Evaluation of Effect of the Plus/Minus Grading System: A Computer Model Rick Matthews, February 4, 1997 Effect of the change on student grade point averages The first of two computer simulations in this study examined effects of the proposed "plus/minus" grading system on student grade point averages (GPA). The "plus/minus" system modeled is the one proposed to the Committee on Academic affairs in September by Page Laughlin, Rick Matthews, and Claudia Thomas. (See proposal for details.) The results of a typical simulation are shown in the graph, "Change in GPA under plus/minus system vs. Old GPA." This graph displays the change students can expect in their GPA from the switch from the current system to the new system. Description of the model Students are assumed to be graded on a 100 point scale with a 10 point spacing between letter grades. The model assumes that each student's performance across courses is normally distributed with a standard deviation of three points on this scale. Students with average raw scores ranging from 50 to 100 were simulated. The model calculates each student's GPA under the current system and under the proposed plus/minus system. The GPAs under the new and old systems are presented in the graph of GPA vs. raw scores . The source code used in this simulation is in the accompanying document, gradeval.f90 . Discussion * Nearly all students (those with grade point averages between 1.0 to 3.6), will see a change in GPA of less than +/- 0.06. The change is small because the benefit of the "plus" grades almost exactly balances the penalty of the "minus" grades. * Students with GPA's around 0.6, well below our standards for continuation, will see their grades hurt by about 0.12. These poorly performing students receive more grades of D- than D+. * Students with a very high GPA of around 3.9 will see a decrease of as much as 0.08. They will on occasion receive an A-, whereas now they receive almost all A's. Fewer students will achieve a 4.0 under the proposed system. *Thus, there will be little effect on student grade point averages.* Effects on errors in assigned grades The next study examined the errors in the grades reported to the registrar as a result of inaccurate assessment by the instructor of student performance. Some faculty have expressed skepticism of the value of a plus/minus system, stating that they cannot assess student performance more accurately than to the nearest letter grade. Therefore, it is appropriate to investigate whether there is any substantial benefit to adopting a grading scale that may be of higher resolution than the accuracy of the assessment of students by their instructors. This computer simulation assumes the same grading system as the previous study (100 point scale, 10 point spacing between letter grades). It also assumes that the errors in the instructor's assessments of student performance are normally distributed with a standard deviation of 3 points on the 100 point scale. Thus, the raw score the instructor determines on a 100 point scale is assumed to be within 6 points of the student's true performance, 95% of the time. If the student deserves a score of 85, the instructor is assumed to award the student a score between 79 and 91, 95% of the time. This assumed accuracy is close to that claimed by many faculty. The results of this simulation are displayed in the second graph, "RMS error in assigned grade points vs. raw grade" . This graph summarizes a computer simulation of the _consequences_ of the errors that instructors make in evaluating student performance. Displayed is the root mean square (RMS) difference between the grade points assigned by the instructor and the grade points the student should have received had the instructor been perfectly discerning of student performance. The RMS error is calculated for a group of students whose performances warranted grades ranging from 50 to 100. The graph illustrates that, under the current system, the RMS error in the assigned grades is typically between about 0.3 and 0.7. The largest errors occur for students close to the cutoff between letter grades, as expected. Students who should have earned an 81 (and therefore a B) are assigned a C almost half the time under the current system. Similarly, students who should have earned a 79 and a C are assigned a B almost half the time. For borderline students, the reported grade is wrong almost half the time. When the wrong grade is assigned, the awarded grade is in error by a full grade point. Under the new system, the RMS error in assigned grade points is between 0.3 and 0.33 for most students. For students who earn raw grades above 68, the largest RMS error under the plus/minus system is less than half of what is seen under the current system. While instructors will be just as inaccurate in their assessment of students under the proposed system, the effects of their errors on student grade points are much smaller. A student who should have earned an 81 and therefore a B- may instead receive a C+ or B; however, these grades carry only small differences (0.333) in grade points assigned from the proper grade of B-. *Thus, reported grades will be more accurate reflections of student performance under the proposed plus/minus system, even if faculty can grade with only an accuracy of one letter grade. Rounding inaccurate grades to the nearest letter grade increases inaccuracy.* Limitations of this study Many courses do not use a grading system that bears much resemblance to a 100 point scale. Of those that do, many do not use the assumed 10 point spacing between letter grades. However, nearly all grading systems can be mapped onto such a scale, though often with some skewing of grade distributions. There is little basis for the assumption that student performance in courses is normally distributed with a standard deviation of three points. To assess the importance of this assumption, other simulations were conducted with distributions of differing shape and width. The findings reported here are rather insensitive to both the detailed shape and width of the distribution. Similarly, little basis exists for the assumed distribution of errors in assessment of student performance. However, the findings regarding errors in student assessment are even less sensitive to the shape and width of the distribution of errors. In particular, the maximum predicted RMS error in assigned grade points is consistently much higher under the current system than under the proposed plus/minus system. Summary Results of computer simulations indicate that adopting the proposed plus/minus system will have little net effect on student grade point averages. However, reported grades will be more accurate reflections of student performance under the proposed plus/minus system. Addendum on the effects of A+, added 4/18/97 Interest has been expressed on the effect of inclusion of a grade of "A+" with 4.333 grade points would have on GPA's. The results of such a simulation are shown in the graph, "Effects on student grades, with and without A+" . This simulation shows that including A+ in the grading system would cause the decrease in A- GPA's to be even smaller (a change of 0.05 instead of 0.08). GPA's above 3.93 would increase in a plus/minus system including A+. An old 3.99 is boosted 4.14 with the A+ system, instead of dropping to 3.96 under a plus/minus system without A+. (Editorial comment: The principal argument against inclusion of A+ is that many employers and graduate schools scale all grades to the 4.0 scale with which they are most familiar. These organizations would thus multiply all WFU GPA's by (4.0/4.333), reducing all GPA's by nearly 8%. Under such a scaling, *all* of our students would fair more poorly under a system including the A+.)