REPORT ON THE REAPPORTIONMENT OF THE ACADEMIC ASSEMBLY

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EXECUTIVE SUMMARY: Our current method for apportioning representatives to the Academic Assembly from the various campuses, called the Sainte-Lagüe method, is the appropriate method of apportionment, even when UC Merced is represented at the Assembly. A second question concerning the appropriate size of the Academic Assembly is not so clear cut. There are cogent arguments for increasing the size of the Assembly and for leaving it at its present size. Considering the current financial exigencies facing UC, it would not be wise to expand the Assembly at the present time.

INTRODUCTION

Last year, the Academic Council asked me to investigate the method we use to apportion representatives to the Academic Council with particular regard to whether this method is the most appropriate one and how matters might change when the UC Merced Division begins operation. According to our bylaws, the Assembly consists of 16 *ex officio* representatives to the Assembly (mainly the Academic Council), 40 divisional representatives, and the Chair and Vice Chair. The bylaws specify that the 40 divisional representatives shall be assigned to divisions in proportion to the number of Senators in the divisions, but with the constraint that every division shall have at least one such representative.

The method we have been using is called the Sainte-Lagüe method (with a divisor of 3), and it is formally equivalent to the Webster method, about which I will say more later. The method works as follows: First, one representative is given to each campus. Then, the campus with the largest population is given the next representative, and the population of that campus is divided by three. Then, again, the resultant populations are compared, and one representative is given to the campus with the largest population, and its population is then divided by three. This continues until all representatives have been assigned.

THE BEST METHOD OF APPORTIONMENT

Is the Sainte-Lagüe method the "best" method available, where by "best" we mean comes closest to one-person one-vote? This question is identical to the question of how seats in Congress are assigned to the various states. The development of apportionment theory is closely linked to the history of the United States. I will give

a short history based mainly on the book Fair Representation (Second Edition) by M. L. Balinski and H. P. Young (2001).

The first apportionment bill, passed by Congress in 1792, used what is known as the **Hamilton method**, named after Alexander Hamilton. That method determines the **quota** for each state by multiplying the state's population by the number of seats in congress and then dividing by the entire US population:

$$\text{quota} = \frac{\text{state's population}}{\text{US population}} \times (\#\text{ of seats in congress}).$$

But each state's quota will certainly include a fractional seat, for example a quota of 4.35. Hamilton's method assigns the whole number portion of the quota to each state, and then assigns the remaining seats based on the largest fractional remainders.

In the first use of a Presidential veto, George Washington vetoed this apportionment bill, and his veto was sustained. This was done at the urging of Thomas Jefferson, whose own apportionment method, called the **Jefferson method**, was adopted and used by Congress through the 1830s. In Jefferson's method, every state's quota is multiplied by the same factor F and seats are assigned based upon the whole number portion of the revised quota. One chooses the factor F so that the total number of seats assigned corresponds to the desired size of Congress. Jefferson's method tends to favor large states, and in truth, it was originally adopted because it gave the important state of Virginia one extra seat.

Because of its obvious bias, the Jefferson method was abandoned by Congress in 1840 for the **Webster method**, introduced by Daniel Webster. This method simply rounds the quotas up or down, depending upon whether the fractional part is greater or less than one half. As before, a constant multiplicative factor F is used on all the quotas so that the method gives the desired total number of seats.

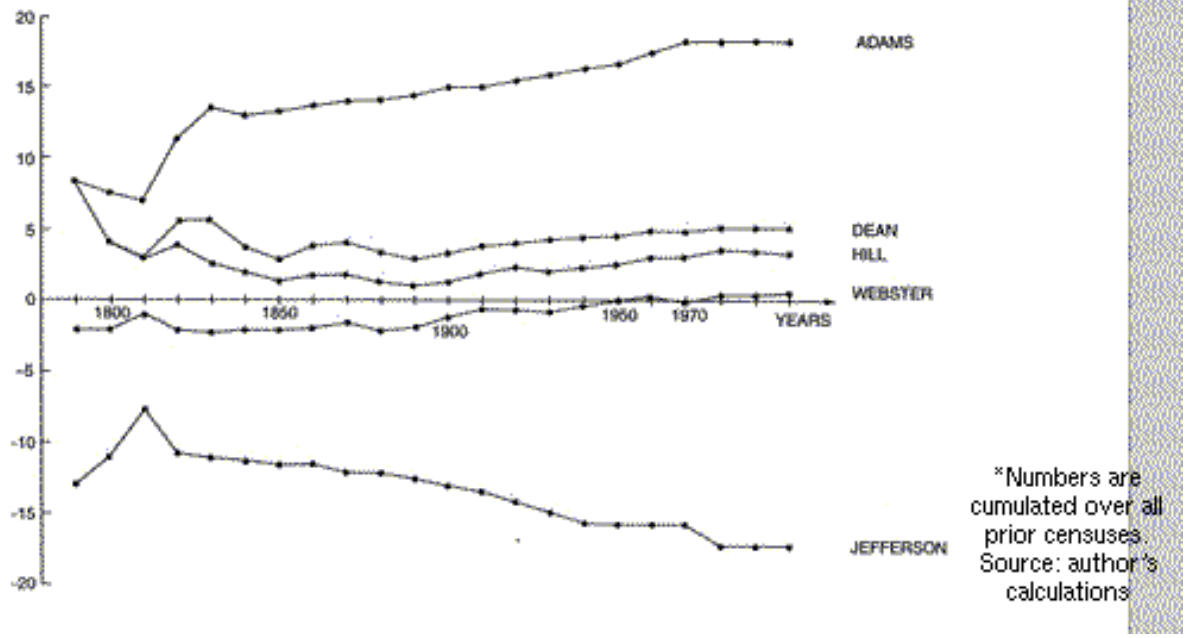
For the rest of the 19th century, both Webster's and Hamilton's methods were used sporadically. By the beginning of the 20th century, it was known that Hamilton's method leads to several unacceptable paradoxes. For example, Congress realized that if the size of the House was increased from 299 to 300 members, then Alabama would **lose** one seat using Hamilton's method. This is now known as the **Alabama paradox**. There are several other paradoxes, such as the population paradox, where a state whose population is increasing faster than that of a second state might lose a seat to the second state using Hamilton's method. The Hamilton method was forever dropped in favor of methods like that of Webster, which are known to avoid such paradoxes.

In 1911, a new method called the **Hill method** was developed. The Hill method is like the Webster method except that quotas are rounded up or down depending on whether or not they exceed the geometric mean (square root of the product) of the next larger and next smaller integer. For example, a quota of 2.45 would be rounded to 3 in Hill's method because 2.45 is greater than $\sqrt{2 \times 3} = 2.449$.

In 1941, Hill's method was adopted by Congress, and it has been used ever since in the US. In reality, the change from Webster to Hill at that time was intended to give one more "safe" democratic seat to Arkansas. However, the argument was buttressed by a report from the National Academy of Sciences (whose signatories included the great mathematician John von Neumann) which claimed that Hill's method adheres more closely to the ideal of one-person one-vote than does Webster's method.

It is now well-known that this report was wrong and that Webster's method is the least biased. One can prove that for Webster's method and only Webster's method, the transfer of a seat from one state to another always leads to a more biased result. Further, people have done numerical modeling, both with census data and Monte Carlo simulations. One such model (from www.brook.edu/comm/policybriefs/pb88.htm) is shown here:

Figure 3: Percent Favoritism Toward Small vs Large States (1790 2000)*



The Sainte-Lagüe method we use is formally identical to the Webster method. The Sainte-Lagüe method is used in various European parliaments to apportion seats among parties, though they sometimes use a different divisor than 3 in order to give some advantage to larger parties. In any event, the conclusion is that the method we have been using is the least biased method, and we should continue using it.

SIZE OF THE ACADEMIC ASSEMBLY

In 1981, an earlier committee of the Assembly raised the question of whether the size of the Academic Assembly should increase as the University grows. Traditionally, representative assemblies do grow for a period of time, and then they stabilize

at some size. This was certainly true of the House of Representatives, which grew steadily over history but stopped growing at 454 members in the early 20th century.

There are several cogent arguments for increasing the size of the Academic Assembly. The University faculty has grown substantially since the number of divisional representatives was set at 40. Currently, each Assembly member represents several hundred faculty, and it is surely difficult to represent so many faculty in a fair manner. In addition, the large number of *ex officio* members of the Assembly means that proportional representatives constitute only about 2/3 of the voting members. A larger Assembly would give greater weight to the representatives of the divisions.

On the other hand, our current Assembly, with 58 members in all, is already a rather large body to be conducting business in a one day meeting. It would be difficult for individual representatives to be heard on important issues if the Assembly were much larger. Furthermore, a larger Assembly would entail additional costs, both for a larger room and for travel expenses.

As you can see, there are good arguments both for and against an increase in the size of the Academic Assembly. However, because of UC's current budgetary difficulties, this would not be an appropriate moment to increase the Assembly size because of the additional costs such an increase would entail.