase funding opportunities and provide scholarly projects for both students and professors.

III. Challenges

A. Required Course Competencies

As mentioned previously, the CS curriculum at JMU is strong and is closely aligned with the ACM curricular recommendations. However, both students and faculty have reported that the content and outcomes for a specific course vary based upon the faculty member teaching the course. This is reinforced by the self-study report which states, in discussing event driven programming, that “…instructors who choose to discuss graphical user interfaces will cover this material.” [P. 21] To say this another way, some JMU graduates will cover event-driven programming as part of their core curriculum and some will not. While we don’t intend to take a stand on whether or not this specific topic should be part of the JMU CS core curriculum, we suggest that the department needs to take a stand on this and similar issues and then construct the core courses accordingly. There is wide praise among students and faculty for the strength and consistency of the core courses CS 139 and CS 239, but the outcomes expected for other core courses are less clear.

B. Advertising/Brand

As mentioned earlier in this report, the CS undergraduate program at JMU is strong and has many distinctive features (such as the applied orientation and the emphasis on oral and written communication). We did not have an opportunity to review written brochures for the undergraduate program, but we note that the website for the program does not emphasize department strengths. It fails to distinguish clearly between the JMU CS program and programs found at other universities. Brochures and flyers should also show these strong characteristics of the CS major.
C. Advising

The students we spoke with identified some problems with the quality of advising in the department. Some students form friendships with specific faculty in the department and prefer to use them as a source for advising rather than their assigned advisor. There is no problem with that, but not all students will form such friendships. We have received indications that students sometimes receive incomplete, inadequate, or incorrect information from their advisor.

D. WRTC 210

The department is to be commended for its emphasis on oral and written communication throughout the undergraduate curriculum. This is clearly one of the distinctive strengths of this department. The review team is shocked to learn that the required course on technical writing, WRTC 210, will no longer be taught. The late notification to the department on this significant change is equally troubling. While the department is to be commended for integrating writing assignments throughout the curriculum, this cannot take the place of a course that is focused on writing. Both students and faculty have praised WRTC 210 and have noted its central role in the curriculum.

E. Diversity

Low numbers of female and minority students and faculty is a national problem in computer science, and it is a problem here. It is encouraging that the new department chair is a woman, but steps should be taken to increase the representation of women and minorities among the students and faculty.

F. External Forces

The CS department will have external forces acting on their undergraduate program that they will have to consider. These include increasing enrollment, moving into a new college infrastructure, developing an assessment process, developing a strategic plan to maintain the quality of their undergraduate program and obtaining ABET accreditation.

The CS department currently does not have the facilities or the instructors to handle the projected student growth. The CS department should put together a budget outlining the resources and faculty they will need to fill the needs of JMU CS undergraduate majors required by the state of Virginia and job growth. It is clear that more offices, more classrooms and more laboratories will be demanded and that instructors will have to be hired to teach the number of new classes that will have to be taught to meet expected student enrollment.

The CS department will have to work with the academic unit head and the dean on the budget issues. The CS department will have to work with assessment and other academic departments on campus to develop tools that help the faculty to develop better ways to ensure that the JMU student will obtain knowledge outcomes above a satisfactory level. There is a perception from administrators, faculty members in the department and the APR review team that more cohesion has to be formed among the faculty members of the department in order to address the external forces on the department.
There will also be outside pressure on the CS department to obtain ABET accreditation. However, meeting the demands outlined above while maintaining a program that is in conformity with ABET will be enough work for the department for the near future. After fulfilling these priorities the CS department should weigh the pros and cons of ABET accreditation.

IV. Recommendations

A. Consistent Learning Outcomes

Both students and faculty have described differences in outcomes for required courses based on who is teaching the courses. Indeed, in the course syllabi that were provided to us, there were cases where multiple syllabi provided for the same required course showed significant differences in course topics. The review team considers this to be a problem.

Students and faculty alike have praised CS 139 and CS 239 for their strength, and many have mentioned the consistency of coverage in the various sections. We understand that there are similar standards in place for CS/MATH 227 and 228. We urge that learning outcomes be defined for every required course in the curriculum. Once this is done, the prerequisite structure should be re-examined to determine which specific learning outcomes are required by a later course in the curriculum (required course or elective).

This process need not result in a rigid course syllabus that needs to be followed by each faculty member. Order of coverage, relative weight of exams and assignments, and similar decisions should be made by each faculty member. At least 80% of the course should be devoted to coverage of the topics mandated by the learning outcomes, leaving up to 20% of the course that can be used to present relevant material of the instructor’s choosing.

B. Ensure Programming Competency

The instructors teaching the CS 139 and CS 239 courses do a good job of presenting programming concepts to introductory students. We are puzzled by statements we have heard that students can go through the curriculum doing little if any programming after these courses. This could in some way be related to the consistency problem discussed earlier. For example, the catalog description for CS 350 suggests that this is not a programming class, but it is apparently often taught using a programming language. As the curriculum is reviewed for learning outcomes, the sequence should be examined so that the overall curriculum requires reinforcement of the programming concepts learned in the first courses.

C. Upper Level Competency Assessments

The CS department has not fully embraced assessment as a tool for identifying strengths and weaknesses in the undergraduate program. The kind of curriculum review that we recommend in this report can lead naturally to a valuable assessment process. Once the learning outcomes for the required courses have been identified, and once the links are defined between outcomes in one course and prerequisites in a subsequent course, the department can assess the extent to which the students in
the following courses have obtained the desired knowledge and skills that are expected to have been developed in the prerequisite courses. CARS can be a helpful resource to the department in creating and implementing suitable assessment processes.

D. ABET Accreditation

At this time, we recommend that the department defer consideration of ABET accreditation. As pointed out earlier, there are other curricular and infrastructure issues that we judge to be of more importance. Once these issues have been resolved and some time has passed, the department should re-evaluate the choice to apply for accreditation.

In the meantime, the department should ensure that it has a document that all faculty members are familiar with its contents. This document should clearly state why the department has chosen not to pursue accreditation at this time, and should reinforce the departmental branding on advertising and recruitment materials. Some ideas for the contents of this document include:

- Explain the possible loss of the program's liberal-arts uniqueness.
- Point out the lack of a clear benefit.
- Detail the large expense, both in terms of finances and in faculty effort.
- Provide as evidence other successful programs that are not accredited.

E. WRTC 210

The loss of WRTC 210 is of great concern to us, because of the strength and uniqueness of the technical communication aspect of this program. The department needs to quickly develop an academically rigorously equivalent replacement for WRTC 210, possibly in collaboration with other technical or scientific departments (e.g. engineering, mathematics, chemistry, physics, biology, etc.).

The course should emphasize technical writing in the forms of resumes, memos, reports, manuals, and scientific papers, as well as verbal presentation skills. Other aspects of business professionalism should also be emphasized as appropriate.

F. Student Recruitment

We are encouraged by the recent efforts to increase awareness and recruiting efforts at local middle and high schools. Identifying and attracting promising young students before they reach college is extremely helpful in improving the quality and reputation of the department.

In addition, this may help address the social issue of traditionally under-represented student groups such as females and minorities. Often, these groups never even consider computer science as a potential major in college. Working with them early and ensuring that interested members have the skills they need to succeed in the program will go a long way towards increasing enrollment and retention of these students.
G. Faculty Salaries

It is no surprise to anyone that faculty salary levels in the CS department have not kept pace with those at peer institutions. Indeed, this is a problem throughout JMU. Given that JMU has an objective of meeting the 60th percentile of peer institutions in salary, attention must be paid to salaries in order to assist in the retention of current faculty and the recruitment of new faculty. While we were not presented with specifics, salary inversion and salary compression problems were cited frequently during our interviews with faculty and administrators.

H. Faculty Positions

The self-study report indicates that the current faculty level is adequate to support the current enrollment levels, but there is a clear upward trend in department enrollments (and this is in line with national enrollment trends). The department and the college have recently negotiated workload changes that allow the department to utilize its faculty resources more effectively, but further enrollment increases at the undergraduate level will necessitate new faculty lines. Further, the currently proposed creation of at least one new required course for the major will immediately cause a lack of sufficient faculty resources. If the department proposes to introduce a second new course (i.e. technical writing), that may well be impossible with the current faculty levels. While we have not reviewed the graduate programs in any detail, it is clear to us that the graduate enrollments are stable and require a commitment of faculty resources that is also stable.

I. Resources

Current facility resources are stretched pretty thin. Our examination suggests that current classroom space and general computer labs are barely adequate to support the current needs of the program. The department desires to increase the number of required courses in the major, and to offer additional elective courses, but it is hard to see how that can be done within the current facility configuration. Further, the department is exploring the possibility of participating in several interdisciplinary programs (such as Robotics) and some of these may require dedicated specialized lab space. Additional office space will also be needed as new faculty lines are approved.

J. Linux Support

The CS undergraduate and graduate programs use Linux systems in several of their courses and in undergraduate student projects. There are other departments on campus (notably mathematics and CIS) that also use Linux to support their programs. The CS department is fortunate to have a talented system administrator to configure, maintain, and support this environment. There are also CS faculty members who are able to provide support for these systems. However, because there is no centralized Linux support on campus, those faculty and staff in the CS department who know Linux end up providing support to multiple departments on campus. While their willingness to do this is commendable, it is a distraction from the primary role these individuals need to fill in the department. Further, when a Linux problem arises within the CS department, the system administrator has no centralized support to look to for assistance. We recommend that JMU identify the prevalence of Linux use in departments around
the campus. If, as we expect, there are several programs making use of Linux as a tool in instruction and research, we recommend that JMU establish a central resource to provide support, much as is currently done for Windows and Macintosh systems.

K. Branding

There needs to be a consistent and clear message about what makes the CS department a great program. The CS department has a strong mission statement that clearly illustrates the desires and goals of the program, and this should resonate strongly with students and parents. The following should be especially highlighted by the CS department

**Applied Education** - There is a heavy focus on hands on software development and lab work. Throughout the four year major, students are constantly exposed to various technologies from writing software to physical networking.

**Liberal Arts Focus** - JMU provides a broad range of liberal arts classes and required course work to help create a well rounded student.

**Technical Communications** - The required communications courses for all CS majors exposes students to skill they will need to thrive in a highly social work environment. No matter the industry or position, technical communication skills will differentiate a top performer from everyone else.

The following areas are top priority avenues to focus on

**Improving the CS department website** - The public web site could be a great place to house a lot of the ideas in further sections around supporting students. While doing so, that would set a great image in potential new students and their parents. Using the web site can allow the CS department to plot out career paths, potential employers, potential career options and anything else that may spark interest and enrollment in the CS department and that shows why the CS major is unique and valuable.

**Recruiting materials including brochures and CD’s** - There needs to be clear and consistent message between all media. A consistent brand will help students learn what the CS department is all about.

**Increasing campus-wide awareness** - This has the potential to increase enrollment in CS courses across the campus. From our research, we realized that various departments across JMU were adding their own programming courses. Those courses are typically taught in a language very specific to their academic area, but we believe that the CS department could work with other departments at JMU to create more service courses, centralizing the various technical topics. Another opportunity for increased enrollment is emphasizing the CS minor. Computer programming skills are beneficial across many industries. A CS minor provides a graduating student with a differentiator between them and students without a programming course load. With rising technical needs in fields like bio-informatics, physics, chemistry and music, a technical education can provide a solid foundation when they enter the workforce.

L. Student Support

It is evident the CS department has made leaps and bounds in its efforts to improve student advising. The students interviewed during our research process indicated to us that there were areas of focus that can continue to be improved. Advising within the CS curriculum was noted as being solid. Students knew what courses they would have to take in order to graduate and fulfill their concentration requirements. Multiple students echoed questions and concerns on the topic of external class requirements, for example, the mathematics requirements. Students were unclear as to why they would choose among
the different tracks available for the mathematics requirement of the CS major. While no one expects the advising faculty in the CS department to know all in regards to the classes at JMU, we would expect solid foundation and understanding of choices regarding a student’s major. Another topic of discussion had to do with job placement and career paths. Students told us they never had anyone lay out what types of 'post' JMU careers they could have, or even what might best suit them as a career. Four potential career ‘tracks’ for students that could be presented are

- Industrial jobs
- Government based jobs
- Education (K-12) outreach jobs
- Research/Graduate/PhD opportunities

Developing an 'example' curriculum for each career track would certainly be beneficial for the students, if only to spark discussions on what their ideas and intentions were for graduation.

Summer internships are also important to expose to students. The junior and senior interviewed seemed like excellent candidates for internships or job placement, but neither had any set plans or really any idea of what they could do, besides going back to the Geek Squad or Subway for the summer. It would be very helpful for the students to have a pro-active plan or assistance in getting a position that is beneficial for their JMU career and beyond. The on campus career center was definitely an option, but no one seemed to have visited or been introduced to it. It might be worth investigating whether or not a specific program or practice needs to be put into place for these rising and graduating students.

**V. Strategic Planning**

The APR team recommends that the CS department create a strategic plan that addresses both the internal and external recommendations found in this report. The CS department conducted a strategic planning session in early Fall 2011. During this meeting CS faculty members developed an updated department mission statement and formulated five guiding principles for the department. In addition, six possible initiatives (3 curriculum-related and 3 outreach-related) were put forth.

The mission statement and five guiding principles form an outstanding foundation for the department’s strategic planning. However, the first round of the strategic planning process appeared to exclude participation by external constituencies (industry and government partners) in the planning process. In addition, there appeared to be only a slight linkage between the planning process and the JMU planning database.

As part of the strategic planning process, the APR team recommends the following

1) Include the CS Advisory Board, along with CS faculty, in a discussion about the mission statement and the five guiding principles. Great value can be added by considering input from both internal and external constituencies into the strategic planning process. Possible questions to ask members of the CS Advisory Board include:
   a. Is the mission statement comprehensive and complete?
   b. Does the mission statement include forward-looking visionary goals?
   c. Will the guiding principles help prioritize future opportunities?
   d. Will the CS department be able to form more corporate relationships?
2) Develop clearly defined strategic goals/objectives linked to the department’s objectives in the JMU planning database.

3) Develop a strategic planning document that:
   a. Lists objectives
   b. Lists associated activities/plans
   c. Lists metrics/measures associated with objective
   d. Lists individual(s) responsible for objective
   e. Lists timetable for completing objective

4) Debrief progress on an annual basis with CS department faculty and the CS advisory board.

The CS department has developed a comprehensive list of twelve programmatic objectives. Each of these twelve programmatic objectives has been mapped to courses/experiences in the CS curriculum. In addition, a set of seven program-level “student learning outcomes” were developed. This set of program objectives and student learning outcomes are an excellent foundation upon which to build CS undergraduate program assessment.

For several years the CS program used the Major Field Test (MFT) for Computer Science, developed by Educational Testing Services (ETS). The department faculty reached consensus that this test was adding minimal value and was discontinued. As a result, the department has recently embarked on an assessment process that is in greater alignment with the department’s specific learning objectives.

The most recent feedback from CARS on the CS Program’s Assessment Progress Template (2010-2011) indicated that a very solid set of student-centered learning objectives had been specified and had been mapped to course/learning experiences. As the department moves away from the CS MFT, it will be important for the department to develop a systematic method for evaluating progress on objectives and for documenting the use of assessment results for improvement of the CS program.

The APR team recommends the following:

- Focus on the assessment of the seven program-level student learning outcomes.
- Establish assessment timelines and responsibilities.
- Develop at least one or two assessments that would determine the degree to which CS students are able to integrate material from prerequisite courses into higher level courses.

We encourage CS faculty interested in leading assessment activities to

- work with CARS to develop effective assessment instruments.
- serve as a CARS summer fellow.
- attend ABET sponsored assessment workshops and webinars.

Clearly job placement for JMU CS students is very strong. The “2009-10 Recent Graduate Employment & Education Survey Report” conducted by JMU’s Office of Institutional Research indicated that 73% of CS recent graduates were employed full time and 18% were seeking employment. The APR team was able to discuss job placement, internships and career possibilities with a group of CS students.
representing each class level (FR, SO, JR and SR). While the students appeared confident of their job and internship prospects, there seemed to be a relatively high degree of uncertainty around the process for securing jobs/internships and for investigating different career opportunities with the CS discipline. Therefore, the strategic planning should include proactively engaging all CS students in career and professional development activities.

The CS department can work with students at each class level through advising, counseling and classes to help students understand the different mathematics requirements, the core requirements, prerequisites, different career paths, technical writing aspects, internships, job application skills and other important CS knowledge and technical tools and skills. The strategic plan should address these issues and make sure a process exists to ensure that this is succeeding.

As part of the effort to improve the career and professional development of CS students the strategic plan should also include

- Systematic data collection
  - senior exit survey
    - % CS students who attended fall or spring career/internship fair
    - % CS students who have paid CS-related work experience (including internships) prior to graduation
    - % CS students who participated in mock interviews
  - available through CAP (Laura Hickerson)
    - % CS students who participated in on-campus interviews
    - % CS students who are registered in Recruit-A-Duke

- Feedback from recruiters
  - CS Advisory Board – ask members to receive informal feedback from on-campus recruiters
    - How did JMU students perform in the interview process?
    - How are JMU new hires performing on the job?
  - Formal feedback from recruiters
    - Work with CAP to determine an effective way to survey recruiters of CS majors.
  - Suggestions on how to prepare all CS students for the interviewing process.
  - Suggestions on how to prepare all CS students for an internship.
  - Suggestions on how to prepare all CS students for their first full-time position.