

## **The Site Visitation Report for Green River Community College, Auburn, WA, February 27-28, 2003**

### **I. The College:**

Green River Community College (GRCC) is a two-year public college offering degrees in academic, professional, and technical programs located in south King County. The main campus is beautifully nestled on 186 acres of forested growth in Auburn, WA. Satellite campuses located in Kent and Enumclaw meet the need for increasing higher education in the county. Over 100 full-time faculty and over 200 part-time faculty teach daytime and nighttime classes to approximately 9000 students. The institution provides quality education and training to the communities it serves through instructional excellence, innovative programs, and responsive services. The student population reflects the growing diversity of ages and ethnic backgrounds in the surrounding area.

### **II. Physics Program:**

The physics program located in the Science, Math, and Technology (SMT) building is one unit of the Science Division. The mission of the science division states "All students will learn their science by direct experience with the methods and processes of inquiry." The goals of the science division are statements about what a learner will do following instruction. Physics supports the Associate Pre-professional degree in engineering. Courses in conceptual physics, college physics, physics for scientist and engineers, electric and magnetic fields, modern physics, and interdisciplinary science are offered. Independent study is also available to students. Conceptual physics is a hands-on inquiry-based course for liberal arts students. College physics is an algebra-based sequence of three courses for students in technical and transfer programs. Physics for Scientists and Engineers is a calculus-based sequence of three courses for SMT students. Electric and Magnetic fields is a unique course for transfer students in physics and engineering. Modern physics is the fourth course of the general physics sequence for physicists and engineers. Interdisciplinary science is a sequence of three courses integrating physics, chemistry, biology, and geology for elementary childhood education students. Independent study is a contractual course with topics in physics or physics related fields. Two astronomy courses are offered through the physics program in order to satisfy the math/science requirement for the Associate of Arts degree.

The Physics Program employs two full-time faculty, five part-time faculty, one laboratory technician, and one part-time student tutor. A building secretary provides support for science, math, and technology faculty. Keith Clay and Ajay Narayanan comprise the full-time physics faculty. Antonia Bennie-George, Glenn Hall, Mark Hamody, Carol Anway, and Marvin Nelson comprise the current part-time faculty. Marvin Nelson is one of the original physics faculty members. His leadership and innovation in physics teaching over the past 33 years built an environment that fosters collegiality, collaboration, respect, and excellence in teaching. Leadership transferred to

Keith Clay over a period of four years. Keith is committed to hiring qualified faculty to sustain this environment. Interviews conducted with SMT faculty, support staff, administrators, and students clearly demonstrate this environment continues to exist. The physics program is currently advertising for another full-time instructor to meet the increased enrollments in calculus-based physics and interdisciplinary science.

### **III. Accomplishments of the Physics Program:**

The Physics Program at GRCC has developed and maintained a thriving and exemplary program. The Program has a large number of STEM majors, strong female and minority student enrollments in physics, and an unusually strong emphasis on students who plan to become K-12 teachers, particularly math and science teachers. The Program actively uses innovative teaching methods (primarily inquiry using Tutorials in Introductory Physics, CASTLE materials and their own generated materials) in all of its classes. The Program has two microcomputer-based laboratories and utilizes technology in a systematic way in all of its classes. Students are actively involved in the instruction and excited about what they are learning in physics.

### **Trend in Physics Enrollments at GRCC**

Table 1 indicates the number of physics students in the classes offered at GRCC. Physics 101 is a hands-on inquiry-based course for liberal arts majors. Physics 110-111-112 is a three-quarter algebra-based sequence. Physics 201-202-203 is a three-quarter calculus-based sequence. Physics 208 is a two-credit hour advanced course on Electromagnetism. Physics 221 is a three-credit hour course on Modern Physics. Astronomy 101 is for liberal arts majors. Interdisciplinary Science 101-102-103 is a hands-on inquiry-based course combining geology, physics, chemistry, and biology into a three-quarter sequence for future elementary school teachers. The physics program at GRCC is showing a growing demand for more calculus-based physics and the interdisciplinary courses. The physics faculty is also working with the biology faculty to increase demand for the Physics 110-111-112 sequence. ***To handle the increase in enrollment demands, the GRCC physics program is adding a third full-time faculty member in the Fall 2003.***

Class	Fall	Winter	Spring	Average Students per Section	Sections Offered During Summer	Students per Section	Historical Trend
Physics 101	3	3	3	25	1	25	Fairly constant enrollments
Physics 110	2-3	2-3	2-3	25	1	25	Fairly constant enrollments, but may drop some this year
Physics 111		1		18	0		Down from previous years
Physics 112			1	18	0		Down from previous years
Physics 201	3		1	24	0		Enrollment increasing, will add 1 section in Fall 2003
Physics 202	1	3		22	0		Enrollments increasing, will add 1 section in Winter 2004
Class	Fall	Winter	Spring	Students per Section	Sections Offered During Summer	Students per Section	Historical Trend
Physics 203		1	3	20	0		Enrollments increasing, will add 1 section in Spring 2004
Physics 208			1	6 to 20	0		Uneven enrollments, but fairly constant
Physics 221			1	3 to 7	0		Low enrollments
Astronomy 101	2	2	2	24	1	24	Fairly constant enrollments
IDS 101, 102, 103	2 - 101	2 - 102	2 - 103	50	0		Program is 3 years old and demand is increasing

Table 1. Enrollment and Trend of GRCC Physics

## **Declared Majors of Physics Students**

The number of STEM majors varies with level of physics. In Physics 101 and Astronomy 101, there are usually no STEM majors, although there may be an occasional astronomy major (who takes Astronomy 101). In Physics 110, almost all students are STEM majors with roughly 1/2 majoring in allied health or applied technology, 1/4 are physical science or engineering majors (taking this course as an introductory course), and 1/4 are in other fields or other sciences. In Physics 111-112, almost all are science majors. In Physics 201-202-203, approximately 2/3 are engineering majors with the remaining 1/3 science or mathematics majors. Fewer than 10% of the students in Physics 11x or 20x claim teaching as an intended profession. (Note: according to Keith Clay, the overwhelming majority of secondary science teachers chose teaching as a career during their junior or senior years of college. In contrast, most elementary school teachers chose that profession before they entered college and many of them decided on teaching while they were in elementary school.) In Physics 208, 40% intend to go into electrical engineering and 40% intend to major in physics or astronomy with the remainder math majors. In Physics 221, almost all are physics majors with an occasional astronomy major.

In the Interdisciplinary courses, 80% of the students in IDS 101 are elementary education majors while at least 90% of student in IDS 102 are elementary education majors. This difference is due to attrition among those who are not interested in teaching, although they do see a few converts to teaching.

*The number of physics students at GRCC who are STEM majors is extremely high for its size of institution. The number of physics majors (from 3 to 7 per year) is extremely high for a TYC of any size. The number of students who are going to be elementary education majors majoring in science and/or math is extraordinary at GRCC.*

## **Tracking of Physics Students**

Although institutional-initiated tracking of students has been limited, tracking of student success at transfer institutions for engineering and physics students has occurred for years through the faculty. Both engineering and physics and more recently Project Teach have tracked their students. **During the past several years, only one student that has graduated from GRCC with a pre-engineering degree has failed to complete a bachelor's in engineering. (This is out of about 400 students)** Tracking of physics majors has a similar success rate. Most of the GRCC graduates that have received baccalaureate degrees in physics have received job offers right away. At least two graduates have entered graduate school in physics during the last five years. The elementary education program is too young to track any students who have finished this curriculum; however, there are a large number of students who have finished IDS 101-102-103 who are in their third year as elementary education majors at Central Washington University with classes held on the GRCC campus.

***GRCC tracking of its engineering and physics majors is excellent.***

## Diversity of Physics Students

Results of a survey of GRCC calculus-based students (n=63) in the Fall Quarter 2002, gives a breakdown of the background and diversity of these students. The 29% of students who are female taking calculus-based physics is considerably higher than the national average. The

Percent female	29%
Percent who consider themselves an ethnic minority	47%
Percent from public schools	69%
Percent from private schools	24%
Percent who have a GED	2%
Percent from urban high school	35%
Percent from suburban high school	49%
Percent from rural high school	8%
Percent who took physics in high school	57%
Percent who took AP physics	8%
Percent who were born in the US	49%
Percent who intend to transfer to a 4-year college or university	96%
Percent who intend to earn a 4-year degree as a STEM major	94%
Percent who intend to become an engineer	63%
Percent who intend to become a teacher	2%
Percent who intend to earn a 2-year degree in STEM	14%
Percent who intend to go to graduate school or professional school after completion of a 4-year degree	51%
Percent in which English is the native language	53%
Percent whose first math class was below 100	33%
Percent whose first English class was below 100 or ESL	22%

number of females taking the algebra-based physics and the Physics 101 course is also higher than the national average. In the IDS sequence, the percentage of female students is the vast majority. Although the number of females who take physics at GRCC is higher than national norms, these percentages are below the percentage of all students who are female at GRCC (except the IDS sequence). The 47% of students who are minorities taking calculus-based physics is also above the national average (and well above the GRCC minority student percentage). The number of students who are minorities taking the algebra-based physics sequence, Physics 101, and the IDS sequence are roughly the national average and are also the GRCC average.

***By all indicators, the GRCC physics program has outstanding female and minority physics student representation.***

## Innovations in the Physics Program

One of the more innovative aspects of the Physics Program at Green River Community College is the teaching methodology used in **all** physics classes. The GRCC physics program tries to emphasize hands-on and minds-on inquiry-based learning in all courses from those for non-science majors to those attended almost exclusively by majors in physics and astronomy. In most classes there is no distinction between "lab period" and "lecture period." The physics faculty (both full-time and part-time) favor general-purpose class periods that can include all kinds of active learning.

The Physics 101 class and the Interdisciplinary Science sequence emphasize student-led investigations with less than 20% of class time devoted to lecture. Using inquiry-based materials written at the college and published materials such as CASTLE and *Physics By Inquiry*, students perform experiments using simple equipment and draw their own conclusions. Both courses also feature more extensive projects that require students to initiate their own investigations.

In the algebra-based and calculus-based physics sequences, students use the same inquiry methods combined with additional didactic instruction from the faculty. GRCC has employed many innovations in these sequences:

- Day-time class periods are ninety-minutes long when the schedule allows. This length facilitates lab activities, lectures, active learning exercises, or all three in the same class period. Instructors have devised their own active learning exercises that form the backbone of their courses. Both GRCC physics classrooms are equipped with computers for lecture or lab use. Course syllabi and materials are often available via the Internet.
- In the 1990's GRCC was one of the first community colleges to employ *Tutorials in Introductory Physics* in a calculus-based sequence. Since that time GRCC faculty have replaced many of the *Tutorials* with materials that they have written themselves. In recent years GRCC became one of the first colleges to pilot the *Tutorials* in an algebra-based sequence.
- GRCC owns a full spectrum of Vernier sensors and interface equipment for use in all forms of physics experiments. A single class period will often feature some discussion, a very low-tech laboratory exercise, and a computer interfaced reproduction of the same experiment. For more formal labs, GRCC uses a combination of *RealTime Physics*, *Physics with Computers*, or materials written at the college.
- GRCC physics labs are also equipped with video digitization equipment and VideoPoint software. Although the software is primarily used in Physics 110 and Physics 201, it can be applied in many classes.
- GRCC physics classes make extensive use of mathematical computing software including Excel and Maple. Spreadsheet-based assignments allow students to use numerical techniques on what would otherwise be difficult calculus problems. Maple allows two and three dimensional visualization, solution of differential equations, and simplification of complex problems that would otherwise be beyond the reach of our students.

For more advanced students, GRCC offers two courses that are unusual among community colleges.

- GRCC offers Physics 208, an intermediate-level course on electromagnetism intended to bridge the gap between the limited understanding of the subject that students gain in introductory courses and that which is expected in the junior or senior level courses on the subject.
- GRCC also offers Physics 221, Modern Physics. Community college students interested in majoring in physics can be at a disadvantage due to the availability of only a single year of physics courses. While a single modern physics course does not solve the problem completely, it helps their students remain within reach of the curriculum at many universities.

In the past five years, GRCC has begun to offer programs aimed primarily at future teachers. These programs include the successful Interdisciplinary Science course as well as other programs in their infancy. The physics faculty is investigating the creation of a program to get physics students into K-12 schools as tutors or demonstrators of concepts in physics. The physics faculty plans to seek funding for the project later this year.

Another remarkable aspect of the GRCC Physics Program has been its high retention rate. **Retention rate for all courses has been remarkably high.** It is not unusual for the retention rate in Physics 201-202-203 sequence to be well above 80%. The retention rate in the IDS 101-102-103 sequence has also seen incredibly high with rates well above 80%.

Student understanding has been measured using instruments like the Force Concept Inventory (FCI), the Force and Motion Conceptual Evaluation (FMCE), and the Science Attitude Inventory by Moore and Foy. These instruments have been given to various levels of courses with good success compared to national averages. For example, the FCI has been administered both as a pre-test and post-test to the algebra-based and calculus-based sequences. Post test scores have averaged above 60% for the algebra-based course and above 70% for the calculus-based course. **Both of these results on the FCI are much better than national average.** Using the FCI has also allowed the GRCC faculty to see the gap between the understanding of their native students and international students. In the Interdisciplinary Science sequence, the Science Attitude Inventory is used a pre-test and post-test with significant gains in many key areas.

***The GRCC Physics Program has shown a sustained effort in doing innovations in their curriculum that have had a positive impact on their students, their retention, and their understanding.***

## **IV: Analysis**

The site visit team believes there are several key ingredients in the success of GRCC physics program that could be used at other colleges and universities with success. These key ingredients are: collegial spirit among the faculty; long term quality leadership; departmental attitude promoting innovation and a commitment to inquiry-based teaching; and strong student commitment to the program.

### **1. Collegial spirit among the faculty.**

The ingredients at GRCC that lead to an exceptional amount of collaboration are:

#### **a. Proximity**

Several faculty members noted that the proximity of their offices led to collaboration among programs and individuals. There were many citations of both formal and informal discussions of curriculum and students.

#### **b. Collaboration is recognized as an essential ingredient in both hiring and the evaluation process.**

Keith Clay discussed that there are questions for each interview candidate to probe their level of commitment to collaboration with other faculty. As part of the evaluation process, new faculty is expected to form ties with other faculty.

#### **c. Process in place to remove faculty that don't align with the mission of the program.**

Faculty has been removed for being unwilling to cooperate with their colleagues and there are clear cut expectations of cooperation.

#### **d. Mentoring of new faculty and part-time faculty.**

Keith indicated that Marv refused early tenure buy out and stayed four additional years so that Keith could obtain tenure before he left. The entire faculty talked about the mentoring they received from senior faculty and the dramatic effect of this mentoring on their approach to teaching.

### **2. Long term quality leadership.**

Long term leadership is fostered through:

#### **a. One or more strong faculty members have a clear vision of the future direction of the physics program.**

The faculty members at GRCC have long term dedication and have a clear vision of the appropriate direction for the program. They explicitly discuss the future direction of the program and try to build consensus. The faculty continually stresses innovation and has a fundamental philosophy that teaching is not static.

#### **b. Multiple full-time faculty**

Leadership can be sustained and passed from one faculty to another. There are also long time adjunct faculty members that mentor new adjunct faculty members.

#### **c. A transition period from old to new leadership.**

Mutual respect between administration and faculty, faculty and faculty and faculty and students takes a certain amount of time to develop. The overlap between the terms of Marv and Keith allowed for this respect to be built and have made it possible for Keith to continue to implement new ideas.

**d. Transfer institutions have the respect for the GRCC program and the faculty as individuals.**

The quality of the students from the GRCC program has created an excellent reputation for the GRCC faculty at local transfer institutions. This has allowed the faculty to create new courses in physics that are not commonly offered, including modern physics and E&M and has convinced CWU to offer the 3<sup>rd</sup> and 4<sup>th</sup> year of their elementary education certification at the GRCC campus. The faculty is also extremely active in physics education.

**e. An attractive environment where there are rewards for staying long term.**

The entire faculty cited the rewards of working at GRCC. The faculty felt that the rewards were the associations with their colleagues and their students. Some of the faculty likes the flexibility of their job and the amount of control they have over their courses.

**3. Departmental attitude stressing innovation and a commitment to inquiry-based teaching**

**a. The faculty union gives the faculty freedom to innovate.**

The administration stated uniformly that physics has local control over the curriculum. There is no penalty for implementing changes in the classroom.

**b. Inquiry-based teaching is stressed in the hiring of new faculty.**

Questions in the hiring process focus on an instructors' commitment to inquiry-based teaching techniques.

**c. There is support for curricular improvement in the form of grants and release time.**

There are Faculty Excellence Awards and Faculty Development Funds available to provide stipends and release time for both full and part-time faculty. Both the full and part-time physics faculty take substantial advantage of these programs. They also have written many successful grants for external funding some of which were germinated by these internal grants.

**4. Strong student commitment to the program.**

**a. A faculty dedicated to student learning.**

The faculty are always available and accessible to students. The students can get what they need when they need it from both the full and part-time faculty. The faculty has an open door policy and is on campus many hours per week.

**b. Active student organization.**

The ASME club is extremely active on campus. This provides a strong community for physics and engineering students. The newly re-formed SPS club on campus is eager to perform service in local schools.

**c. Sound advising.**

The advising is competent and continuous by the faculty. There is a formal mechanism for students to be assigned a faculty advisor in their discipline. Students are encouraged by the administration, faculty and fellow students to see their faculty advisor and are extremely positive about the quality of advising they received.

**d. Recommendation of physics by other STEM programs.**

Math, Engineering, Natural Resources and Pre-physical therapy faculty all recommend that the students take physics and take physics at GRCC. The physics program meets regularly with both academic and technical faculty to determine the needs of those programs.

**Future Challenges**

- How to handle increased growth and demands on the program.
- How to sustain the program at the current high level and prevent faculty burnout.
- How to maintain the collegial environment as the program moves to a new building and the physics program is physically separated from the engineering and math program.
- How to maintain the physics programs without equipment funds.

**V. Conclusion:**

The GRCC physics program is a stellar program that can serve as a model for other Two-year College physics programs. While it is not easy to duplicate the intense commitment of the faculty, it is possible to encourage other colleges to replicate some of the structure of the college that allows the program to flourish. The GRCC physics program, SMT faculty and Administration are to be commended for their dedication to students and their clear focus on creating an innovative program.

**VI. Site Visit Team**

- Martin S. Mason, Team Leader, Assistant Professor of Physics at Mt. San Antonio College, Walnut , California
- Thomas L. O’Kuma, Lead Teacher of Physical Science at Lee College, Baytown, Texas
- Andrew Wallace, Professor of Physics at Angelo State University, San Angelo, Texas

## **Appendix 1: Site Visit Narrative**

The following narrative is chronological and is included to give additional information about the college and its programs.

### **Dean Michael Casella**

The site visit began Thursday afternoon with Assistant Dean Michael Casella who is in charge of hiring and evaluating part-time faculty. GRCC has an extensive system to evaluate and encourage the growth of adjunct faculty. All adjunct faculty are evaluated during each of their first two quarters at GRCC and if they are approved by the faculty they are placed "in the file." Michael asserted that the adjunct faculty had to be willing to innovate and "not just stand up and lecture." Faculty in the file must be offered teaching positions before faculty not in the file, which results in a sense of security for the part-time faculty. Part-time faculty in the file also have access to professional development funds both for attending professional meetings and developing curriculum and are encouraged to participate in teaching workshops on campus.

### **Executive Vice-President April Jensen**

April Jensen, Executive Vice-President, says the physics faculty is wonderful and that physics is a popular program on campus. She is aware of the sustained continued leadership in the physics program and the introduction of inquiry methods in both the physics program and Project TEACH. She believes the high school market is strong due to the Running Start program. Returning students coupled with the southern migration from Seattle increased enrollment to over 9000 students. Approximately 5% of the enrollment is international and 95% is from within southern Kent County. The institution is in the process of building student housing and a new science and technology building to meet the needs of its growth. April stated that the Green River Community College Foundation identified Project TEACH as a priority for institutionalization.

### **Division Chair Michael McVay**

Michael McVay identified his role as an interface between the administration and the faculty. Michael receives 4/9 release time from his role as a biology faculty member to serve as Division Chair, and has 12 science faculty in his area of responsibility. He identified the physics faculty as always pushing innovation in their programs. Michael noted that the physics program contributed extensively to the division portfolio (for regional accreditation) and were instrumental in defining the division's instructional plan (done primarily by Marvin Nelson). He discussed the general lack of funding to support laboratory equipment and supplies and mentioned a multi-year trend in decreasing funding. The physics program has been very successful in obtaining funding for equipment from other sources including grants and the college foundation. One of the physics faculty members served as the Master of Ceremonies at a foundation fundraising gala dinner that raised \$20,000 dollars for microscopes in the biology

laboratories. Michael was very pleased that the physics program was serving a large number of students efficiently in their facility without using double sections.

### **Adjunct Faculty Dana Rush**

The astronomy program is part of the physics program at GRCC and has been taught entirely by adjunct faculty member Dana Rush for the last twelve years. The program is extremely popular and fills all the sections that are offered. Dana indicated that he had total control over his program including the design of curriculum, choice of textbooks, course scheduling and budgeting. Funds to support the astronomy program come from CO-OP funds that are charged directly to students amounting to about \$400 dollars per year. Dana said he attended the recent American Astronomical Society meeting in Seattle and was able to get partially reimbursed for his fees through faculty development funds. He added that if he had applied earlier he would have been reimbursed for the entire conference. Dana indicated that he had minimal interactions with the rest of faculty.

### **Carol Anway, Adjunct Physics Faculty**

Carol Anway is a Ph.D. engineer at Boeing who teaches part-time at night. This was her second quarter of teaching. She said that she was really enjoying teaching and didn't mind spending the extra time required to get ready for classes that involved inquiry. She thought she was mentored well. She enjoyed teaching and thought that the GRCC physics staff made her teaching life as easy as possible. She emphasized that she appreciated all the support that she had received.

### **Jeff McCauley and Janet Hannan, Engineering Faculty**

Jeff McCauley and Janet Hannan both emphasized the high level of communication between the physics and engineering faculty and how well the physics courses served the engineering program. Jeff stated, "We have great physics teachers and they care about their students ..... Engineering and physics always have time for each other." They speak to the physics faculty on a regular basis about specific course content issues and difficulties with particular students. They work consciously to avoid scheduling exams on the same day as physics and treat the physics/engineering students as a common student body. The engineering faculty carefully defined the role of the engineering program relative to the physics program. The engineering faculty often creates bridges between material in Statics and Dynamics and Physics 201 and 202. Jeff described how he was mentored by Marv Nelson, a past physics instructor, and felt that Marv had helped to shape him into a student-centered instructor. The full-time engineering faculty sees one of their substantial roles as providing academic and career advising. They actively encourage their students to take the entire physics sequence at GRCC. The engineering faculty is active in recruiting at high schools and has previously offered a summer program. Engineering students come from a variety of sources, such as the engineering club and Project TEACH. Some four-year schools send engineering students to GRCC for their first two-years of instruction. A Science Olympiad held in the past and periodic science contests aid in recruiting. Engineering

faculty at GRCC are active in state level professional societies. The American Society of Mechanical Engineers (ASME) club on campus was selected as the best club on campus in 2002. Students present engineering design projects at ASME regional meetings. The engineering club meets once a month at a local restaurant to discuss design projects and presentations. A new transferable curriculum has been designed and implemented. The first course of this curriculum requires students to investigate various engineering careers, complete a cardboard vehicle project, and learn fundamental skills of a successful engineer. The faculty collaborated with instructors in other disciplines on the Transferable Integrated Design in Engineering Project (TIDIE) to create a design element in other courses. Finally the engineering faculty cited the proximity of the offices of physics and engineering faculty to a student work area as a factor that encourages increased collaboration between students and faculty.

### **Marv Nelson, Emeritus Physics Faculty and Adjunct Physics Faculty**

Marv Nelson is a retired GRCC physics faculty member who still serves as an adjunct faculty member for the physics program. He provided the leadership for many years in developing and maintaining the physics program as well as mentoring new faculty. When asked what he was most proud of about the physics program at GRCC, Marv replied that it was the diversity of students serviced by the physics program. He was proud that they had started the Physics 101 course to address needs of non-science students. He also took pride in the fact that they have worked hard to increase the number of female students taking physics. He felt that they have improved significantly the image of physics on campus and in the community. With the recent addition of the IDS courses, he feels that the physics program is able to provide a quality physics course for all students on campus, regardless of age, gender, ethnicity, learning style, major, or math/science background. He believes strongly that the administration at GRCC supports the physics program well and that the SMET faculty and other GRCC faculty are innovative and work well with students and each other, and that teaching is still the highest priority on campus.

### **Judy Burgeson, Dean of Science**

Judy Burgeson served as an instructor at GRCC for 24 years and has been Dean for at least 6 years. She was proud of the innovative spirit of the physics faculty. She described the physics faculty as leaders on campus and sited Keith Clay's work on creating a new Associate of Science degree where only Associate of Arts degrees had existed on campus previously. She noted that the current budget situation was severe but the physics program was extremely successful in generating grant funding. The GRCC foundation has a person devoted to seeking and writing grants to support campus programs. She identified the Faculty Excellence funds and Faculty Development funds as two sources of money to improve existing courses, create new programs or perform other professional development activities. Faculty can get a quarter or more of release time from these programs or from grants if they propose innovative changes to their curriculum.

### **Connie Jones, Building Secretary**

Connie Jones has been at GRCC for 5 years. Connie is a graduate of GRCC. Connie reports to the Executive Vice-President office and supports SMT faculty. She is responsible for typing, mail, reception, and ordering. Two part-time work-study students assist her in the "busiest building on campus." Connie stated that the physics faculty is great to work with and that she likes multitasking and helping students. She says that her rewards are working with students and instructors. She indicated that a full-time support position lost to recent budget cuts is needed.

### **Ajay Narayanan, Physics faculty**

Ajay Narayanan has just finished his tenure review process in physics and is due to be reviewed by the Board in March. He appreciates the small classes that allow for one-on-one teaching at GRCC. He has taught the entire sequence of physics courses at GRCC and is committed to inquiry-based teaching techniques. Ajay has restarted the SPS chapter at GRCC this semester and sees this as his highest priority outside of his teaching assignment. He has just submitted a grant to fund sending physics students to local high schools to present demonstrations and recruit future students. He has been active in local professional organizations and is the head of the Washington State chapter of the American Association of Physics Teachers. He has worked extensively with the Physics Education Group at the University of Washington, and pioneered the use of the Tutorials in algebra-based physics at GRCC.

### **Sam Ball and Leslie Heizer, Project Teach**

Sam Ball and Leslie Heizer are respectively Dean and Center Director of Project Teach. Keith Clay and Steve Kinholt wrote a NSF CTEP grant to start a teacher preparation program at GRCC. The program now called Project Teach includes as its key elements: a three quarter sequence in math for teachers, a three quarter integrated science course, an introduction to education course, and a service requirement of 20 to 60 hours in the K-12 classroom. The integrated science course is inquiry-based and was developed collaboratively by physics, geology, chemistry and biology faculty. The program includes a future-teachers club, which was selected as the runner up to most successful club on campus and provides a strong sense of community for the student involved. The club organizes a yearly conference that features teaching workshops and panel discussions by current teachers who came through the project teach program. The center director is now working to disseminate the program to other campuses by developing modules on how to start each of the components of Project Teach. The program maintains an extensive database which tracks students through their college career and also maintains contact with in-service teachers who want to mentor project teach students. Project Teach encourages teachers across campus to integrate assignments about teaching into their classrooms by providing funding to develop these assignments. Having the project on campus has made a large number of faculty think about teaching. Finally Project Teach has created an agreement with Central

Washington University for students to complete the third and fourth year of their program on the GRCC campus.

### **Glenn Hall and Toni Bennie-George, Adjunct Physics Faculty**

Glenn Hall has served as an adjunct in physics for four years and teaches both the inquiry-based conceptual and algebra-based physics courses. He received extensive mentoring from Toni Bennie-George and the other physics faculty when he started teaching at GRCC and still has many discussions about curriculum and pedagogy with the other faculty. He appreciates having a part-time lab tech to provide support for the equipment intensive integrated lecture laboratories. He cited a week long class on how to develop syllabi and scoring rubrics which he was paid to attend by the college as instrumental in starting him thinking about teaching and learning. Toni Bennie-George has worked with GRCC for twelve years and was mentored by Marv Nelson. Toni was selected as the Adjunct faculty of the year. She attends regional AAPT meetings and workshops and receives professional development funding from the college. Toni discussed techniques she uses to retain female physics students, including ensuring that female students are not left alone in groups, and deliberately calling on female students. She and Glenn received a faculty excellence award to improve the inquiry-based optics materials in the conceptual physics program. She, Glenn, Ajay and Keith agreed on the future direction of the physics program and decided to spend more time per topic and cover fewer topics. All physics courses were changed to meet for ninety-minute sessions. Glenn and Toni both agreed that the department is extremely well stocked with equipment and anytime they requested equipment they received it within a year.

### **Students**

Lunch with students confirmed the strong sense of community in the SMT building. They commented on how physics faculty is always accessible and willing to help. Several students did complain about parking and facilities not being adequate for the current enrollment. Many of these students are active in the engineering club that was recently recognized as the outstanding student organization. The engineering physics students were enthusiastic about their courses and showed a high level of understanding of the material. They explained that at first the course was somewhat strange because there was no distinction between lecture and lab, but they all enjoyed the experience. We could uncover no negative comments about the instructors other than that they told bad jokes. The students reported using the Math Learning Center and the Library extensively for on campus studying. The overwhelming majority of students had picked GRCC because of its proximity to their homes but some students reported driving up to forty-five minutes because of the reputation for excellence in the physics and engineering programs. The majority of SMT students plan to concentrate on engineering careers after they complete a bachelor's degree. The diversity of student ages is quite noticeable, but the ethnic diversity was not that obvious.

The students we spoke with in the algebra based physics sequence were either technology majors or undecided. One of the three students was interested in taking an additional physics course and indicated he would probably major in some sort of science. All of the students were positive about their instructor and stated that they enjoyed the experiments.

The integrated science students were overflowing in their praise of the integrated science courses. They described making a transition from science phobia to enjoying their science classes. They enjoyed the projects assigned in class and felt that the approachability and commitment of their instructors made the program work. Students enrolled in Project TEACH have high morale and are proud of the program. These students are eager to complete their bachelor's degree, acquire certification, and begin a career in public school teaching.

### **Laura Moore-Mueller and Rochelle Mitchell, Math Faculty**

Laura Moore-Mueller and Rochelle Mitchell are both math instructors that have worked extensively with the physics program. Laura has developed and taught a coordinated physics and calculus course with Marv Nelson in which both instructors were in the room at the same time. They worked carefully to develop common language for the course and define clear roles for the math and physics portions of the course. She and Rochelle interact with the physics faculty on a daily basis to discuss issues with their common students. They assign common projects between the upper level math courses and the physics courses. They both use "fun toys" from the physics department in their math courses. The Math learning center is midway between the math and physics departments and serves as a common gathering place for the math and physics students. Laura and Rochelle recognized that the math, physics, engineering students were a common block and identified the close proximity of the departments as essential to their continued collaboration. The math faculty feels that applications are one of the primary focuses of their curriculum. Laura has worked with Keith to integrate Mathematica and Maple into her math classes and the math faculty use CBL equipment in their courses. They would like to restart the coordinated physics and calculus course.

### **Christie Gilliland, Math Chair and Future Dean**

Christie Gilliland cited the active role that the physics department took in creating innovative programs and that the physics faculty was the campus leader in grant work, professional development and obtaining administrative support for their programs. She discussed the CSEF scholarship program that provides support for physics and other SMT majors that the physics faculty was instrumental in getting on campus. She has combined projects between her linear algebra class and the engineering physics courses. She cited that the physics faculty works closely with math on scheduling and creating a sense of common community for students even though they are in different divisions. The Math Learning center serves as an important nexus for the physics, engineering, math student population and provides a tutor for physics courses. Many of

the tutors in the Learning center are physics students which further leads to the strong community of physics students in the Math Learning Center.

### **Bob Filson, Geology & Interdisciplinary Science Faculty**

Bob Filson worked with Marv Nelson on a number of collaborative courses for over twenty years and worked with Keith Clay to create an integrated developmental science (IDS) curriculum. In designing the IDS courses there was a decision to look at the desired skill outcomes of the course and place the emphasis on these rather than specific content. Several members of the science faculty met to develop an overarching theme and identify the essential exit skills. The course was originally designed for all students but the majority of the student body is future teachers. The course introduces material from the text "Inquiry and the NSES, Guide for Teaching and Learning." While the course does not explicitly discuss methods of science teaching, the inquiry technique is modeled throughout the course. Bob continues to work closely with Keith on both the IDS sequence and Project Teach.

### **Treela McKamey, Scientific Instructional Technician I**

Treela McKamey has been employed in the physics program for almost one year. She is responsible for physics and geology laboratory management 80% of the time and tutoring English as a second language through the international program 20% of the time. Treela is also responsible for ordering equipment and supplies, equipment repair, and coordinating about six geology field trips per quarter. She reports to the Dean of Instruction for English and Humanities. Treela enjoys the relaxed atmosphere in physics and geology. Flexibility appears to be her main source of job satisfaction. Treela is leaving GRCC at the end of the spring quarter to attend graduate school at UC Davis to study linguistics.

### **Keith Clay Physics Faculty**

Keith Clay functions as the lead physics instructor on the basis of his seniority. He was mentored by Marv Nelson for four years prior to Marv's retirement and Keith's assumption of a leadership role in the department. He serves as co-director of the Project Teach program and is active in both campus wide and state wide efforts to promote teaching preparation. Keith is active in the national American Association of Physics Teachers and is a member of the Two-year College committee. He co-chairs the Washington Committee on Articulation for Math and Science Teachers. Keith recognized that the Associates of Arts degree did not work for Engineers. In Washington, a student who earns an AA degree automatically has all of the courses in that degree accepted at the transfer institution. The physicists and engineers were abandoning the AA and the engineering faculty had to create agreements school by school. Unfortunately, the non science classes were not transferring. Keith created an Associate of Science degree with both a Biology and Engineering/Physics/Computer Science track. Students completing this degree are able to get one year of general education credit and their major course work credit. Keith believes that inquiry-based, student centered instruction is a trend that runs throughout the physics program. He

works to ensure that there is participation by all members of the department in shaping the physics courses and the direction of the program. Keith organizes formal discussions about the skills required in algebra-based course and calculus-based course between full-time and part-time physics faculty. His highest priorities outside the classroom are institutionalizing the innovations that have been made in the physics program, Project Teach, and preserving the strong relationships between the different program areas.

## **Appendix 2: Core Indicators**

The GRCC program excelled in each of the Core indicators defined by the SPIN-UP TYC project.

### **1. Enrollment**

The program is experiencing increasing enrollment and class offerings are limited by available faculty and facilities. The faculty are happy with the strength of engineering and conceptual physics sequences. The faculty is addressing concerns about the size of the second and third quarters of the algebra based physics sequence.

### **2. Successful Transfer**

There are state wide direct transfer agreements which guarantee the acceptance of all credits in an AA or AS program. UW, CWU Washington State is the primary transfer institutions. Students and faculty reported that there weren't problems with transfer to other institutions. Only one out of nearly 400 physics and engineering majors has failed to complete a BS degree according to the engineering program chair. Administration and faculty believe that transfer is not a problem and the students verified this. The mathematicians discussed some transfer problems with UW and private schools.

### **3. Morale**

Clear in discussion with other STEM areas that the morale is excellent throughout the department. The engineering faculty met regularly with the physics faculty to discuss students and common curriculum. The morale within the entire building is excellent and fosters many collaborative projects: Examples are IDS shared projects between math and physics courses and the combined courses between math and physics and geology and physics. There is a strong sense that they share a common student population. The good morale is shared by the students who identify themselves as engineering/math/physics students. The students hang out in a common area. The faculty believes that a Student SPS organization is important to the program and there is evidence that a program is in formation. We saw flyers advertising the second SPS meeting posted around the department and Ajay asserted that his highest priority was to build a successful SPS program.

### **4. Respect**

The physics faculty is viewed as a leader on campus particularly in curriculum innovations. Each of the administrators we spoke to identified the physics faculty as taking a leadership role in several campus programs including Project Teach, creating new degree programs and raising substantial amounts of money for the college. The division chairs, assistant deans and deans and academic VP all respect the physics program and consider them the leader in curriculum innovation on campus. Physics has local control over how they fit into degree plans. The administration has given the physics program the opportunity to offer programs as they see fit. The physics faculty is concerned about addressing all student needs. They are not currently offering

anything in particular to address the life science and pre-professional students. They are addressing the biology students on the topic and seeking to find a balance between serving these students and technology students.

## **5. Cooperation**

There is evidence of substantial collaboration between different disciplines including team taught and integrated courses. There are formal and informal meetings between different program areas and shared projects between math and physics. There is excellent cooperation with Project Teach and the effort to expand Physics 101 to address a broader audience.

## **6. Diversity**

The physics program makes an effort to be female friendly. The faculty indicated that they implemented strategies designed to make female students comfortable in groups by pairing them up and giving them recognition for their contributions. The Physics 101 program is successful in retaining female students as the female is 60% (SR). There were no special efforts to attract minorities or women. There is a strong high school attraction and retention program due to the running start program. There is a southern migration of Seattle that has led to 4-5% population of international students which is heavily enrolled in the physics program. 47% of the calculus-based physics students self identify themselves as minority students.

## **7. Professional Development**

The physics faculty and adjunct faculty in the file have the opportunity to access professional development funds. Keith has a strong national presence and Ajay has a strong regional presence. The adjuncts are involved at the regional level in the AAPT and AAS. GRCC supports them to attend professional meetings and will give them release from their assignment to attend professional development meetings. The campus also provides professional development activities on expert teaching for both full and part-time faculty. Some part-time faculty indicated that they wanted more professional development. There is a high level of funding for professional development. There are both faculty excellence funds available to pay faculty to develop new curriculum and professional development funds to pay faculty to attend conferences, workshops or courses. They also can buy themselves out for a quarter to work on curriculum development projects. Toni and Glenn were awarded faculty excellence funds as adjunct to develop curriculum for the 101 course. Keith and Toni were previously awarded Faculty Excellence funds for work on the algebra-based physics course. Keith has used NSF funds to develop curriculum for the calculus based sequence.

## **8. Assessment and Evaluation**

There is formal assessment of student learning gains in the courses in the form pre-post testing using the FCI or FCME exams. In the IDS program they are using the science attitudes survey. They also interview exiting students to obtain feedback about

the success of the program. There are also informal discussions between different disciplines about student progress. Students are assigned a faculty advisor based on their declared major and students reported getting excellent advice from the STEM faculty advisors. There are tutors available for students in the math lab. The physics 208 course was created because of student feedback about a need for additional material in electricity and magnetism. The modern physics and E&M course serve the purpose as honors courses. A formalized exit survey could be a valuable tool to learn more about the needs of the student population in physics.

## **9. Articulation**

There is substantial collaboration with all SMET departments. There is articulation with high schools, two-year colleges, and four-year colleges. There is no business and industry council for the physics department. The Engineering program is active in a western consortium of engineering programs which meets to discuss curriculum and courses.

## **10. Teacher Preparation**

The teacher prep program is stellar and has a strong math science focus. They have enticed CWU to offer the 3<sup>rd</sup> and 4<sup>th</sup> year of their program on GRCC campus. There is good tracking of the teacher prep students. The program is well organized and efficient and the students exhibit extremely high morale. The online database is extremely impressive and contains extensive information about students. The program's genesis from the math science area gives a flavor that is unique among teacher prep programs. The students show an interest and dedication to science and math teaching, and the materials generated by the program reflect a focus on math and science education. The administration is committed to institutionalizing the Project Teach program. Project Teach is a stand out that every institution could benefit from emulating.

### Appendix 3: Core Questions

Much of the material addressed in the Core Questions has been addressed previously in this document.

**1. What type of classroom environments and course structures are effective in preparing two-year college students for success at the transfer institution?**

The institution has implemented a variety of inquiry-based teaching techniques including:

- All courses are integrated lecture labs.
- In the 101 course the entire curriculum is based on materials from the castle project and materials developed by Marv Nelson based on ideas from University of Washington.
- The IDS course is based on activity modules developed by an interdisciplinary committee at GRCC.
- The Washington tutorials are used extensively in the 110 and 200 level courses.
- The department offers physics 208 and modern physics which gives students an advantage over students in a traditional program.

**a. What type of classroom environments and course structures are effective in preparing two-year college students for success in the workplace?**

- Students complete substantial projects that require collaboration.
- Applied skills are emphasized in the physics and math courses and there are extensive links between the physics, engineering and math programs.
- Math courses have joint projects with the physics courses.
- Computer modeling packages are emphasized in the physics and math courses.
- The engineering club sponsors design competitions and invites speakers from local industry.

**b. What type of classroom environments and course structures are effective in providing opportunities for self improvement?**

There are no substantial efforts in this area. Occasional students take physics 101 for self improvement.

**c. (Non credit students) What activities and practices of the physics program and faculty effectively address the educational and career needs of the diverse student population characterizing two-year colleges?**

This has been substantially addressed in previous sections. In summary the faculty has open communications with each other and with students which results in a strong sense of student ownership of the program. The faculty is extremely aware of the needs of their students due to their continual formal and informal evaluation of their program. There is a strong sense of faculty student collegiality. The faculty respects the students. In our discussions with students the students would admit to no faults among the faculty except the cornyness of their jokes. There are no non-credit courses offered in the physics area.

**2. What institutional and faculty activities and practices are effective in promoting change in the classroom? In the physics program?**

Professional development funds are available to support faculty innovation. The physics faculty has taken a leadership role on campus for many years. The Administration provides the freedom to make changes in the curriculum. One of the program goals is to continually revise and improve the curriculum. The physics faculty is willing to share ideas and improvements on the curriculum with other faculty. The respect generated by Marv Nelson winning the undergraduate physics teaching award has given the department the freedom to implement many changes and new ideas.

**3. What institutional and faculty initiatives are effective in recruiting and retaining STEM majors?**

There are continual discussions between physics and engineering faculty. The faculty has a strong idea of what the transfer institutions want. There is a strong effort to retain students based on the faculty respect of students. Students are the best recruiting tool of the campus. IDS students are used to recruit more project teach students. Student word of mouth is extremely strong and brings students from the area.

**a. What institutional and faculty initiatives are effective with women and under represented populations?**

The faculty is aware of women and minority students. The faculty makes efforts to retain these students. Both the part-time and full-time faculty discussed efforts to encourage female students in their classes.

**b. What institutional and faculty initiatives are effective with future K-12 teachers, especially STEM teachers?**

Project Teach is an exemplary program. It should serve as a model program for both two-year and four-year colleges. Please see the attached Project Teach materials for details.

**4. What formal (articulation agreements, bridging program courses) and informal (professional interactions) mechanisms are most effective in ensuring a seamless transition for students from the two-year college to the four-year institution?**

Articulation agreements with high schools through Project Teach allow students to begin their education program in the high school. Physics Faculty member Keith Clay created an AS degree specifically for engineering, physics, CS students that guaranteed program articulation with in state four year colleges. Students report that they have no difficulty transferring their classes from GRCC and that they are extremely well prepared.

**5. What institutional and faculty initiatives are effective in establishing cooperative activities with local schools (pre college), private and public?**

Project Teach requires students to complete 30 hours of service in local schools. GRCC has a summer math program. The Physics program holds workshops for local teachers during the summer. In the past the department has held courses on introductory physics teaching based on Arrons book.

**a. What institutional and faculty initiatives are effective with civic clubs and/or youth organizations (e.g., Boy Scouts of America) and the general public?**

The focus of the program is on students. Ajay is planning to use local grant money to fund educational activities that give GRCC students (from the Society of Physics Students and elsewhere) the opportunity to do activities at the local schools. The physics program has been active with the GRCC foundation in shaping details of this project.