Summary of Identified Issues

Four areas of concern arose in nearly every meeting: 1) The level of Differential Equations and Linear Algebra, which is sometimes upper division and sometimes lower division; 2) The need and level for instruction in writing proofs; 3) The need for early warning and informal contacts between community colleges and four year institutions whenever curriculum changes are planned; 4) The need for a description for Discrete Mathematics, a course of great interest for Computer Science.

Identify Trends/Future Directions

Physics is nearly universally required as part of the Mathematics Major. It is seen as the most important way for students to put the calculus to work, after all calculus was invented to solve physics problems, and as a way to solidify the concept of vectors. However, in the last 50 years other areas have become more quantitative, using mathematics extensively. Economics, biology, and computer science are but three of several areas where mathematics majors could put their mathematics to work. It was argued successfully at one of the regional meetings that we should no longer cite physics as being required in a model mathematics major. We should embrace the concept that for some students, other math intensive applications would better suit their needs. Thus we should allow for different sciences or applications to play the role in the major, once filled by physics.

At least in the CSU, a larger and larger percentage of mathematics majors are planning on being high school mathematics teachers. Consequently departments will have to examine their major, not only allow for such preparation, which we all do, but to really make it one of our core concerns.

Comments from Statewide Meetings and the General Field

It was argued that physics should not be required of every mathematics major. There are now several disciplines that have intensive use of mathematics at the level accessible to early mathematics majors. We should allow these in the major in place of physics. This argument, when first proposed was rejected by all community college instructors, in fact by most all in attendance, but as discussion continued giving examples of valid learning objectives from different disciplines, more and more acceptance followed, until in the end, a motion to this effect passed. As a side note, there was a comment to the effect that the host of biology prerequisites for upper division biology classes has kept mathematics majors from contributing to the growth of mathematical modeling in that field. Mathematicians would have a lot to contribute in the modeling arena without having to know the vocabulary of anatomy classes for example.

The computer science faculty presented their need for a course in discrete mathematics. Their professional organization had adopted a list of topics for such a course. At a joint meeting between mathematics and computer science, we debated the design of this course. Much of the debate centered on the prerequisite for such a course. The prerequisite sets the level of the class. This was a difficult decision since, a calculus prerequisite would delay students taking the class in the major, while the level or depth of the class would greatly benefit from a calculus prerequisite. At the joint meeting with computer science faculty the majority opinion settled on a calculus prerequisite, that is the sophistication desired would require a stronger background.

The discussion of the role that community colleges should play in the development of competence in creating proofs started with the desire by computer science for their majors to have early training in this area. This is usually accomplished in a class such as discrete structures. Since the construction of proofs is the essence of upper division mathematics, clearly mathematics majors are also in need of instruction. Most four-year institutes have found it necessary to create specialized classes to help their mathematics majors develop this essential skill. All community colleges demonstrate proofs in their classes and most ask students to prepare proofs, but few give actual instruction on proof techniques. It was recommended that all community colleges try to incorporate proof instruction into key classes.

We spent a great deal of time looking at CAN descriptors. In fact, most was spent on the description for the General Education course for liberal arts majors. Finally, we

admitted that we had not come prepared to discuss in detail the description of these service courses, but could make some headway with major courses. Subsequently, we abandoned even that modest goal, finally coming to believe that a separate conference on CAN descriptors was needed to make consensus headway.

Recommendation for the Discipline

If a four-year institution's requirement for differential equations is at the upper division level and a transfer student has taken a similar course (at the lower division level) the four-year institution should try to give "content" credit for the course even though they cannot transfer the course.

The same for linear algebra, recognizing that there is a strong difference between an early junior level and a senior/graduate level linear algebra course.

Four-year institutions should keep in close contact with their area community colleges. They should alert them early in the process about proposed changes in the curriculum including major course modifications. This is especially important if the proposed changes could affect articulation agreements. It is proposed that on a regional basis that there should be a face-to-face meeting at least once per year. Institutions could rotate hosting such meetings.

Proofs need to be part of the community colleges' curriculum. Not just demonstrated in classes, but expected of mathematics majors. It is unlikely that community colleges can support a separate course for this purpose, but it is essential for students to do proofs within existing courses.

Recommendations for Support Courses

Discrete mathematics is an important issue for computer science. Roughly speaking, finite mathematics is the non-calculus mathematics useful to business majors and discrete mathematics is the non-calculus mathematics useful or necessary for computer science majors. Thus Boolean algebra, the fundamental mathematics of and/or decision making and Lattice Theory, the structures underlying data structures are topics to be included in discrete mathematics courses. While the topics are not fully prescribed in this emerging course, there is a great deal of agreement. Computer science professional societies have developed lists of suggested topics. What is not well discussed is the desired level of such a course, and where is the ideal position in the curriculum for such a course. Unfortunately, the desired placement for the course (early or later) is at odds with the desired level (freshman, sophomore) for the course. Add to this mix the desired sophistication of the problems considered in the course and there is no general agreement.

Topics for Future Discussion

- Engage in relevant discussions with Engineering. A review of the topics needed from calculus as well as the need for experience in modeling would be two starting points.
- Discuss with computer science the outcomes desired from Discrete Mathematics as well as the level of prerequisites.
- Discuss the content of the service courses for prospective elementary school teachers. There is a disparity between the demonstrated performance in elementary topics such as fractions, percentages, and number sense and the areas we think should be learned such as geometry, number theory, statistics.

Recommendations Forwarded/to be forwarded to CAN

Convene a CAN discipline review committee to thoroughly review CAN descriptors. Can descriptors for Discrete Mathematics and for Mathematical Proofs need to be created. Our review indicates that while the major courses are in pretty good shape there is much disagreement in the descriptors for the service courses such as the General Education courses for non-quantitative majors, the math for elementary teachers, and statistics. While we started this review at our statewide meeting it was clear that the participants didn't feel empowered to propose these descriptors. Participants for this review committee should be empowered by their institutions to propose changes. The process then should continue with a wide dissemination of the proposed changes with feedback solicited.