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ABSTRACT

The end of faculty growth in higher education has led to near panic predictions of aging, highly tenured, more costly, steady-state faculties as the "growth bulge" hired in the 1960's age. This study discusses two models for simulating the behavior over time of indices of faculty health such as average age and salary, annual new hires, and percent tenured. These models are then applied to a specific faculty to demonstrate their usefulness and to provide recommendations. Each school should explore the future implications of its current faculty distribution by age and tenure status and of current hiring and attrition behavior before accepting predictions based on national data. Schools should not overlook "natural" attrition which accounts for much of the difference between annual new hires and retirements. A time perspective is important, and the behavior of indices of faculty health is cyclical. The young, regularly rejuvenated faculty of the 1960's was somewhat artificial since it was based on permanent growth, and the current deterioration of faculty health indices is in part a return to pregrowth normalcy and will be eventually reversed. The study concludes with a discussion of options for avoiding the aging, more costly faculty approach to steady-state and experiment with the impact of variations in tenure standards on faculty health indices. (Author/JMF)

X-03-73

STEADY STATE STAFF PLANNING: THE EXPERIENCE OF A "MATURE" LIBERAL ARTS COLLEGE AND ITS IMPLICATIONS

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Carleton College
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Preface

We wish to warn at the outset that any quantitative work in this study is subject to a wide margin of error and is of only imperfect accuracy. While it may become redundant, we shall repeat this warning often so that the reader is not lulled into comfortable acceptance of that quantitative work or any policy conclusions it implies. Conclusions and predictions in the social sciences are always based on some set of variables which in reality change in unexpected ways but which have been assumed constant for purposes of analytical convenience. These are called parameters. The practitioner who uses conclusions from the social sciences, therefore, is best off when he can interpret the impact of a real world change in a parameter's value on the conclusions and predictions of the work he is using. No amount of statistical precision in computing past values of that parameter can substitute for understanding what will happen if that past value, in fact, changes.

Put differently, we would hope that the reader will approach this study as he would a textbook --- as an interested observor seeking useful generalizations, models, and hypotheses and very secondarily seeking quantitative truths and predictions. We, at least, have approached its writing as one would approach writing a textbook. Mathematical modelling almost necessarily requires using numerical values for parameters, and in a textbook using such models, the writer typically seeks "reasonable" numbers and real world cases for illustrative purposes to better appeal to the readers' intuition and interest. He, thereby, semi-consciously produces "reasonable" predictions which are nevertheless subject to a margin of error. Carleton's faculty in 1963 - 2023, then, is our real world case and its past behavior is the basis for our parameters' "reasonable" values.

Aware of the warning, the reader may be struck by our frequent use of numerical values up to two decimal points. This is neither "false precision" nor "hypocrisy." It is, in fact, the most convenient and useful way of expressing our decidedly imprecise numbers. Since it will be encountered, again and again, an example at the start will be useful. Let us say that it appears "reasonable" that over the next four years 6 faculty members will be retiring: 2 in the first year, 0 in the second, 3 in the third and 1 in the fourth. This imprecise (because some may die or quit!) "fact" could be expressed exactly that way: "2 will retire in the first year....etc." However, a less cumbersome way of expressing this fact which is still quite useful so long as one can think in averages or a four-year time horizon is: "on the average 1.5 faculty members will retire each year over the next four years." Now, if we rounded this number up to 2 per year on the average we would be mistakenly saying that 8 will retire rather than six and if we rounded it down to 1 per year on the average we would be mistakenly saying that only 4 will retire. Similarly, if on the average 1.05 per year will be retiring over the next 20 years and we express this as 1.1 or 1.0 we will be overstating or understating the actual number (20 x 1.05 or 21 retirees) by one faculty member. One faculty member seems a small number, but it represents almost one per cent of the permanent teaching faculty at Carleton, about two per cent of the tenured faculty at Carleton, 20 per cent of the 1973-74 group of permanent new hires, and 25 and 50 per cent of the number who stood for tenure in 1972-73 and 1973-74. It is important in small faculties.

Chapter I

Introduction and the Basic Conceptual Framework

A steady-state faculty has recently become a basic operating tenet in nearly all institutions of higher learning. This has been due to a combination of pessimistic predictions about future enrollment trends in higher education and equally pessimistic predictions about the amount of resources any individual enrollee (or his family) is willing to pay for, either directly in tuitions or indirectly through the tax system.

The former prediction is based on nearly incontrovertible demographic analysis which shows the 18-26 year old age group declining in absolute size in the forseeable future and on three or four years worth of declines in the proportion of that age group actually attending college -- an apparent shift in preferences (how permanent no one knows) away from expenditure on conventional higher education. Thus, one major justification for faculty growth during the 60's, the increases in the scale of operation needed to service expanding student bodies, has been eliminated. The latter prediction is much less solidly based on impressionistic evidence that students will not pay for further declines in student-faculty ratios -- increased resources per student -- a factor that also justified much faculty growth during the 60's. The apparent difficulty that high cost, low student-faculty ratio, private colleges have had in attracting their traditional share of students seems the strongest basis for this impression, and this lesson has not been lost on state legislators.

Our purpose is not to question this basic operating tenet although we would warn against any unthinking, year-to-year application of the no-growth rule. Rather, our principal aim is to examine the implications of the transition to a steady-state faculty for the conventional measures of faculty health and vitality and for the faculty wage bill. College administrators have long recognized intuitively that the transition to steady-state will exact a high price in the ability to make new appointments, to make promotions, and to maintain an appropriate balance of age and ranks in the faculty. They have also recognized that while eliminating faculty growth will slow the rate of growth in the faculty wage bill it will not stop growth. Quite apart from economy-wide increases in wage rates from inflation and productivity increases (cost increases which in principle should be largely offset by revenue increases), the faculty wage bill will rise as the steady-state faculty ages. Our purpose is to examine these intuitively held opinions and to specify more precisely, if possible, the implicit relationships behind those opinions.

A. The Variables.

Before an introductory examination of our steady-state models let's first outline the major variables we will be dealing with and introduce the notation we will follow throughout the paper:

1. The Proportion of Faculty Which is Tenured (% T.)

Most discussions of the ill-effects of a steady-state policy have expressed their conclusions in terms of a school reaching an "excessive" % T without explicitly recognizing that % T is only a proxy for a variety of probably more important variables. Tenure is only a label that says: "This is a scholar who by this school's standards is a desirable member of this academic community and to whom the school commits itself to quasi-automatic contract renewal." Were a faculty composed of 90% such persons, were they to be paid little more than a starting Instructor, and were they voluntarily to remain employed for no more than 10 years from the age of, say, 35 to 45; few would find this "excessive" or undesirable. It is obviously the great length of the tenure commitment and, therefore, the implications of a high % T for the ability to make new appointments, for the average age of the faculty, and, given the tie between age and salary, the implications for the average salary and total faculty wage bill which makes a high % T undesirable. Any relabelling device which changes % T without changing the likely behavior of these other variables is merely cosmetic. Moreover, the ill-effects of reaching a high % T will be delayed until many years after that point has been reached.

2. The Ability to Make New Appointment or New Hires Per Year (H).

It is not a fixed tenure ratio...that provides flexibility (and renewal) but the ability to appoint new members to the faculty.[1] We will accept this as another basic premise but warn that this, too, may be only cosmetic if the new hire has little opportunity to interact with other faculty members to say nothing of students. The device of a rapidly turning-over, poorly credentialled and ill-experienced pool of "temporaries" may bring some new ideas to the student; but students are likely to be sensitive to their"second-class faculty" status and may tend to underutilize them; and if the permanent faculty is to gain from the new appointee it must have some minimum level of contact and respect for him. Unable to weigh these effects we will maintain the distinction permanent-temporary new hires throughout.

Obviously, in a steady-state faculty new hires can be made only through attrition, i.e.,as other members of the faculty retire, quit, are layed-off, die or are not granted tenure. This is the most intuitively appealing way of viewing one of the basic relationships of our models, but there is an alternate way of expressing this: In a steady-state faculty new hires can be made only because there is a limit to the average term of employment, and more new hires can be made only if the average term of employment becomes shorter. We will expand considerably on this below.

We should, finally, remind the reader that the absolute number of new hires per year is a poor index of flexibility and renewal. Obviously, 10 new appointments per year has little impact on a faculty of 1,000 whereas it is quite reasonable in a faculty of 100. The proportion of the faculty turning over each year, or new hires/number of total faculty, is the appropriate index of renewal. We will, therefore, often deal with hypothetical 100 person steady-state faculties so that the absolute H values can

[1]See W. Todd Furniss, Steady-State Staffing in Tenure-Granting Institutions and Related Papers (Washington, D.C.: American Council on Education, 1973), p.3.

be quickly translated into proportions.

3. The Probability of Receiving Tenure (p).

This may be expressed either as the proportion of the initial total of any class of new hires who may expect to receive tenure including those who leave before the tenure decision or as the proportion from any class remaining for the full probationary period and actually standing for tenure who can expect to receive it. The former approach would, in effect, lump together all sources of pre-tenure attrition in a single probability whereas the latter approach separates the departures that result directly from a negative tenure decision from the departures that precede such a decision and deals only with the "purely" tenure related attrition. Thus, if one of an initial class of 5 new hires were to normally leave before the end of the probationary period for whatever reason and one more of those four remaining who actually stand for tenure were to leave due to a negative decision, one might call p either 60 per cent or 3 of 5 (lumping together both sources of attrition) or 75 per cent or 3 of 4 (dealing only with pure tenure related attrition).

We will seek as much as possible to deal with p as the "pure" p, i.e., the proportion of those actually standing for tenure who can expect to receive it, because this is the only attrition variable which a school can directly control and is a matter of universally discussed and stated policy to be clearly outlined in the faculty handbook. Moreover, we would be less than honest in not admitting that the major staffing question confronting faculty and administrators alike is whether non-tenure related attrition and retirements are currently sufficient to permit a steady flow of new hires, and the major issue confronting them is whether formal tenure standards should be accordingly tightened. Other pre-tenure attrition, therefore, will be dealt with separately as "Quits" of a more or less voluntary sort and not directly under the control of the school.

We warn, however, that this approach has its disadvantages: it will necessarily smack of a discussion of policies that sound like a formal "tenure quota," and the distinction between Quits and tenure-related attrition is not clear-cut. In many schools even purely voluntary quits are based on expectations of low likelihoods of receiving tenure if one stands for it, and the absolutely involuntary lay-off is in large measure an early recognition of what might be formalized later were the person to be permitted to actually stand for tenure.

4. Quits and Other Attrition Per Year (Q).

We see no obvious reason to distinguish between any of the segments of the spectrum between purely voluntary quits and absolutely involuntary lay-offs because whatever mutual inconsistencies exist between employer and employee that produce them are no more subject to school-wide discussion and control for one than for the other. We should also remind the reader that this variable includes attrition in the tenured group from a range of causes as diverse as death, ill-health, "seeking greener pastures" or early retirement. We should finally remind the reader that this is undoubtedly the historically most important and yet least predictable of the determinants of new hires, or what is the same thing, the average term of employment.

5. The Average Term of Employment (D).

This is the average number of years which a faculty member may expect to remain employed. As we suggested above, it is in part determined by and indeed, is another way of viewing the sources of attrition we have just discussed; the more attrition there is and the earlier it occurs, obviously the shorter the average term of employment. It is also determined, of course, by the average age at which new faculty are hired and by the retirement age.

We should remind the reader however, that it is not only the amount of attrition but the date when that attrition occurs which affects the average term of employment. For example, were the average faculty member to stand for tenure at the age of 33 (average hiring age, 28, and the normal probationary period, 6 years inclusive) and the retirement age were 65; the average term of tenured employment (one component of the total term of employment) ignoring attrition would be 32 years. Now, were 50 per cent of the tenured faculty to leave before retirement but were they to leave at the age of 64 (after 31 years of tenured service), this would affect the average term of tenured employment very little, it would drop from 32 years to 31.5 years.

It would also have little impact as we shall explain below on the ability to make new appointments (H) or to grant tenure (p). As has been pointed out many times, early retirement provides little relief for aged, highly-tenured faculties for just this reason.

6. Average Age (A).

This variable is fairly straightforward, but we should remind the reader that the mean is only one and often a poor measure of "central tendency." Only in a "well behaved" distribution does it tell a great deal. Assume, for example, a faculty of 24 were distributed in the following extremely uneven manner: 2 persons in each of their first 6 years of employment (or 12 of between 28 and 33 years of age) and 12 more in their last year of employment who were 65 years of age. The mean or average age of this faculty would be 48 indicating a fairly "well balanced" faculty even though half of the faculty were about to retire. Moreover, a year later (assuming all of the retirees are replaced by 28 year olds) the mean age will drop precipitously to about 30 with a correspondingly precipitous drop in the wage bill. Often, the median age, 65 in this case, or indeed, a description of the whole distribution would be more appropriate as a basis for analysis.

7. The Average Wage (W).

In this analysis we shall initially abstract from consideration any economy-wide or market-wide influences on the average wage or total wage bill such as inflation, productivity increases, or the excess supply of PhD's. We will be dealing primarily with the impact of staffing policies and therefore aging on the average wage and total wage bill. This in itself, we hope, will be useful. To know, for example, that a particular staffing policy implies a 3 per cent annual increase in average salaries due merely to changes in the composition of faculty and specifically its age would be a strong indication that a prediction of 3.5 annual increase from all sources of upward pressure in wages understates the most likely rate of increase. We warn, however, that all of our analysis assumes a stable relation between age and average salary when in all probability the relation will shift. We have already pointed out that such economy-wide upward pressures on wages as inflation and productivity increases can probably be ignored because they presumably affect revenue in the same direction and probably the same proportion as costs. Moreover, they are hardly under the control of an individual college. However, the likely excess supply in the faculty labor market, and particularly in that segment of the market represented by older faculty, should have a differential impact on costs and revenues; other parts of the economy will continue to experience rapid wage increases and will therefore be willing to pay high tuitions while the faculty labor market will remain depressed for the foreseeable future producing relatively lower institutional cost increases. We will experiment, therefore, with some downward shifts in the faculty age-income profile to determine how much these might offset the effects of an aging faculty.

B. The Models: An Introduction.

Our discussion so far has indicated implicitly that under steady-state conditions there is some relation between tenure policy (p), the ability to make new appointments (H), the % T, average age (A), and average wage (W) assuming constant the variables which are not directly under the control of the college or if controllable are not used as a matter of policy: the age of new hires, the retirement age, and amount and timing of non-tenure attrition (Q). It seems, moreover, intuitively reasonable that the more liberal a tenure policy (the higher the p), the fewer the new hires per year (the less renewal or flexibility) and therefore the higher the % T, A, and W. In general, our models will examine the nature of the trade-offs between p and H and indicate how each of many given "mixes" of p-H policies will affect % T, A, and W.

Essentially two types of models have been developed to examine these relationships, and for want of any better terms we will characterize the first as the Static Steady-State Model With a Uniform Age Distribution (see LaSalle, J.P., "Appointments, Promotion, and Tenure Under Steady-State Staffing," Notices Amer. Math. Soc. 1972 pp. 69-73) and the second as the Dynamic Steady-State Model With An Uneven Age Distribution (see the 12-College Survey, Institute for Educational Development, 1973). The static model is more elegant and is perhaps best able to provide useful policy generalizations of a non-quantitative sort. It may also provide some gross quantitative bench-marks. However, it is a model which assumes that a college has "no history" and, therefore, no "bulges" in the age distribution of its faculty. This, unfortunately, makes it a very poor predictor because it cannot follow a "bulge" as it "ages" over time, the typical problem facing most schools today. The dynamic model on the other hand, is school-specific and takes the existing age distribution of the faculty as given. It can trace over time the values of each of the variables mentioned above and, therefore, provides more useful predictions. Its failing is its lack of any mathematical base and, therefore, of any policy generalizations; it is largely a "counting exercise." The combination of the two should, hopefully, provide the reader the most insights into the problems of staff planning. We will devote Chapter III to the static model and Chapter IV to the dynamic model. Chapter II will deal with the Carleton-specific data on which the models depend. First, however, an introductory description of each.

1. The Static Steady-State Model With A Uniform Age Distribution.

The Static model is based on the following truism: the number of faculty at any point in time is the product of the number of new hires per year and the average term of their employment or $N = H \cdot D$. Thus, if 5 new appointments were made per year and the length of each contract were 2 years the total number employed would be 10 at any point in time. The 5 new hires of any given year would replace those hired two years before whose contracts were expiring and be added to those 5 hired one year previously. If one wished to increase the new hires rate to 10 per year to provide more renewal while holding the faculty size constant at 10, the term of employment would have to fall or, put in more intuitively appealing terms, the rate of attrition would have to rise. Contracts could only be one year in length so that all 10 employees left each year.

The most direct means a school has of controlling the average term of employment of its faculty or what is the same thing, the rate of attrition, is the tenure decision. Ignoring other non-tenure attrition and assuming that the average age of new hires was 28, that they stood for tenure at 33 (after a six year probationary period) and that they retired at the age of 65 (after 32 years of tenured employment), the extreme cases of p = 0 and p = 1 would produce average terms of 6 years and 38 years, respectively. With p = 0 no one could expect more than 6 years of employment, and given a desired faculty size of 100, new hires could be 16.6 per year (if they could be found!); the 16.6 new hires would replace the 16.6 who were not granted tenure (the "up-and-outs") hired six years earlier and be added to the 5 times 16.6 or 83 hired five or less years earlier. With p = 1 everyone could expect the full 38 years of both probationary and tenured employment, and again given a desired constant faculty size of 100, H could be only 2.63 per year; the 2.63 new hires would replace the 2.63 retirees hired 38 years earlier and be added to the 2.63 times 37 or 97.37 hired 37 or fewer years earlier. Obviously, the more liberal the tenure policy the less the ability to make new appointments.

Using more realistic values for p and H we can also derive the % T and A and W values consistent with them.[2] If one wanted a new hire rate of 4 per year (4% turnover), the only p consistent with this, given the 6 years probationary period and 32 years period of tenured employment, would be .6. This would yield sufficient attrition from retirements and negative tenure decisions to allow a 4 per cent replacement rate without changing faculty size. Or, what is the same thing it would produce an average term of employment (about 25 years), short enough to permit an H of 4 per year. Thus, every year the 4 hired 6 years earlier would stand for tenure and 1.6 or 40 per cent would not receive it and have to be replaced. Moreover, every year 2.4 faculty members or the 60 per cent who had successfully stood for tenure 33 years earlier would retire and have to be replaced. The sum of the two types of attrition would be 4 persons per year permitting an H rate of 4 per year.

This p -- H "mix" would produce a % T of 76, an average age of 44.9, and an average wage of, say, $16,100. Since there are 4 probationers hired per year (and no quits in this simple example), there will be 4 probationers in each of their 6

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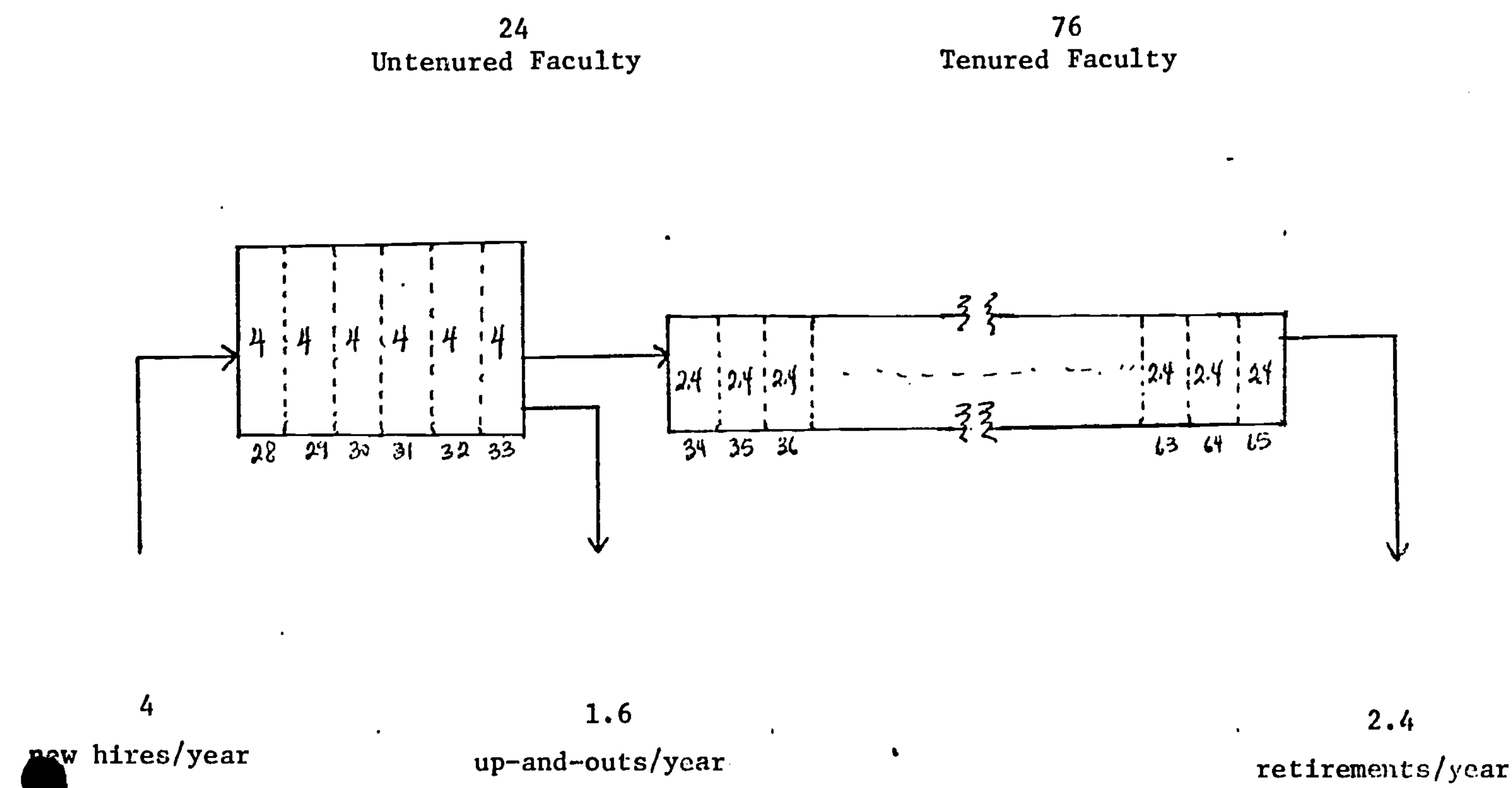
[2] For an extended discussion of how this is done, see Chapter III, Section A.

years of pre-tenure employment or 24 untenured employees. In addition, there will be 2.4 tenured faculty members in each of their 32 years of tenured employment or a total of 76 tenured faculty members (2.4 times 32). This means, in turn, an average age of about 44.9. The faculty member beginning tenured employment will be 34 years old so the average age of the 76 per cent of the faculty who are tenured will be mid-way between 34 and 65 years retirement age or 49.5 years of age. The average age of the 24 per cent of the faculty who are untenured is 30.5, <u>i.e.</u>, mid-way between 28 and 33 years of age. The <u>weighted</u> average of the two averages (.76 times 49.5 plus .24 times 30.5) is about 44.9 years of age. Finally if the average <u>wage</u> of the average untenured faculty member (between 28 and 33 years of age) is $10,000 and the average wage of the average tenured faculty member (between 34 and 65 years of age) is $18,000, the <u>weighted</u> average wage of the whole faculty is .24 times $10,000 plus .76 times $18,000 or $16,100.



<u>Figure I</u>

It is this model which will serve as the basis for our Chapter III elaboration in which such further complications as non-tenure attrition, Q, and temporary faculty will be added. We think it is a useful conceptual device, and starting point for discussions but we warn, again, that it will be a poor quantitative guide to policy options because it effectively ignores a school's existing distribution of faculty by age and rank, or what is the same thing, the school's past history. In the example above, it was possible to say that with a p = .6 tenure policy, H could be 4 per year (and therefore % T would be 76, average age, 44.9 and average wage $16,100) only because that p -- H policy had been followed more or less closely for the past 38 years. Thus, the model says that this year you may make 4 new appointments: 1) because 38 years ago you hired 4 new faculty; 2) because a p = .6 tenure policy was applied to that group 32 years ago and, therefore, only 2.4 are left and retiring this year; and 3) because six years ago you hired 4 new faculty who are now standing for tenure and of those, 1.6 will be untenurable (see Figure 1). That kind of "history," we submit, is really the same as "no history at all" since for most schools today the problem is: how best to achieve a steady-state faculty given that the history of the recent past was one of growth and not steady-state operation.

On the other hand, we should also remind the reader that if faculty size has been more or less stable for many years, if the same p -- H policy mix has been followed for many years, and if the existing age and rank distribution approximates that pictured in Figure 1, then obviously, the p -- H policy mix which has been applied in the past can be continued in the future. This, unfortunately, is like saying there is no problem with past or present staffing policies and therefore little need for further analysis.

Let us be more specific about some of the kinds of deviations from the ideal age and rank distribution pictured in Figure 1, which one should expect in the real world. As a gross statement, the existing distribution will be more "uneven" or filled with "bulges" in particular age groups due to bursts of past growth. First, in most schools there will tend to be more untenured faculty than is consistent with a given p policy because faculty sizes have grown most rapidly during a period recent enough for many of the new hires to be still in their probationary period. Using the Figure 1 example as a bench-mark, assume that the school had been in a steady-state, hiring 4 per year and permitting 2.4 per year to become tenured until six years ago when H rose to 8 per year (p = .6 constant). This, then, produced a six-year rise in faculty size from 100 to 124 and a drop in % T from 76 or 76/100 to 61 or 76/124 because in each of those six years 8 non-tenured faculty were hired and only 4 left; 2.4 of them were tenured retirements and 1.6 of them untenured up-and-outs. Assuming now a desire to return to a steady-state with a constant faculty of 124 the issue is how to accommodate this "bulge" of young untenured faculty.

At first glance there would seem to be little difficulty: One can reduce the new hires rate toward its former 4-per-year level and still apply the same p = .6 tenure policy. Indeed, one needn't reduce H fully to 4-per-year. With such a large absolute number of probationers standing for tenure, even the fairly liberal p = .6 policy would produce 3.2 up-and-outs each year (1 - p or .40 times 8 is 3.2) and with the 2.4 retirements, this would permit 5.6 new hires per year without changing faculty size. The % T (and average wage and average age), of course, would begin to rise toward its former levels. In 6 years there would be about 33 probationers (6 times 5.6) and 91 tenured faculty--the 4.8 (.6 of 8) who had successfully stood for tenure and were now in their first 6 years of tenured service, a total of 29, plus the 2.4 of the pre-growth tenured faculty in each of their last 25 years of tenured service or 62 (26 times 2.4) -- and therefore a % T of 73 or 91/124. Figure 2 describes this age and rank distribution.

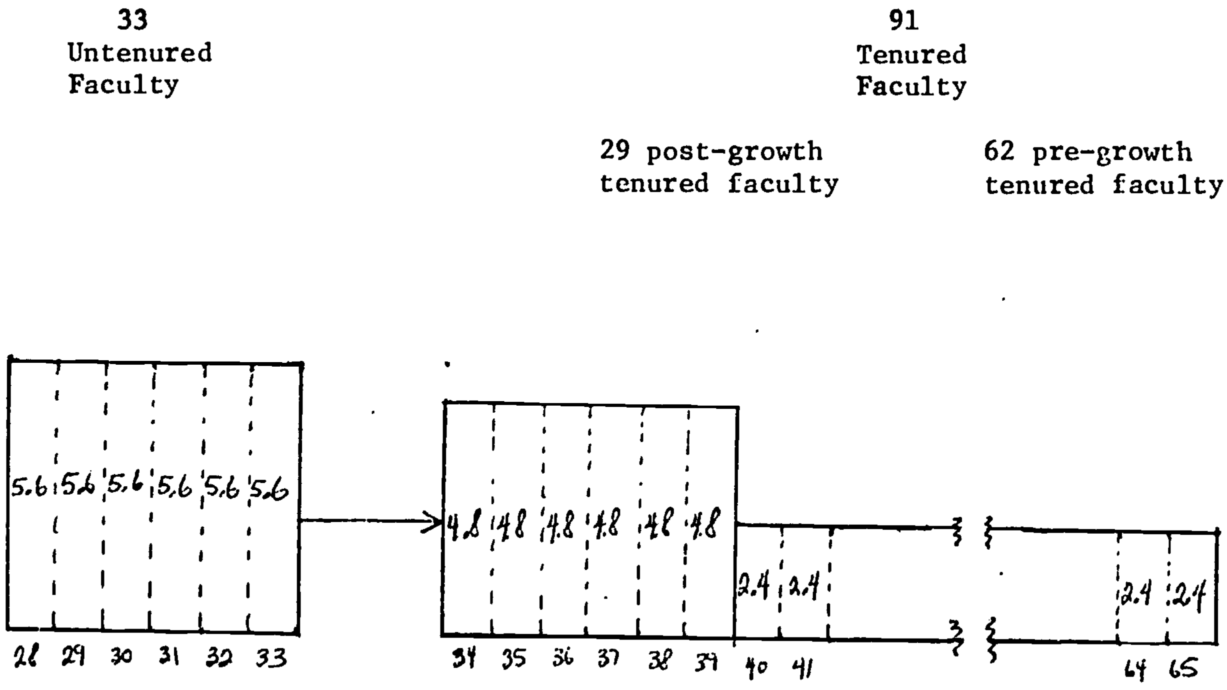


Figure 2

This age and rank distribution is a second major characteristic of the distributions of many schools. Even though the faculty rank sub-groups (Tenured - Untenured in this example) are at or near the appropriate proportion (73 per cent here) the age distribution within those sub-groups is not uniform, i.e., there are not equal numbers of faculty in each year of employment in that sub-group. More specifically, many schools have age distributions which are heavily skewed toward the younger tenured age groups, 34-40. It is this type of faculty which is truly "impacted" in that the school has committed itself to quasi-automatic contract renewals for a very large number of faculty for whom the expected term of employment is as yet extremely long; it has thereby "lost" the one chance it has of directly controlling the average term of employment or what is the same thing, the level of attrition -- the tenure decision.

Let us return to our example and complete our story. First, note that although the absolute number of new hires per year (5.6 per year) remained above its 4 per year pre-growth level during the first six years of the 124 member steady-state faculty, it is about the <u>same</u> as a proportion of the now larger 124 member faculty. And, it is presumably this <u>proportion</u> of the total which best measures the degree of renewal and flexibility provided by new hires. Moreover, by the 6th year % T has nearly reached its pre-growth level, and A and W are beginning to climb. In the seventh year after the new steady-state, conditions worsen markedly. Still assuming p = .6, H must drop to 4.6 per year; retirements are still at their pre-growth levels of 2.4 per year and up-and-outs are 40 per cent of 5.6, the new hires of the previous six years, or about 2.2 per year. As this policy is followed over the following six years % T, A, and W continue to rise. In the 13th year after the 124 member steady-state faculty was decreed H must drop again to only 4.2 per year (2.4 plus 40 per cent of 4.6 or 1.8 up-and-outs) with still further ill-effects on % T, A, and W, and in the 19th year after the new steady-state, H reaches nearly 4 per year again. <u>The whole problem, of course, is that retirements are based on an earlier, smaller faculty of 100 whereas the number being tenured each year is based on the later new hires to support a large 124 member faculty</u>.

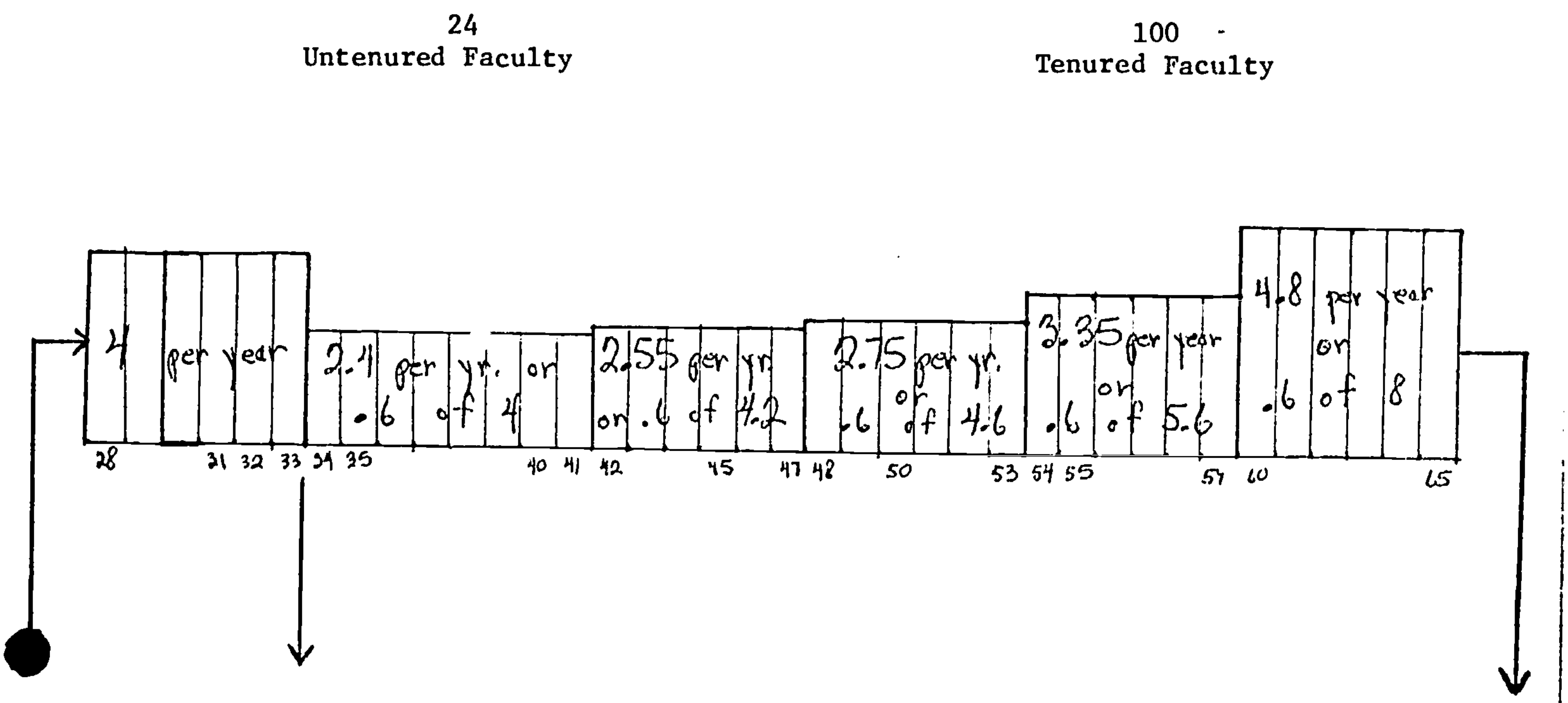


Figure 3

The % T, A, and W are all above their "acceptable" pre-growth levels, because of the "excessive" number of employees in the older and more costly 54-65 age groups, and until this point in time, H has been below its "acceptable" level of 4 per cent of the 124 member faculty turning over per year or 5 per year (it will, of course, rise in the following year). Moreover, had we used a "larger" or "longer" bulge, the distributions would have been yet further skewed.

To recapitulate, then, past growth and its associated uneven age distribution make the achievement of any particular steady-state difficult, and rob our static model which assumes a uniform age distribution of much of its quantitative predictive powers. The discussion above of our hypothetical school with an age bulge, moreover, emphasizes that rigid adherence to any particular tenure standard (or new hires policy for that matter) may have undesirable consequences if past operations have not been steady-state. Much of the hypothetical school's later difficulties could have been avoided (at other costs!) if tenure standards had been tightened along with the 124-person steady-state decree. And, one of the major tasks of the explicitly time-oriented, dynamic model would be to help specify these dynamic options.

2. The Dynamic Steady-State Model With An Uneven Age Distribution.

The dynamic model shares most of the basic characteristics of the uniform distribution, static model. Tenure policy (p) is still "traded-off" against the ability to make new appointments (H), and the more liberal the tenure policy, the fewer new appointments one is able to make. Finally, the mix of p -- H policies chosen, implicitly determines % T, A, and W. The dynamic model, however, differs significantly from the static model in that: 1) it takes as given the existing faculty which is distributed in a highly uneven manner like our immediately post-growth school above and 2) its task is to specify the time paths or year-by-year values of H, %T, and A, and W given a range of p policies as the "age bulges" proceed through time.

The model itself is less a mathematical model than a "counting exercise" of the sort we engage in heuristically for our hypothetical school above. The model's empirical base is the school's current distribution of faculty by age and tenure status which will almost necessarily be uneven. This distribution will then serve as the real world predictor of the number of retirements each year (suitably corrected for quits) for a period in the future equal to the normal term of tenured employment. For example, if there are currently five tenured faculty members who are 50 years of age, one can expect (ignoring quits) 5 retirements 16 years from now. It will also provide real world predictions of the number of those actually standing for tenure each year (suitably corrected for quits) for a period in the future equal to the probationary period of the most recently hired probationers. The number of probationers standing for tenure each year <u>after</u> the normal probationary period of the most recently hired and the number of retirements each year <u>after</u> the normal term of those most recently tenured, will depend on the particular values of p and, therefore, H which we chose for the simulation. Quits, too, will depend largely on the particular values of p and therefore H, chosen because quits should be concentrated in the probationary group and the size of this group will, in turn, depend on the p -- H mix chosen after the first year.

The p -- H trade-off over time should be grossly of the following form: the number of new hires in any given year must equal the sum of the retirements that year (externally given from the age distribution) suitably corrected for other sources of attrition, the number of quits that year, and the number of up-and-outs that year (or 1 - p the probability of not receiving tenure) <u>times</u> the number of new hires of six years earlier. Obviously, if new hires equal retirements plus tenure and non-tenure-related attrition in every year, faculty size will remain constant, and if one wishes to raise H, given retirements and quits, tenure-related attrition must rise through the application of stricter tenure standards (a lower p).

The behavior of % T, A, and W over time will obviously depend on the p -- H mix chosen. Clearly, % T will rise in any year if in that year the number of newly tenured exceeds the number of retirements and tenured quits, if any. The behavior of A and W, however, is not as clear cut, and we repeat our earlier warning that A and W need not always move closely with % T. The % T figure is but a poor proxy for A and

W. Take our hypothetical school, again, in its first six years after the 124 member steady-state faculty had been decreed. It had a very uneven age distribution with relatively few older faculty and, therefore, relatively few retirements. This would have appeared to suggest that H would have to be fairly low to accommodate the bulge of young faculty. However, there was a sort of "correction factor" which maintained the ability to make new hires relatively stable.....for a time! The age distribution was skewed at that point toward the young non-tenured group; and even though retirements were low, replacements needed for up-and-outs were high, partially compensating for the small number of retirements. Thus 2.4 (65-year-old) retirements per year and 3.2 (34-year-old) up-and-outs per year were replaced every year for six years by 5.6 (28-year-old!) new hires. Put differently, roughly 5 per cent of the faculty (5.6 of 124) dropped sharply in average age (and average wage as well) each year of those six years. While this does not fully offset the fact that the remaining 95 per cent of the faculty aged one year in each of those six years, it does affect it considerably. It was only in the seventh year after much of the initial bulge of probationers had become tenured that conditions began to worsen and A and W began to climb sharply. In short, changes in A and W will considerably lag changes in % T.

Chapter IV will formalize and elaborate considerably on this dynamic model and, we hope, will provide further insights of the sort just mentioned as well as some real world predictions of the time paths of our variables given Carleton's existing age distribution. Moreover, and most important, we hope that the dynamic model will give some feeling for the kinds of dynamic options for achieving steady-state that are still available.

3. The Dynamic Options.

Carleton's age distribution is in many ways like our hypothetical school early in its first six years after the decree of a new steady-state. It still has a large bulge of young untenured faculty but the age distribution of its tenured faculty is becoming less and less uniform as this bulge of young untenured is promoted using earlier more liberal tenure standards.

What Carleton chooses to do now, depends, in part, on what our dynamic model will predict for the distant and far distant future, and we have not brought our hypothetical school through the last stages of the cycle. We left it, instead, in its worst state, the 32nd year from "today" (see Figure 3) with % T, A, and W all above their acceptable pre-growth levels and H below its acceptable level because of the excessive number of employees in the 54-65 age groups. We should now emphasize that our hypothetical school will return very rapidly toward its growth-oriented levels of cost and vitality, thereby completing one cycle. It will, moreover, continue beyond those levels to begin another roughly 40-year cycle of gradual erosion in the faculty health and later return to health. The reason for this is that retirements are no longer based on the pre-growth faculty but rather on the growing faculty of from 32 to 38 years earlier and then on the new 124 member faculty with its initially high but then steadily declining number of new hires.

Let's be more specific: in the 33rd through 38th year from today those 4.8 faculty members left each year from the bulge of 8 new hires per year which expanded the faculty will begin to retire. They, plus the 2.4 up-and-outs based on the recent new hires of 4 per year will permit a sharp increase in new hires to 7.2 per year, not quite as high (and this is important for the very long run!) as the initial 8 per year associated with faculty growth. Therefore, a full "new hire cycle" is 38 years, beginning with the first upswing of new hires which expanded the faculty to the second upswing as that group retires in 38 years. This cycle, moreover, may be shorter if the hiring age is above the assumed 28 years and the full term of tenured employment is below the 32 years we have assumed; at Carleton, for example, the cycle is closer to 35 years.

The other measures of faculty health, % T, A, and W, nearly reach their growth oriented floors roughly 10 years after the sharp upswing in new hires in the 33rd year. They drop much more precipitously than they rose because of the precipitous increase in new hires in the 33rd year. However, there is still much inertia in them because of the large number of faculty in the 54-59 year age group at the 32nd year (see Figure 3). Therefore, the full "A and W cycle" beginning with their low levels in the immediate post-growth period when the steady-state was first decreed to their new low levels, 10 years after the sharp increase in new hires in the 33rd year, is about 40 to 45 years long. In short, one can take some comfort in the knowledge that even with a constant tenure policy and an aging, more costly faculty following a growth bulge, there are limits on the diminishing vitality of the steady-state faculty. Furthermore, if a school is well into the worsening part of the cycle, then when relief comes, it comes in massive doses.

There is further, although largely academic, comfort in the knowledge that the cycles gradually erode and all but disappear after something over 200 years. As we underlined above, the upswing in new hires in the 33rd years does not quite reach its 8 per year growth level. Nor, therefore, will % T, A, and W fall fully to their post-growth floors. <u>This process of erosion in the cycle continues if there are no further disturbances (sic?!) until the values of H, % T, and A, and W become stable at the levels predicted by the static model</u>. For example, the H rate consistent with a p = .6 policy and a post-growth <u>124</u> - member faculty is 4.95 per year contrasted with the 4 per year consistent with the same tenure policy and a <u>100</u> - member faculty. After many years of first rising sharply and then gradually dropping, H will approach this 4.95 per year level. Similarly after years of gradually rising and then dropping sharply % T, A, and W will approach their static levels consistent with a p = .6 tenure policy and a 124 member faculty (% T = 76, A = 45.3, and W near $15,500). In short, there is a precise relationship between the static and dynamic models, although they are very distant in terms of the passage of time. Any disturbance of a faculty in long-run static equilibrium - a burst of growth, a change in tenure policy, a drop in non-tenure attrition, etc. - will produce an age bulge and cyclical dynamic behavior. These dynamic cycles, however, eventually disappear, (or "converge" in formal terms) and, everything else constant, the faculty returns to whatever values of H, A, W, and % T are consistent in the static model with the particular tenure policy (p) being followed. The longer one's time horizon, therefore, the closer the static model approaches "reality."

With this understanding of the full cyclical behavior of a faculty over time let us return to the school at the beginning of the worsening part of the cycle and consider its options.

There are approximately four dynamic options that are still available; none have been fully foreclosed. All unfortunately will have costs or undesirable consequences; a) New appointments, H, can be reduced to accommodate the bulge, leaving p at its growth and pre-growth level. As we have noted above, so long as p is a good deal less than 1, (not everyone receives tenure who stands), say .6 or .7, the drop in H is delayed by the initially fairly large absolute numbers of up-and-out spots. However, as we have also described above, when H begins to drop fairly sharply, thereafter, all the undesirable consequences of an (at least "temporary" -- 25 years?) aging, more costly, more tenured faculty on teaching, admissions budget etc. would result (as well as later repetition of the 40-45 year cycle). b) p, alternately, could be reduced to keep H at its fairly high pre-growth if not growth-oriented levels. This would tend to even out that part of the age bulge that is not yet tenured and avoid at least part of the later tendency toward an aging and more costly faculty. On the other hand, this "may require the departure of persons who are better qualified than the best to be considered in following years"[3] and will have a no less undesirable qualitative impact on faculty morale, teaching etc. It will also smack of discriminatory practices and may lead to litigation, unionization, etc.

There are, of course, two other possible options which could, but will probably not, be considered: c) One might violate the steady-state decree; p and H could remain at higher levels inconsistent with a steady-state faculty. This would maintain % T, average age, and therefore, average wage at their lower growth oriented levels but the total wage bill would rise with the size of the faculty. And, finally, d) One might experiment with a continued high p level and lower H levels combined with new hiring at what Furniss calls "the ages of least concentration" i.e., hiring older, tenured faculty members rather than the traditional, fresh-out-grad school 28 year old. As we see it, this would spread the

[3] Furniss, op. cit., p.4

ill-effects of Option A above more evenly across the whole 40-45 year cycle rather than allowing them to be concentrated toward the end of the initial 25-30 years. Thus, if the school began hiring costly 40 and 50 year olds now to fill the retirement and up-and-out vacancies of the next 5-10 years, it would be assured of much higher level of new younger hires in 15 or 25 years when the current tenured age bulge had moved on to the point that it was significantly restricting H. On the other hand, this would tend to "validate" our pessimistic predictions about the far future now, when, in fact, those predictions may be wrong.

Most currently enunciated policy throughout the country appears to be producing the aging, highly tenured, more costly faculty approach to steady-state, i.e., Option A above with an ever dropping new hires rate until the end of the maximum expected term of the most recent new hires and a fairly liberal p policy. That is why we chose to illustrate our example of an uneven age and tenure distribution with this type of a policy. Presumably, Chapter IV's elaboration of the dynamic counting model will provide some insight into the alternate time paths of its variables with lower p and higher H values.

An interesting variant on the continued high p -- downward adjusted H approach (Option A) has been suggestions for, and in some cases, the implicit creation of a new class of faculty, the "probably" long-term but "possibly" untenurable group. In effect the probationary period is extended (for the most recent new hires) and the "up-and-out in six years rule" is eliminated. This reduces considerably the equity gap between current new hires and the new hires of a few years ago, i.e., expected wage and job security differentials are lessened between the two groups, and it keeps the % T figure at an "acceptable" level. However, as we have observed again and again % T is a poor proxy for the health of a faculty and particularly so in this case. It alters very little the fact that the current younger age bulge will age and become more costly over time. Moreover, it tends to reduce H immediately rather than in the delayed fashion that we described above because there is an immediate moratorium on tenure decisions and, therefore, up-and-out spots. It is purely cosmetic except in one sense we shall touch on in a moment.

These dynamic options will be significantly affected by the time horizon one works with. How long can an institution remain viable with the values of any one or a combination of these variables at "undesirable" levels? If the age bulge is small and concentrated in a few years and/or if the planning horizon is very long, a school might live with the option of an aging, more costly faculty approach to steady-state. Our hypothetical school in its worst state, the 32nd year from "today" (see Figure 3) will thereafter experience a sharp rise in H and consequent return to health through a drop in A, W, and % T in the next 10 years (from the year 2005 on!). If, however, the bulge is large and the horizon short; the school might well consider Option B, a stricter tenure policy. In either case, we think it desirable that our dynamic model extend over the full cycle (a decidedly unrealistic 40-45 years) so that the options are not obscured by the model's own imposition of a "too short" time horizon. The 12-College Survey model, for example, "stops" after 10 years (possibly realistic as a time horizon), but it thereby forecloses consideration of any alternate time horizons and almost neccessarily produced a conclusion that Option B, stricter tenure standards, is necessary.

The long-term probationer, untenured faculty variant of Option A seems to be a response to the uncertainty over an appropriate time horizon given a large age bulge. It appears to say: "right now, we are going to try to live with an aging and more costly faculty and to promote those currently employed who we think are qualified (on the assumption they'll be better than the best of you to come later), but should this begin to "hurt," you, the new-comers after this year, will be the first to depart to permit us to raise H. In short, we will not, hereafter, commit ourselves formally to quasi-automatic contract renewal i.e., to tenure." One wonders how mobile a 45-year-old would be should the worst happen. However, someone must bear the risk if any institution's very viability is at stake.

To conclude, a final source of pressure for an increased consideration of stricter tenure standards as a dynamic option is the affirmative action program and other commitments to achieve a particular proportion of women and minority members in the faculty.

Assuming that there is some upper limit on the proportion of new hires that can be committed to minorities and women -- limits imposed by the market itself and by a school's own quality standards -- the fewer the new hires, the longer it will take to achieve a particular proportion of minorities and women in the faculty. Unfortunately, the very drop in p which would be necessary to raise H to achieve the affirmative action goals sooner could either worsen the long-term employment prospects for the women or minority members being hired or lead to discriminatory tenure policies.

Chapter II

Carleton - Specific Data: The Parametric Basis For Our Models And A Casual Description Of The Dynamics Of Recent Staffing Policies

Apart from simply satisfying the reader's curiosity this chapter has two major goals: 1) to provide reasonable values for the basic parameters needed for the static and dynamic models and 2) to provide an intuitive understanding of some of the dynamic inter-relations between our variables by a short description of their behavior at Carleton over the past five years and by a contrast between their recent values and those in a year (1958-59) when the faculty was in long-run, steady-state equilibrium.

For both static and dynamic models we need a basic specification of the length and form of the average terms of employment for the "full-service faculty member," i.e., the new hire who remains at Carleton through retirement. This, in turn, requires specification of the average age of hiring, the average age at which the tenure decision is made, and the average age of retirement. Put differently, we must specify the length of the probationary period and the length of full tenured service.

Up to this point we have ignored non-tenure attrition, and in our examples in Chapter I we assumed for expositional simplicity that new hires replaced only retirements and those not granted tenure. We have found, however, that non-tenure attrition -- what we called Quits -- has traditionally been an extremely important source of replacement spots at least as important as retirements or what is the same thing, an extremely important limit on the average or expected term of employment. If this chapter succeeds in accomplishing nothing more, we hope it will be to emphasize both the past volume and the variability of Quits. Because of this unpredictability in an extremely important parameter, we must warn the reader to be very skeptical of any of the quantitative work that follows for both the static (Chapter III) and dynamic (Chapter IV) models.

In dealing with Quits we have found it useful to distinguish between pre- and post-tenure quits because the determinants of each are quite different. We must specify both the proportion of any class of new hires which can be expected to quit before the tenure decision, the Non-Tenured Quit Rate, and the proportion of any class of newly tenured faculty who can be expected to quit or die before retirement, the Tenured Quit Rate. We must also specify the timing or average age of those quits just as we needed to specify the timing or average age at the tenure decision.

We have also ignored so far the temporary or tenure ineligible faculty, and we would also hope to bring an appreciation of the important role they play and the strikingly large proportion of most faculty they represent. We must specify both the average age of the temporary new hire and his average termination age or what is the same thing the average term of temporary employment. We must also specify a reasonable value for the number of temporary new hires one can expect per year.

We, finally, must specify the current age-average wage relation which will be useful in both the static and dynamic models and the age and rank distribution of the existing faculty which will serve as the basis for our Chapter IV counting model and as a means of identifying the degree to which our static model deviates from a "real world" faculty characterized by past growth.

Before beginning an historical description of recent staffing policies, we should describe at the outset the basic unit of measurement and the sources of our data. All amounts of faculty are expressed in terms of full-time equivalents (FTE's). This is because our interest in the faculty is not focused on its "body or name-count" but on the qualitative contribution this group of names has on teaching, research, etc. and the quantitative, financial obligation it places on the school. The FTE figure reflects this contribution and obligation much more accurately than the name count, but we warn that it is by no means perfect. Clearly, three .33 - time faculty members do not contribute or cost the same as three full-time faculty members. However, neither do they typically contribute or cost their FTE value of 1 full-time faculty member. Full-time equivalents are normally based on a full teaching load of six courses per year (or five courses plus a department chairmanship) one-third FTE, therefore, teaches two courses and either works only part-time at Carleton or has non-teaching duties at Carleton presumably equivalent to four courses.

Ages of the faculty are expressed in whole numbers. A person is considered to be a given age in a given year if he was that age on September 1st of that year. Thus, in principle all retirements occur at the age of 64; no permanent faculty member can begin a new academic year as a permanent faculty member if he is 65 in September of that year; he is therefore considered 64 for our purposes even though he may become 65, say, only a month later.

All wages of faculty members are Carleton base salaries before deductions and do not include grants of any sort, internal or external, any of the special subsidies such as mortgage or faculty children subsidies, nor any of the college contributions toward retirement, health care, etc. i.e., "Staff Benefits" in the Treasurers Report. This will tend to minimally understate the financial impact of any faculty "aging" since any college payments above base salary are more likely to be made to older faculty.

We are, finally, concerned largely with the characteristics (% T, A, and W) of the teaching faculty and not the teaching-plus-leave faculty. There are many reasons for this. Most obviously, it is the quality and vitality of the teaching faculty which determines the quality of instruction. For example, even were a school's 100-member permanent faculty 100 per cent tenured, should the school succeed in maintaining fully 90 of these faculty permanently on leave and replacing them with highly credentialed temporaries who stayed fully five years each, few would question the quality of instruction at that school. The % T of the teaching faculty of 10%, (10/100), more accurately characterizes the quality of instruction, we feel, than the % T of the teaching-plus-leave faculty of 53, i.e., 100/190. Moreover, the base unit of analysis in all college decision-making is the teaching faculty, and it is this unit which is conventionally used in inter-college comparisons, e.g., student-faculty ratios use teaching faculty as the base and % T figures are the ratio of tenured teaching faculty to total teaching faculty.

Thus, if an observer feels that describing the teaching-plus-leave faculty is more appropriate, then he is forewarned that much of our quantitative work will slightly over-state (from his standpoint) the proportion of temporary faculty in the total since temporary appointments are partly to replace those on leave, but the total of which they are a part does not include those whom they replace. Our approach will also understate again, (from the critic's standpoint) the A, W, and % T since temporary replacements of those on leave are usually younger, earn lower wages, and are necessarily untenured.

Fortunately, as long as "leave rates" are stable (currently about 10 per cent of the leave-eligible [permanent] faculty) and are roughly the same for both tenured and untenured groups, the factor of "over-statement" and "understatement" remains constant, and therefore the values of A, W, and % T consistent with given p's remain "correct" except for that constant. If either model says that reducing p will reduce % T by "x" per cent, this will be true whether % T is the higher number calculated including tenured faculty on leave and using a larger size teaching-plus-leave faculty as the base or our lower number calculated ignoring tenured faculty on leave and using the smaller teaching faculty as the base.

For example, assume a teaching faculty which is to be kept constant at 200. Assume as well that there are 200 permanent faculty, 100 tenured and 100 untenured, and leaves are a stable 10% of that permanent faculty. Ten per cent of that 200, 10 tenured and 10 untenured, will be on leave and be replaced by 20 untenured (younger and less costly) temporaries. Using the "teaching-plus-leave approach," the % T is 100/220 or 45.5. Using our "teaching-only" approach, the % T is 90/200 or 45, a minimal "under-statement" of .5 percentage points. Finally, assume that a drop in p reduces the number of tenured faculty to 50, thereby reducing tenured leaves from 10 to 5 and raising untenured leaves from 10 to 15. Whichever approach one uses, % T will drop by one-half; i.e., our approach would show % T dropping from 90/200 or 45 to 45/200 or 22.5, the alternate approach would have % T dropping from 100/220 or 45.5 to 50/220 or 22.75. The same would be true for the behavior of A, W, and H consistant with given p's.

In short, so long as our primary interest is centered on changes in our variables' values, it makes no difference which approach is used. Moreover, we think a good case can be made that any secondary concern with the absolute values of our variables should be directed toward the values for the teaching faculty only. Where it seems appropriate, we will also indicate their values for the teaching-plus-leave faculty. For example, in any calculation of the absolute value of the total wage bill (but not its rate of growth which is unaffected by the presumably stable amount paid to those on leave) we will include wages paid to those on leave. Finally, our models do not "lose" those currently on leave; they "return" to either stand for tenure, quit, or retire and are replaced by new hires.

Our basic sources of data are two-fold. All current data, the age, rank, and wage distribution of the existing (1973-74) faculty and the departures and new hires of the most recently completed academic year (1972-73) were obtained from the Office of the Dean of the College. Our "historical" data, any data for years prior to 1972-73, were based on FTE records of the Business Office and conversations with officials of the Office of the Dean of the College.

The major problem encountered in the compilation of the historical data was the often limited usefulness of official college records. When an individual receives a Carleton appointment, the exact status of that appointment (temporary vs. permanent) is not always a matter of public record, and sometimes may even be unclear to the individual hired. Also, though a faculty member may leave for any one of a number of reasons, official college records are no help in determining which of them is the applicable one. For the purposes of our study it has been necessary to determine which departures were a natural consequence of the end of a temporary appointment, which occurred as a result of a denial of tenure, which were retirements, and which occurred for other reasons not specified.

Thus, it has been necessary to rely on the memories of present and former academic administrators to determine the status of past appointments and the causes for faculty departures. Though the basic data used are from the recent period 1967-68 through 1972-73, recollections cannot be guaranteed to be perfect. However, we feel confident that they are quite close, and certainly are adequate to show general past trends and be a basis for choosing what are "reasonable values" for the relevant variables at Carleton.

We must emphasize that at no point in the research were any of the final data identifiable by name or other identifiable individual characteristics and that all data will be presented in aggregated form of no fewer than two individuals. Such individual identification of current faculty data is known only by the Office of the Dean of the College and the Coordinator of Institutional Research. Individual identification of historical faculty data is known only by the Coordinator of Institutional Research who obtained the data from previous members of the Dean's office.

A. Some General Observations: The Dynamics of Recent Growth

In our heuristic discussion of the growing 100 to 124 member faculty in Chapter I, we described in broad outline the dynamics of the impact of growth followed by a steady-state decree on a faculty. We did not perhaps emphasize enough that the "growing" faculty in some sense enjoys an "artificial" (so long as there is some limit to growth) reduction in % T, A, and W, through very high new hire rates. Thus, no school committed to steady-state can even hope to enjoy the kinds of faculty staffing conditions characteristic of the period of rapid growth in the mid-and-late-1960's. Moreover, when growth stops, part of the rise in % T, A, and W and drop in H is merely a return to the "normal" pre-growth levels of those variables. Carleton, for example, still has a slightly younger, less tenured, and less costly (on the average and ignoring economy-wide inflation and productivity increases) faculty than it did in 1958-59, a year when Carleton was still in an earlier long-run steady-state equilibrium. Finally, there is a stage which Carleton has not yet fully entered when the measures of faculty health and financial obligation deteriorate beyond those "normal" levels, the extent and type of deterioration depending on the dynamic options chosen.

Carleton's recent staffing decisions mirror this scenario quite closely. Since 1960-61 the college has significantly expanded the size of the faculty, and as a result of the influx of younger appointees, % T was on the decline until several years ago. Exact data for the beginning of the period is unavailable, but it can be safely said that in the academic year, 1958-59, the college had roughly 90 teaching faculty and was 54 per cent tenured. By 1967-68, the beginning of our year-to-year data, the teaching faculty (and teaching-plus-leave faculty assuming leaves are a constant proportion of teaching faculty) had risen by 30 per cent to about 117, and % T had dropped to about 48%. These numbers, imperfect measures as they are, are surely indicative of a dramatic change in faculty size and composition in less than a ten year period. The trend seems to have continued three more years until 70-71 where % T bottomed out at 45.37% and the faculty size was 122.51. In the three years since, faculty growth has been much slower, and % T has risen considerably to 53.24 in 1973-74. A and W are presumably following the same paths but with a lag.

TABLE I

Size and Composition of the Teaching Faculty 1967-73

Year	Temporary Faculty	Permanent untenured	Tenured	% Tenured	% Temporary	Total* Faculty	Change From Previous Year
1958-59	----	----	48.60	54.00	----	90.00	
1967-68	7.73	53.28	55.96	47.84	6.46	116.97	
1968-69	10.30	55.62	57.56	46.61	8.34	123.48	+6.51
1969-70	10.55	58.09	57.30	45.50	8.38	125.94	+2.46
1970-71	12.44	54.49	55.58	45.37	10.15	122.51	-3.43
1971-72	13.51	51.36	58.24	47.31	10.97	123.11	+ .60
1972-73	15.84	43.54	68.42	53.54	12.39	127.80	+4.69
1973-74	16.76	43.18	68.26	53.24	13.07	128.20	+ .40

*(Excluding part-time music and other academic personnel with 0.00 FTE designations)

The rise in % T and presumably A and W has been due, obviously, to the particular choice among options for coping with the decision to approach steady-state or at least to slow the rate of faculty growth -- the choice to lower H while maintaining p at its former levels. While % T, A, and W have not quite reached their pre-growth levels, H appears to have already dropped below its presumably appropriate pre-growth level. Hiring information for the late 1950's is poor, but an average of 10 new hires (temporary and permanent) or 12 per cent of the 85 or so member faculty seems appropriate. This contrasts with the most recent 12.75 per year figure which though larger in absolute terms (5.92 permanent new hires plus 6.83 temporary new hires), is a smaller proportion, 10 per cent, of the 1973-74 faculty (see Table II). Although extremely variable on a year-to-year basis, the proportion of tenure requests granted over the whole period averaged about .71. This is the weighted average p where the weights are the proportion standing in any given year of the total of 37.33 who stood over the whole 1967-73 period.

Table II also demonstrates the importance of Quits as a source of replacement openings. Fully 60 per cent of the total attrition over the six years or 4.5 per year are permanent Quits, and there seems no marked decline in the figure regardless of the recent tightening in the job market. Moreover, as can be seen, a large part, 30 per cent, of these permanent Quits are, surprisingly, from the tenured group. Non-tenured quitting, nevertheless, is also large, and there are considerably more untenured departures classifiable as Quits than those linked (directly!) to the formal tenure decision.

B. The Basic Parameters: Average Terms, Quit Rates, and the Temporary Faculty

1. The Full-Service Faculty Member. Although relatively few of any group of new hires will fall into this category, we will first consider the case of the faculty member who begins teaching at Carleton at some average age, successfully stands for tenure, avoids quitting, and works through the retirement year.

a. The Probationary Period. The college has had an official guideline that the tenure decision is made during the fifth year for Associate Professors and during the sixth year for Assistant Professors. However, there appear to have been many cases where Assistant Professors went through the process during the fifth year. Thus, the probationary period, though it must necessarily be between 5.00 and 6.00 years, could vary with the relative composition by rank of the faculty in the tenure decision region and the extent to which the official guidelines are adhered to.

The determination of the average probationary period, in short, required first determining for any given year the proportion of those standing for tenure who were standing in their fifth year and the proportion who were standing in their sixth year. These proportions then served as weights for determining the weighted average probationary period for the whole group. For example, if half stood in their fifth year and half

TABLE II

New Hires, Sources of Attrition, And

The Proportion of Tenure Requests Granted 1967-73

Year	New Hires Temporary	New Hires Permanent	Number Standing For Tenure	Proportion of Requests Granted	Negative Tenure Decisions	Temporary Terminations	Quits (Deaths in parentheses) Untenured	Quits (Deaths in parentheses) Tenured	Retirements	Excess of Hires Over all Sources of Attrition *
1967-68	6.70	17.00								
1968-69	9.41	11.14	6.67	.70	2.00	6.84	2.25		1.00	+8.46
1969-70	6.19	10.00	3.00	.33	2.00	5.94	3.00	4.00(2.00)	1.00	+ .25
1970-71	6.94	11.67	5.67	.82	1.00	5.05	7.64	3.00(2.00)	2.00	- .08
1971-72	9.51	9.50	8.00	.75	2.00	8.44	2.14		1.00	+5.43
1972-73	7.67	5.00	12.00	.75	3.00	5.34	2.00		1.00	+1.33
1973-74	5.92	6.83	2.00	.50	1.00	5.00	2.00	1.00(1.00)	1.00	+2.75

*This will not be identical to the change in teaching faculty size in Table I because of year-to-year changes in the number of faculty on leave. For example, in 1968-69, the teaching faculty rose by 6.51. However the Excess of Hires over All Sources of Attrition was 8.46 indicating that 2 more faculty members went on leave in 1968-69 than in the previous year.

in their sixth, the weighted average of both groups would be 5.5 years. As Table III indicates a strikingly large proportion of those standing for tenure, nearly one-half, did so in their fifth year and the average probationary period for all is 5.51. Since our Chapter III static model does not pretend to accuracy and the difference between using 5.51 and 6 years has relatively little impact, we will use 6 years for the static model. However, in the dynamic model of Chapter IV we could take this deviation from 6 years into account by telling the computer to "call" half of those in their fifth year to stand for tenure and all of those remaining untenured, in their sixth year.

TABLE III

Weighted Average Probationary
Periods 1967-73

Year	Number Standing For Tenure	Probationary Period
1967-68	6.67	6.00
1968-69	3.00	5.00
1969-70	5.67	5.65
1970-71	8.00	-5.00
1971-72	12.00	5.67
1972-73	2.00	5.50
Weighted Average Of all Six Years		5.51

b. The Full Term of Tenured Employment. Two further pieces of information are necessary to determine the remaining years of tenured employment a full service faculty member can expect to enjoy: 1) the average age of a permanent (or tenure eligible) faculty at the date of hire (assumed by convention, to be Sept. 1 of the academic year he begins employment) and 2) the average age at retirement. As we have already discussed, if the principle that a permanent faculty member cannot begin a new academic year if he is 65 has been strictly adhered to, then, the retirement age is necessarily 64 using our convention of determining age on Sept. 1. This seems to be the case as indicated in Table IV. Given the hiring age and the 5.51 year figure for the probationary period, we know the age at which a faculty member begins tenured employment and the sum of that year and all the succeeding years through 64 is the term of tenured employment.

We should warn that we are making the simplifying assumption that the average age of permanent new hires who are eventually granted tenure is not significantly different from those who do not stand or are rejected. This we believe to be acceptable. We are also assuming that the probationary period for those who are granted tenure is the same as the probationary period for all who stand for tenure, an even more understandable assumption in light of the fact that because of the high p's that have prevailed, the two groups are quite similar.

TABLE IV

Hiring and Retirement
Ages 1967-73 Permanent Only

Year	Mean Age on Sept. 1 of The First Academic Year of Employment of Permanent Faculty	Mean Age on Sept. 1 of The Last Academic Year Before Retirement
1967-68	29.97	64.00
1968-69	34.25	64.00
1969-70	31.40	64.00
1970-71	29.26	64.00
1971-72	29.12	64.00
1972-73	28.00	64.00
1973-74	31.34	?
Weighted Average of All Six Years	30.59	64.00

As table IV indicates the mean age of permanent new hires is 30.59, and given a mean probationary period of 5.51 years the full service faculty is 36.10 years old in the year he is granted tenure, and begins his first year of tenured employment at the age of 36.10. The full term of tenured employment, then, is 28.90 years, the numbers of years between 36.10 and 64 inclusive.

We should warn here that the mean age of permanent new hires obscures the very wide variance in average hiring ages. The year-to-year values indicated in Table IV, for example, vary from 28.00 to 34.25. Moreover, in any given year the hiring age varied from as low as 25 to as high as 42. Clearly, Carleton does not follow a strict "fresh-out-of-grad-school, 28-year-old" hiring policy. Moreover, many "fresh-out-of-grad-school" new hires are not 28.

This degree of variation is relatively unimportant for our idealized static model, but introduces several problems for the Chapter IV dynamic model which seeks greater accuracy. For example, if all new hires predicted for the coming years are entered at the age of 30 rather than being distributed over the whole range of hiring ages, the dynamic model will begin to understate retirements, and new hires at about the 23rd year in which it is "counting" (1996) . During the first five and six years for which it is counting, the model will "call on" those actually employed now with fewer than five or six years of service (whatever their ages!) to stand for tenure. For 24 years it will also be "retiring" those actually employed now with 24 years or less left before retirement. It will, finally, base all Quits and deaths during the first five years on those currently employed. However, were it to replace these existing faculty members with "lumps" of hypothetical 30 year old new hires, it would begin to understate the retirements that would probabl· occur in the real world after the 23rd year from today. This is because the model placed all the new hires of 23 years earlier in the 30 year age group (nowhere near retirement by 1996) when, in fact, in the "real world" as many as three new hires have entered the Carleton faculty at age 42 and would, in fact, be reaching retirement.*

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*Note, even if the model did lump all new hires at age 30 rather than distributing them,

(continued)

Ideally, then, our counting model should <u>distribute</u> any of the hypothetical new hires it makes over the <u>whole range</u> of hiring age classes and not in one lump at the mean hiring age of 30. While we can never predict with certainty the exact age distribution of new hires we can reduce any known biases in the model by some spreading of new hires over a "reasonable" range of age classes with the mean being thirty.

2. <u>Quit Rates on Non-Tenure Attrition</u>. We have pointed out that a model which assumes that all new hires reach the age of the tenure decision or that all of any newly tenured group will reach retirement age is a far cry from the real world. Untenured Quits are considerably more important than negative tenure decisions in producing replacement spots and although Tenured Quits are less common than Untenured Quits they are also very important. Since Tenured Quits are due primarily to death or are largely at the volition of the faculty member whereas Untenured Quits are more directly influenced by the college, we will deal with each separately.

a. <u>Untenured Quit Rates</u>. A quit <u>rate</u> is the <u>ratio</u> of those quitting before tenure in a given class of new hires to the initial size of that class of new hires. Put differently, it is a measure of the expected amount of survival from each hiring year. This means one cannot simply look at the quits of a given year in comparison with the hires of that same year. This would distort the magnitude of the attrition because of the changing rate of growth of the faculty that has characterized the period which the data cover. Therefore data on quits were rearranged so that for any given year we would know the number who were hired in that year who quit before standing for tenure. All the hiring decisions for a given year were listed and the tenure decisions for five and six years later were then examined. Those who did not stand for tenure were assumed to be Quits.

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*(continued) it would contain no biases for % T and A until it begins making predictions for 1996. Even though it "calls" a "real world" 39-year-old (or 26-year-old) only 30, that hypothetical new hire will still become tenured or leave in 5 or 6 years or quit in 3 or 4 years, so % T will be not affected by its "error." Nor, will A. Remember, the <u>average</u> age of the new hire is, in fact, 30. If the counting model describes both a real world 26-year-old new hire and a real world 34-year-old new hire as being 30, it has not distorted the mean of their two ages nor, therefore, the mean of the faculty that they enter. The counting model <u>would</u> slightly overstate W if all new hires are treated as 30 years old rather than being distributed. The mean age of two "real world" 26 and 34 year olds will be lower than that of two hypothetical 30 year olds because their wage rises less than proportionally with age. (see Section D)

This information was obtained for the hiring years 1963-64 through 1967-68. Information for later hiring years is not yet available because the individuals concerned have served less than six years, and not all potential quits have in fact left. Information for earlier hiring years is not included because tenure decisions for 1966-67 (the fifth year of service for the new hires of 1962-63) and earlier were not obtainable. Unfortunately, this means that these data are older and therefore most likely weaker than other data discussed so far because none of the quits by faculty who have been hired since 67-68 enter into our determination of the Untenured Quit Rate. On the other hand, one can form a rough idea of the value of more recent Quit Rates through the use of six-year averages of Permanent New Hires and of Untenured Quits from data in Table II, and we will at least compare these two Quit Rates for stability.

Untenured Quit Rates from the 1963-68 hiring classes were remarkably high. Of the 1963-64 class of permanent new hires, for example, fully 100 per cent quit before standing for tenure, and quit rates in other hiring classes ranged from no lower than 43 per cent to as high as 81 per cent (see Table V). The weighted average Untenured Quit Rate for the whole group of hiring years was an astounding 64 per cent; more than 6 of any 10 new hires quit before standing for tenure. While this rate is undoubtedly too high given current market conditions, it provides a well documented and fairly firm upper limit of .60 for the Untenured Quit Rates.

TABLE V

Untenured Quit Rates

Year	Number of Permanent New Hires in That Year	Number Quitting Before Tenure	Quit Rate
1963-64	7.00	7.00	1.00
1964-65	14.30	11.63	.81
1965-66	7.00	3.00	.43
1966-67	18.00	9.00	.50
1967-68	17.00	10.00	.59
Weighted Average of All Five Years			.64

Data in Table II, on the other hand, give evidence of some decline in the Untenured Quit Rate since the 1963-68 period. The absolute number of Quits in the 1968-73 period only has been 2-3 per year with one notable exception, 1969-70, when there were 7.64 Quits. We, therefore, must attempt some estimate of more recent Untenured Quit Rates by using the ratio of the average of the number of Quits per year to the average of the new hires per year over the same years. Using this approach yields an imperfect estimate of the recent Untenured Quit Rate of .35. We know of at least two sources of bias in this estimate which should hopefully cancel out. First, the recent quits (3.1 per year on the average) are, in fact, quits from the hiring classes of from 1 to 6 years earlier which were somewhat larger (see Table V) than the recent hiring classes of 8.8 per year on the average; the most rapid growth in the faculty and the largest new hiring classes occured in the hiring years 1964-65 through 1967-68. This means that the .35 figure overstates the likely rate of untenured quitting because the "wrong" (too small) base of new hires is being used to calculate the rate. On the other hand, this is probably more than offset by the fact that not all of the potential quits from those hiring classes have yet been recorded. In short, there is some support for using .35 - .40 as the Untenured Quit Rate or an even lower number if one feels that the large number of quits in the 1968-70 academic year was unusual and will not be repeated. For the initial runs of both static and dynamic models we will use a .40 Untenured Quit Rate, considerably less than the fairly firm upper bound of .60 derived from the 1963-68 hiring class information but a little above the most conservative inferences that one might make from the 1967-73 data.

The reason for our unwillingness to be "too conservative" (at least initially) is the heavily involuntary nature of Untenured Quits and the growing institutionalization of the pre-tenure "weeding out process." Untenured Quits appear to fall into two broad categories: a group of faculty which leaves more or less voluntarily within two years of being hired because of an awareness of mutual inconsistancies between existing faculty and themselves, and a second group that leaves in the third or fourth year after being informed of the likelihood of a negative tenure decision in a more or less formal manner akin to what is now institutionalized in the Third-Year Review. In many cases this is an early, informal tenure decision and is nearly as clear-cut and definite as the formalized procedure. Although a matter of opinion, this "early decision" may be more humane in that it does not make the decision a public one and gives one time for job-hunting and for self-improvement.

At any rate, while the first more or less voluntary group has diminished in size with the recent worsening of market conditions (only 3 of the 20 quits from 1967-73 did so before their third year whereas 8 of the 40.63 quit from the 1963-68 hiring classes did so in their first year), a second group of less voluntary quits has always been large and seems unaffected by market conditions. Probably for most, the expected trauma and other ill-effects of a negative tenure decision are great enough to induce a quasi-voluntary departure before an absolutely involuntary one no matter how poor the alternate job possibility. While we had no individually identifiable data, 28 per cent of the total of all Untenured Quits between 1968 and 1973 were characterized as early informal tenure decisions in which faculty members were told directly the likelihoods of a negative decision. Moreover, all but three of the remainder quit in the third year or after, and if not directly informed of the likelihood of a negative tenure decision had at least formed their own expectations of such a decision.

b. The Average Term of Untenured Quits. This is simply the weighted average of the number of years the Untenured Quit was employed. Thus, if we break down a particular year's quits into separate groups by the date of hire and find that half were hired two years earlier and half, four years earlier, then the weighted average term of Untenured Quits is three years (even though no one quit who had been hired three years earlier!) As we have indicated, there has probably been a shift in the distribution of lengths of employment before quitting since 1967-68 because the recent worsening of job market conditions has reduced the early voluntary departure. Assuming that these deteriorating conditions will be with us for many years to come, we will work with the 1968-73 Quits rather than the 1963-68 data that were used to determine the upper limit on the Untenured Quit Rate.

TABLE VI

The Average Term of The
Untenured Quits

Leaving at the End of the Academic Year	Number of Untenured Quits*	Weighted Average Term of Employment
1967-68	2.38	4.00
1968-69	3.00	3.67
1969-70	8.46	2.79
1970-71	2.14	5.34
1971-72	2.00	4.00
1972-73	2.00	4.00
Weighted Average Of All Six Years		3.58

*Average FTE while employed.

Based on Table VI, 3.5 years appear to be a reasonable number to represent the average amount of time an Untenured Quit is employed at Carleton. However, as we suggested above, this mean obscures the distribution of Untenured Quits, and as Figure 1 indicates the modal year for Untenured Quitting is 3 years with most quitting occuring in the third year or after. For convenience, we will use 3 years as the term of Untenured quit in our Chapter III Static Model. In the dynamic model however, we could distribute untenured quitting over the whole range of quitting ages in a manner exactly the same as indicated in Figure 1. A simpler approximation is to still distribute untenured quitting, but equally in the third and fourth years of service.

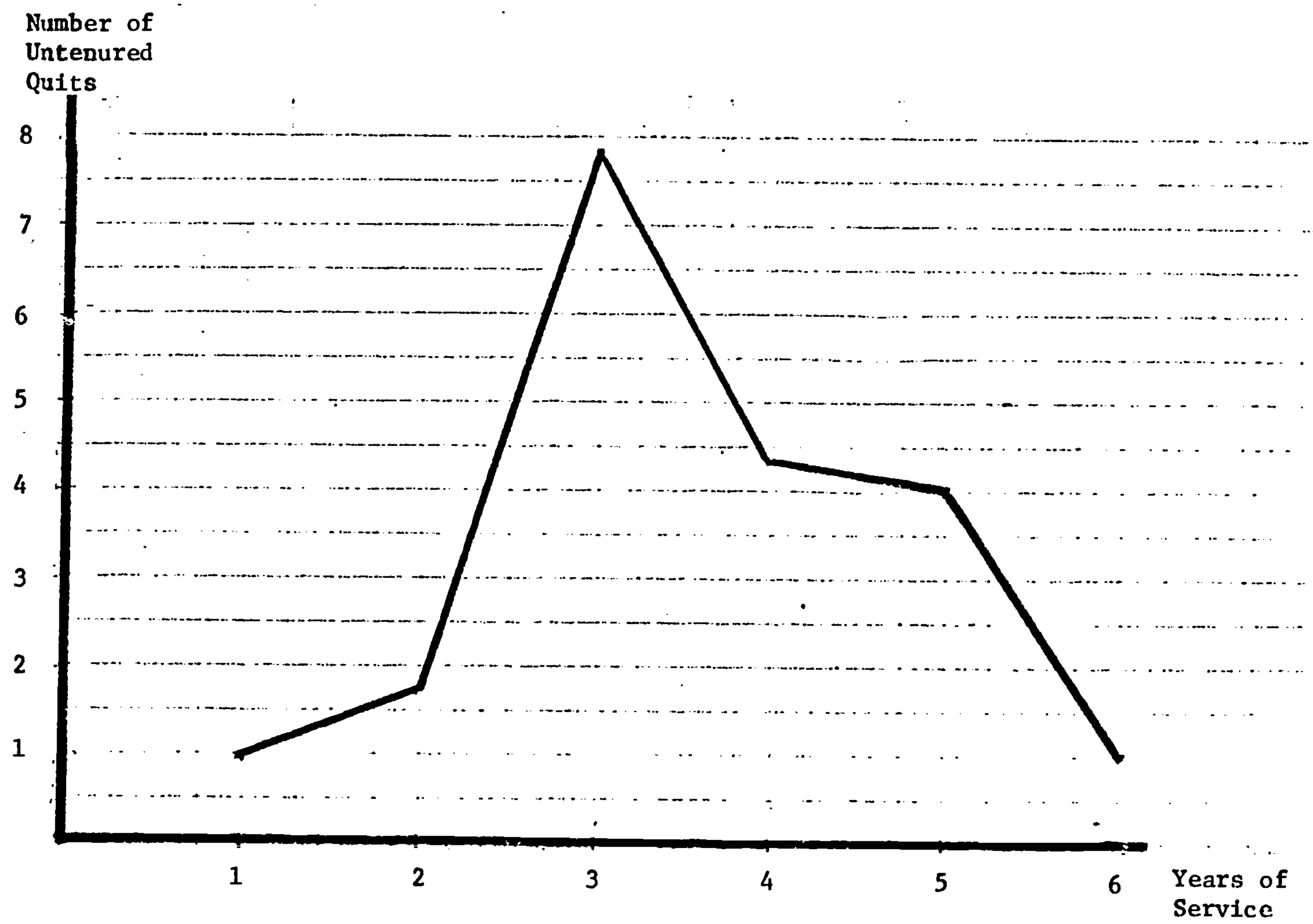

FIGURE I

Years of Employment for all Pre-Tenure Quits 1968-73

Before leaving this discussion of Untenured Quits let us warn again of its extreme variability, and unpredictability. We have mentioned the likely influence that varying job conditions should have on it, and we should also point out that it will also be affected by tenure standards themselves. The less liberal the tenure policy, probably the higher the Untenured Quit Rate. To take this variability into account, therefore, we will experiment in both Chapter III and Chapter IV with changes in quit rates rather than treating them solely as a presumably "certain" parameter or given value.

c. Tenured Quit and Death Rates. This is simply the proportion of any given class of newly tenured faculty (36 years of age on the average) who can be expected to leave or die before reaching retirement age. Since no data are available on the size of the groups being tenured 15 or 20 years ago, the groups which are now quitting or dying, estimates of this parameter will be even more impressionistic than our estimates of Untenured Quit Rates. They, moreover, must borrow heavily from external sources.

Examination of the Tenured Quits of the period 1968-73 (Table II) shows a fairly large number of deaths (a total of 5) and departures "to seek greener pastures" (a total of 3). On the average, then, 1.33 tenured faculty members died or quit each year over the whole period, and if one assumes these annual groups of tenured quits were based on groups being promoted to tenure 22 years ago that were roughly 3.00 faculty members in size (1945-51), then the Tenured Quit Rate is a surprisingly high .43. That is, if 22 years ago 3 faculty members became tenured each year and now, 1.33 of these are quitting or dying each year, then only 5.7 of any 10 newly tenured faculty members who are 36 can expect to reach retirement age at Carleton.

This estimate is based on a statistically insignificant sample and on a very weak estimate of the size of the newly tenured groups 22 years ago. It should be treated only as an unrealistic upper limit for the Tenured Quit rate. However, there is one (very outdated) external source (Brown, D.G., The Mobile Professors, American Council on Education, 1967, pp. 37-43) which supports with national data the 1968-73 observation that 3 of 50 tenured faculty members at Carleton would switch jobs every 6 years. And, mortality tables support the 5 deaths in six years we observed and more importantly, provide a rough lower limit for our Tenured Quit Rate of .15 due to mortality alone.

According to the ACE study, 2.1 in 100 Associate Professors switched collegiate teaching jobs in 1963, and 1.2 Full Professors in 100 did so. The Associate - Full Professor "mix" of the tenured faculty was roughly 40 per cent - 60 per cent so that in a tenured faculty of 100 distributed that way between Associate and Full Professors, roughly 1.5 could be expected to switch each year. Moreover, only one-third do so after the age of 49, and the likelihoods of switching were 20 per cent higher for the "least prestigious" schools. Assuming Carleton falls closer to the more- than to the least-prestigious category, then a "prestige corrected" 1.3 per year switch rate for a group of 100 tenured faculty would seem appropriate.

This, however, is still not our Tenured Quit Rate. We are asking: "What proportion of a given class of newly tenured faculty will leave Carleton before retirement" not "what proportion of the total tenured faculty will leave in any given year." Again, we have only the roughest notion of the size of the newly tenured classes in the years when these "switchers" first became tenured. (We said 3 per year above but without much confidence). It is, nevertheless, a surprise that the ACE data are consistent with the absolute number of "switches" (the numerator of our Quit Rate) we observed in 1968-73. The national rate was 1.3 each year from a total tenured faculty of 100 in 1963, and we observed 3 in 6 years or .5 each year on the average from an average tenured faculty of 50 -- a percentage of 50 which was only a little lower than 1.3 of 100.

Mortality alone places a surprisingly high lower limit on Tenured Quit Rates. An insurance company specializing in handling group life policies for college professors has developed mortality tables which predict that a 36 year old faculty member (the average age of the first year of tenured employment) has an only 85 per cent chance of reaching the retirement age of 64. (This contrasts with an even lower probability of .76 for the population as a whole). Moreover, as we shall discuss below, the average age of death is not a few years before 64 as one's intuition would suggest but considerably younger. Thus, without looking at any Carleton data, e.g., recent deaths as a proportion of the newly tenured groups of 20-29 years earlier, we can still be fairly certain of a .15 floor on our (perhaps misnamed) Tenured Quit Rate from national mortality data.

In short, the major problem is deciding how much to add to the mortality-based Tenured Quit Rate to account for switching, or voluntary departures as a proportion of any given class of newly tenured faculty. Our ACE data and the 1968-73 data with weak estimates of the size of the newly tenured many years before could justify adding as many as 23 percentage points to account for switching, but all intuition suggests that this is far too high particularly given the current expectations of a depressed faculty labor market for many years to come. Note, nearly all of our tenured switches left before 1970-71, well before the "depression in higher education" became a common phrase. We will, therefore, use a .20 Tenured Quit Rate as a conservative estimate for both models but experiment with higher values.

There is one thread of support from the ACE study for the addition of 5 percentage points to account for tenured "switching." Their findings showed that 15 per cent of all switches, tenured, and untenured, were tenured, and given our estimated Untenured Quit Rate which excludes deaths of .40, we would need to add 6 percentage points to account for tenured switching.*

d. The Average Term of Tenured Quits and Deaths. Our mortality information provides a fairly firm estimate of the average term of employment of the tenured death. The 15 deaths of any class of 100 (newly tenured) 36-year-olds is distributed in the following way: 2.2 (or 15 per cent) die over the ages 36-49 and are distributed more or less equally in each of those age groups; 1.8 (or 12 per cent) die over the five age groups 50-54 inclusive; 4.1 (or 27 per cent) die in the age group 55-59; and the remaining 6.9 (46 per cent) die in the age group 60-64. The weighted average age of death (where the weights are the percentage of the total 15 who die in each age group) is, therefore, 56.57 years of age. This compares fairly closely with the average age of the 5 deaths at Carleton between 1968-73 of 57.00.

As we indicated above roughly two-thirds of those leaving Carleton to take a job elsewhere do so before the age of 50, and one-third at 50 or after. Assuming (probably unrealistically) that pre-50 tenured switching is distributed equally across the age classes 36-49 and post-50 tenured switching, equally in their 50-64 age groups, then the mean age of pre-50 switching is 42.5 and of post-50 switching is 57. The weighted average is 47.33 years of age, quite close, again, to our observed average of 46.67 for those 3 tenured faculty who left Carleton between 1968-73.

The combination of switching and deaths in our Tenured Quit Rate requires one final operation to arrive at an average age of both quitting and dying. We have assumed that

*This is approximately the 5 per cent which we use periodically in our models.

one-fifth of our tenured departures occurs due to switching (at an average age of 47.33) and that four-fifths occurs due to death (at an average age of 56.57). The weighted average of the two is 54.72 or 55 years of age, the value we shall use in our Chapter III static model. However, in any experiments in which we raise the Tenured Quit Rate to reflect a higher level of switching jobs we must correct the average term of tenured quits to account for the fact that a larger proportion of those tenured quits are younger "switches." In the dynamic model we should ideally distribute the tenured quits and deaths in each age class in the manner in which they occur in the real world; e.g., 15 per cent of the deaths spread over the 36-49 year age groups, 12 per cent over the 50-54 age groups, 66 per cent of the tenured switches over the 36-49 age groups, etc., etc.

3. The Temporary Appointee. For the purposes of most of this study we are assuming that the stock of temporary faculty in the total teaching faculty is a constant fraction, the 12 to 13 per cent that it has been in the most recent years. As we noted above, the (assumed fixed) proportion of the temporary faculty in the teaching plus leave faculty will be slightly smaller than that in the teaching faculty only, about 11.9 per cent. Since temporary appointments are largely determined by the number of leaves, since this is a reasonably stable fraction of the leave-eligible (permanent) faculty, and if a steady-state policy means that the permanent faculty remains constant, this is not an unreasonable assumption even though the temporary faculty has actually risen somewhat as a proportion of the total since 1967-68.

On the other hand, not all temporary appointments are solely to cover leaves; leaves are only 10 per cent of the teaching faculty whereas temporary appointments represent 12 per cent. There must be, therefore, a constant stock (turning over regularly, of course) of temporary faculty which serve other, perhaps "renewal-oriented" functions, e.g., the visiting professor, the practitioner, etc. Since the group appears to have risen since 1967-68 and since there are strong academic pressures to increase the number of such temporary new hires it may be worthwhile to examine the effects of such a policy. Clearly, if a higher rate of temporary new hires is desired without affecting the size of the permanent faculty, the duration of employment (average term) for the temporary employee must drop or what is the same thing, more must be terminated each year. On the other hand, if this is not possible, then, the temporary population in the faculty as a whole will rise and there must be a compensating drop in permanent new hires or a lower p policy. Whichever approach is followed, it will be helpful to know the average term of the temporary employee to determine how much it could be "compressed" or if constant, how much a rise in temporary new hires would affect the permanent faculty.

a. The Average Term of The Temporary Appointee. This was determined by taking a weighted average of the number of years of employment enjoyed by a temporary appointee leaving in any given year. If half of the temporary appointees leaving in a given year were hired three years earlier and half, two years earlier, then the weighted average duration of employment would be 2.5 years.

TABLE VII

Average Term of Temporary Appointee

Year	Number Leaving In That Year	Weighted Average Term of Employment
1967-68	6.84	1.09
1968-69	5.94	1.00
1969-70	5.05	1.17
1970-71	8.44	1.65
1971-72	5.34	1.00
1972-73	5.00	1.00
Weighted Average of All Six Years		1.27

According to Table VII, the Average Term of the Temporary Appointee appears to be 1.27 years. However, this again obscures the distribution about that mean. There was a "temporary" appointee who left after as long as 4 years of employment, and there are several temporary appointees with more than 4 years of service whose contracts have not yet been terminated in the 1973-74 faculty. This suggests that the distinction temporary/permanent is not clear-cut and that there may well be some regular flow of temporary faculty into the permanent faculty. While this is a likely source of upward pressure on faculty size and a matter of current concern in many schools, we will ignore this slippage. It is, in itself, a subject for an equivalently long research study.

In addition, as we shall point out in the next section, there are strong grounds for arguing that the 1.27 figure understates the current (and probably expected) figure. Should those long-term temporary appointees currently employed actually be terminated, i.e., leave Carleton, move to the permanent category, or move into non-teaching jobs at Carleton, then, averaging them into our 1968-73 data will increase somewhat the average term. For purposes of both models, then, we will use an average term of 1.5 years, i.e., half of any group of temporary appointees leave after a year and half leave on the average after two years.

b. The Number of Temporary New Hires Per Year. Given the truism that the number of temporary faculty at any point in time, N, is the product of the number of new hires per year, H, and their average expected term of employment, D, and given knowledge of N and D, one can deduce the value of H. The average size of the temporary faculty in the academic years 1967-68 through 1972-73 was 11.7 (see Table I), and given our computed average term of 1.27 years, this would mean an annual temporary new hire rate of 9.1 temporary hires per year. In fact, the observed average number of new hires (See Table II) over the same period was only 7.6 per year. Therefore, either our estimate of the average term is too low or some temporary new hires were not categorized as such. Since there seems no reason for the latter to be true and since there is a substantial number of long-term temporaries who have not yet been terminated and their year of employment included in the average term, we suspect that 1.27 years underestimates the true average term. The average term consistent with the observed average new hires of 7.6 per year and an average stock of temporary appointees of 11.7 is 1.5 years.

Finally, we should indicate that in the 1973-74 academic year the deduced average term rose still further. The new hire rate consistent with the current number of temporary appointees of 16.7 each staying 1.5 years is 7.1 per year but actual new hires for 1973-74 were only about 6 (see Table II). Much of the upward pressure on faculty size apparently has come from a steadily lengthening duration of temporary employment - or what is the same thing a failure to terminate as many temporary faculty per year as before - and in 1973-74 (and 1972-73) this was compensated for by a sharp drop in temporary new hires. The direction of future policy is as yet unclear. Perhaps longer terms for temporary appointees will become the rule with correspondingly smaller numbers of annual temporary hires. For purposes of this study, however, we will assume that Carleton will return to a shorter 1.5 year average term (temporary contracts will be shorter than this years' and fewer will be renewed) and its temporary new hire rate will, therefore, return to 10.5 new appointees per year to maintain a constant 16 or so member temporary faculty.

d. The Average Age of the Temporary New Hires. To conclude, we will need the average age of the temporary new hire if we are to compute the A and W of the total teaching faculty. As Table VIII indicates, the temporary appointee is 28.67 years of age on the average or 29 for our purposes, considerably younger than his permanent counterpart.

TABLE VIII

Average Age of the Temporary New Hire

Year	Number of Temporary Hires	Average Age
1967-68	5.70	31.73
1968-69	7.96	29.63
1969-70	6.05	25.74
1970-71	6.94	28.34
1971-72	9.51	27.00
1972-73	7.67	26.90
1973-74	5.92	32.77
Weighted Average of All Seven Years		28.67

Year-By-Year Age Distribution of the Carleton Faculty

Age	Tenured: Teaching and on Leave	Tenured: Leave Only	Untenured Permanent: Teaching and On Leave	Untenured Permanent: Leave Only	Temporary	Total Teaching and On Leave
21					0.17	0.17
25					1.50	1.50
26			1.00		2.00	3.00
27			2.00		3.00	5.00
28			6.17	2.00	1.83	8.00
29			7.83	0.33	1.00	8.83
30			4.33			4.32
31			2.67		1.33	4.00
32	2.00		4.17		1.17	7.34
33			4.50	0.99		4.50
34	4.00	2.00	4.00			8.00
35	4.00		3.00		0.17	7.17
36	4.67		1.00			5.67
37	3.00				0.67	3.67
38	1.00				1.00	2.00
39	3.00	0.33	2.00			5.00
40			1.00			1.00
41	4.67	0.33	1.00		0.33	6.00
42	2.00		1.00			3.00
43	4.00		0.67	0.34		4.67
44					1.00	1.00
45	5.83					5.83
46	1.83		1.50		0.25	3.58
47	2.00					2.00
48	4.75					4.75
49	4.00	1.00				4.00
50	1.00					1.00
51	1.50	0.33				1.50
52	5.00	1.00				5.00
53	2.00					2.00
54	2.00					2.00
55	2.00					2.00
56	1.00	0.33		0.17		1.17
57	3.00					3.00
58	2.00					2.00
59	1.00					1.00
60				0.50		0.50
61						.00
62						.00
63	1.00					1.00
64	4.00	2.67				4.00
65						.00
66						
67						
68				0.33		0.33
Unknown					0.34	0.34
Totals	76.25	7.99	47.84	4.66	16.76	140.85
					less	12.65
					Teaching Faculty	128.20

C. The Age Distribution of the 1973-74 Faculty.

Table IX above presents the distribution of teaching and leave faculty in the form of populations at each age class in September, 1973. It is further broken down by tenure status, teaching/leave status, and temporary/permanent status. As we discussed above, our primary concern is the general age characteristics of the 128 member teaching faculty and not the 141 member teaching-plus-leave faculty. Therefore, when a generalization is made about the age characteristics of the faculty as a whole it should be understood that this slightly understates the same age characteristic for the teaching-plus-leave faculty. The temporary faculty which is young and not leave-eligible will bulk slightly larger in the teaching faculty than in the teaching-plus-leave faculty. In 1973-74, for example, the temporary appointee represents 13.1 of the teaching faculty by only 11.9 of the teaching-plus-leave faculty. Or put differently, the leave-eligible and older permanent faculty bulks smaller in the teaching faculty than in the teaching-plus-leave group because some are on leave and are replaced by temporaries.

a. A General Description.

It is obvious that the Carleton faculty is not "nicely distributed" by ages. "Dips" and "bulges" are the rule rather than the exception. Ignoring year-to-year variations, there is clearly a sharp dip in the 59-63 age classes and a large bulge in the 27-34 age classes (see Figure 2, Table X which distribute the permanent, teaching-plus-leave faculty in larger age groups to eliminate the year-to-year "chatter.") While part of this is due to natural attrition, much of it is due to past growth of the faculty combined with a recent slowing of that growth.

TABLE X

Distribution of the Permanent Teaching Plus Leave Faculty by Four-Year Age Groups

Age	Tenured		Untenured		Total	
	Number	Average in Each of the 4 Years	Number	Average in Each of the 4 Years	Number	Average in Each of the 4 Years
23-26			1.00	.25	1.00	.25
27-30			20.33	5.08	20.33	5.08
31-34	6.00	1.50	15.34	3.84	21.34	5.32
35-38	12.67	3.18	4.00	1.00	16.67	4.17
39-42	9.67	2.42	5.00	1.25	14.67	3.67
43-46	11.68	2.91	2.16	.54	13.82	3.45
47-50	11.75	2.94			11.75	2.94
51-54	10.50	2.63			10.50	2.63
55-58	8.00	2.00			8.00	2.00
59-62	1.00	.25			1.00	.25
63-66	5.00	1.25			5.00	1.25

Given the location of these dips and bulges it is clear that the Carleton faculty is quite young; 46 per cent of the teaching faculty is 36 years old or under. Another 37 per cent is in the range 37-49. This means only 17 per cent is 50 or older. Within the tenured class the average age is 45.56 and with a few minor exceptions everyone over 43 is tenured. The untenured permanent members are concentrated in the age groups 28-35 with 3 below and 8.17 above. Their average age is 37.52. There is a bulge of temporaries in the age range 25-32 where about two-thirds of them are located. The rest are scattered through all age groups although there tend to be more above 32 than below 25 with the result that their mean age is 32.44, quite close to that of the untenured permanents. The average age of the 128 member teaching faculty is 39.42 and is only slightly below the average age of the 141 member teaching-plus-leave faculty of 39.85.

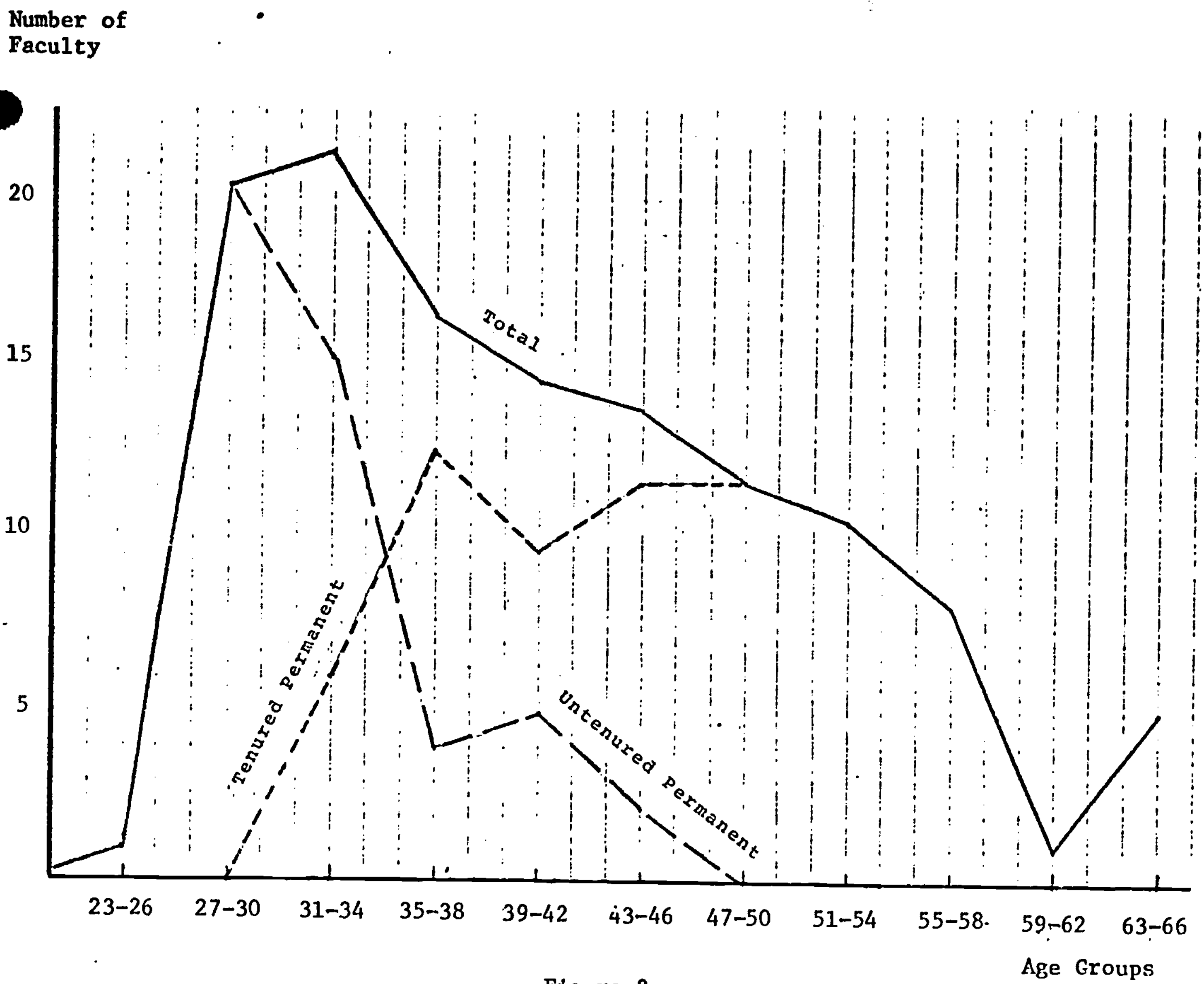

Figure 2

Distribution of the Permanent Teaching-Plus-Leave Faculty by Four-Year Age Groups

b. The Role of Leaves. Both of our models will be estimating the new hires, Quits, Retirements, and negative tenure decisions for a 141 member teaching-plus-leave faculty because those on leave, of course, return to quit, stand for tenure, retire, etc. However, our A, W, and % T figures will be for the teaching faculty only and to arrive at these figures we must make several assumptions about the role of leave in the Carleton faculty. Table IX is the basis for these assumptions, i.e., the leave characteristics of the 1973-74 faculty are assumed to be similar to those of both past and future faculties.

Firstly, leaves are assumed to be distributed evenly across all age classes in both the tenured and untenured permanent faculty; an untenured 30-year-old is as likely to be on leave as a tenured 40-year-old. This seems to be supported by the data in Table IX. The 4.66 untenured leaves are nearly the same proportion (9.7 per cent) of the 47.8 untenured leave-eligible (teaching-plus-leave) faculty as the 7.99 tenured leaves are of the 76.3 member tenured, teaching-plus-leave faculty (10.4 per cent). This observation does not appeal to the intuition; one would have thought that leaves were more common in the tenured than untenured group. However, untenured faculty often take unpaid leaves to complete degree programs and are more likely than the tenured faculty to lead groups of students in international programs or to direct urban programs and the like. The "pure" teaching and research leave, of course, is concentrated in the tenured group. In addition, college policy seems to be increasingly directed to assuring that all untenured faculty who successfully complete the Third-Year Review will take at least a one-term leave. If roughly 6 of any 10 untenured faculty members normally reach their fourth year and the average hiring class at Carleton is 10 per year in size, then if all 6 take one-term (.33 FTE) leaves one could expect at least 2 untenured leaves per year from this source. Add one year-abroad or one ACM directorship and one unpaid leave to complete a degree each year, and one has "explained" the roughly 4.5 untenured leaves actually observed in 1973-74.

The second major assumption we shall use is that leaves are 10 per cent of the leave eligible (permanent) teaching-plus-leave faculty. This, too, is clearly supported by the 1973-74 data; total leaves are 12.65 out of a leave-eligible faculty of 124.1 or 10.2 per cent. This implies, in turn, that the teaching faculty at Carleton should remain constant at about 91.2 per cent of the teaching-plus-leave faculty. It will be composed, first, of the 11.9 per cent of the teaching plus leave faculty which are temporaries, and of 90 per cent (less the 10 per cent on leave) of the 88.1 per cent of the teaching plus leave faculty which are leave-eligible permanents or 79.3 per cent of the teaching-plus-leave faculty (.9 X 88.1). The sum of the per cent each group represents of the teaching-plus-leave faculty is 91.2. As Table IX indicates, the teaching faculty of 128.2 is, in fact, 91.2 per cent of the 140.85 member teaching-plus-leave faculty.

D. The Age - Income Profile.

Table XI and Figure 3 present the observed relationship between mean income and age for 17 two to five-year age groups at Carleton* and an approximate relationship derived from those 17 observations using a least squares quadratic fit.** Increasing age, obviously, is associated with, if not causes, increasing salary, and our fitted relationship predicts the increase in salary that will occur due to aging. Abstracting from economy-wide influences, should a group of 45-year-old professors at Carleton age by one year their average annual income should increase by $280 from $17,079 to $17,354. Clearly, many observed points lie considerably off the fitted curve (note particularly those at age 33, 39, 43, 49, 53, and 57) indicating that there could be considerable deviation from observed and predicted income at a given age.

The most obvious characteristic of the relationship is its convexity or ever-increasing flatness. Income and age do not rise proportionally. This is a general characteristic of the age - wage relationship of any sample of employees drawn from the general population and can be ascribed to many influences. The increase in productivity due to greater familiarity with a task diminishes the longer one is employed. Or, job security and other non-monetary benefits in upper age groups increasingly compensate for income payments. Whatever the reason, this convexity clearly diminishes the impact of an aging faculty on average wage. While undoubtedly excessive, should Carleton's mean age rise from its current 40 years to 50 years over a ten year period and its mean wage rise accordingly by $2,800, this would only represent a 1.75 per cent average annual increase. On the other hand, while this is very small by contrast to economy-wide growth rates in per capita money incomes (4.9 per cent annually between 1951 and 1969 and 6.9 per cent recently), it is the only unambiguous source of an increase in Carleton's relative costs.

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*No group includes fewer than three faculty members.

**Compared to fitting a straight line to the observed points, the quadratic fit reduces considerably the degree of deviation of the fitted relationship from the observed relationship. The root mean square drops by a factor of 126.

Table XI

The Carleton Age-Income Profile

AGE	ACTUAL MEAN SALARY	PREDICTED SALARY	CHANGE
25		19,555	472
26		10,022	463
27	10,917	10,480	453
28		10,929	444
29	11,281	11,367	434
30		11,797	424
31	12,415	12,215	415
32		12,625	405
33	12,681	13,026	395
34		13,417	386
35	13,650	13,798	376
36		14,169	367
37	15,437	14,531	357
38		14,883	347
39	14,300	15,226	338
40		15,559	328
41	15,464	15,882	319
42		16,196	309
43	15,391	16.500	299
44		16,794	290
45	19,600	17,079	280
46		17,354	270
47	17,900	17,620	261
48		17,876	251
49	19,250	18,122	242
50		18,359	232
51	18,350	18,586	222
52		18,804	213
53	16,233	19,012	203
54		19,200	193
55	20,700	19,393	184
56		19,578	174
57	20,450	19,747	165
58		19,907	155
59		20,057	145
60		20,198	136
61		20,328	126
62	20,440	20,450	117
63		20,562	107
64		20,664	97
65		20,757	87

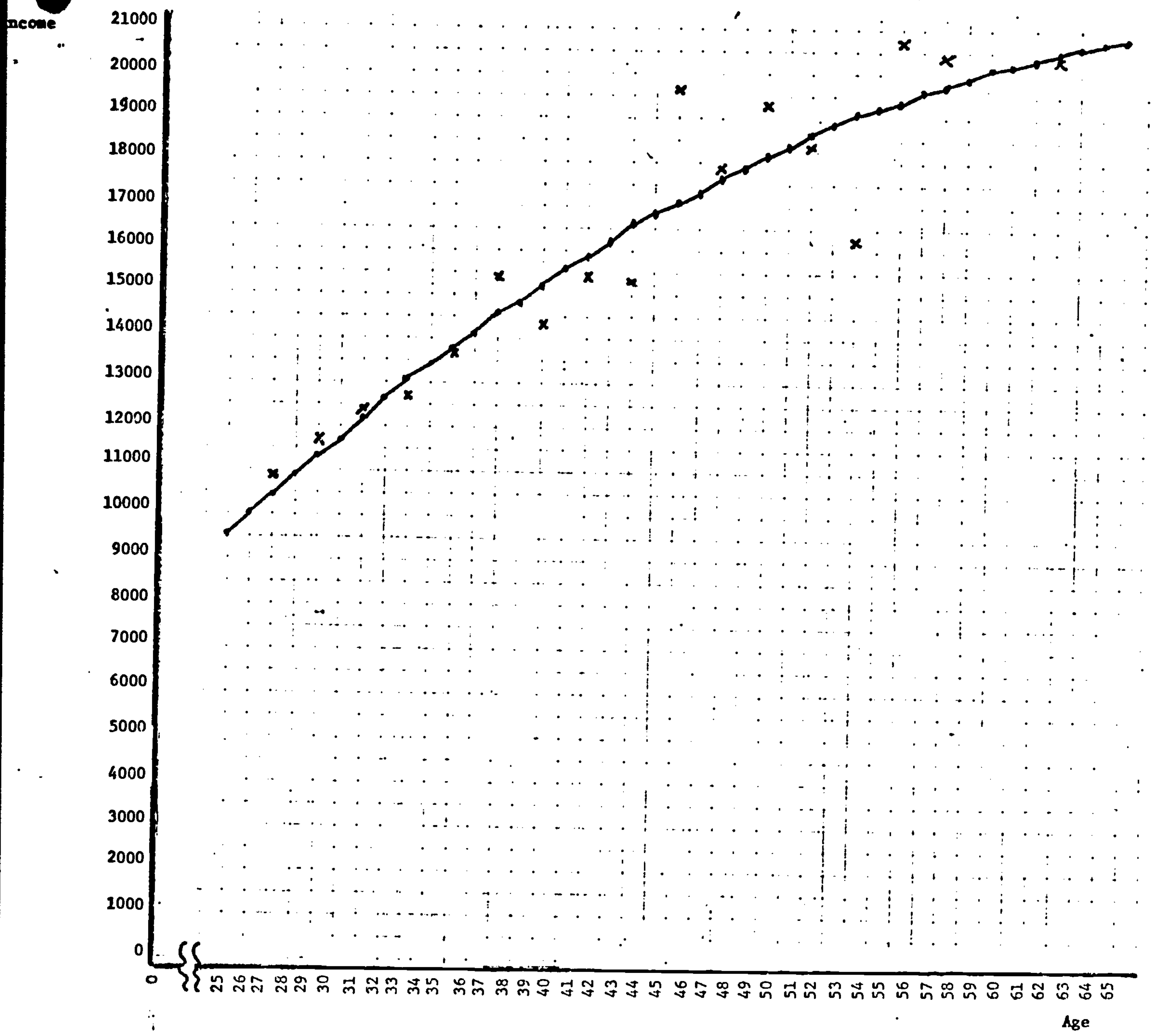


Figure 3

The Carleton Age-Income Profile

____ Predicted Values
X Actual Values

Chapter III

The Static Model With A Uniform Age Distribution

In Chapter I we introduced the static model without considering non-tenure related attrition, quits -- both tenured and non-tenured -- and deaths, and without considering the temporary or tenure ineligible faculty. Our Chapter II examination of Carleton and national data, however, has shown that both of these faculty characteristics are extremely important, and in this elaboration of the static model we will introduce them specifically and examine their impact.

As an obvious generalization, the existence of a temporary or tenure ineligible group in the faculty and of non-tenure related quits and deaths place floors and ceilings on the values of all of our dependent variables: % T, A, W, and H. The fact that roughly 13 per cent of the teaching faculty traditionally have been considered tenure ineligible clearly means that % T can never exceed 87; and since this group is both younger and, therefore, less well paid, its existence places ceilings on both A and W. Moreover, there clearly must be some "extra" renewal provided by temporary hires so long as the duration or average term of employment of the tenure ineligible group is less than that of the permanent faculty.

Quits, (and deaths) both pre- and post-tenure, clearly produce much the same results. Even were $p = 1$, of any group of permanent or tenure eligible new hires a strikingly large proportion, 48 per cent, could not be expected to reach retirement ages at Carleton. Even with the most pessimistic predictions that "pure" quit rates are zero, one can anticipate that 15 per cent will have died before 65. We remind the reader, however, that not only the amount but <u>timing</u> of non-tenure attrition is important. The more non-tenure related attrition is concentrated in the untenured group and the earlier it occurs in both tenured and untenured groups, the lower the ceilings on % T, A, and W and the higher the floor on H non-tenure attrition will provide.

It is these and similar types of generalizations we will seek to provide in Chapter III. We also remind the reader, however, that the quantitative values we determine for our inter-related variables will be poor guides for policy; the quantitative work in this chapter is primarily to illustrate our generalizations and not to provide predictions. This is partly because of the crucial and unrealistic assumption that lies behind this model: the absence of an existing distribution of faculty by age and rank, or put differently, the assumption of many years of past steady-state operation. It is also because of the nature of most work in the social sciences. Parameters' values cannot be held constant as they often are in the natural sciences, e.g., retirement ages may drop, quit rates may rise....indeed, tenure may disappear or be drastically changed. Thus, even in our Chapter IV dynamic, counting model where the existing distribution of faculty by age and rank is introduced, any quantitative work should also be viewed with a great deal of skepticism and, again, as largely illustrative of generalizations and not predictions.

A. The Static Model Elaborated.

Our elaborated static model still depends on the basic truism that the number of faculty (teaching and on leave) at any point in time is the product of the number of new hires per year and the average term of their employment. And, as in Chapter I, the tenure decision remains one determinant of the term of employment, or what is the same thing, the flow of total attrition per year. Now, however, we are distinguishing two types of faculty, the permanent and temporary (tenure ineligible), and this means that the number of teaching-plus-leave faculty at any point in time is the sum of the products: a) of the temporary new hires per year and their average term and b) of the permanent (tenure eligible) new hires per year and their average term or:

1) $N = H^t \cdot D^t + H^p \cdot D^p$

where the superscripts, t and p, refer to temporary and permanent.

Moreover, D^p is no longer determined solely by the age of new hires, length of probationary period, retirement age, and the probability of successfully standing for tenure. We must now consider both tenured and non-tenured "Quits" (including deaths) and the average terms of employment for those who quit, both tenured and non-tenured. Thus:

$$2)\quad D^P = q_{nt}\ D^P_{qnt} + (1-q_{nt})\ D^P_{nqnt} + p\ (1-q_{nt})\ (q_t)\ (D^P_{qt}) + p\ (1-q_{nt})\ (1-q_t)\ D^P_{nqt}\ *$$

This says that the expected or average term of employment of the permanent faculty is a probability weighted sum of the terms of employment of the now four major sub-groups in the permanent faculty where the weights are the probilitities of any new hire actually falling into one of those sub-groups and thereby remaining employed for the average term of employment in that sub-group.

In our Chapter I introduction we dealt with only two subgroups in the permanent faculty, Tenured and Non-tenured, and an intuitive understanding of the construction of such a probability weighted sum was not a difficult matter. We assumed a probationary period of 6 years and a term of tenured employment of 32 years; and in our example on pp. 9-10 we pointed out that if p = 1 (everyone received tenure), the expected or average term of employment would obviously be 38 years. Everyone could expect the full 6 years of probationary employment plus the 32 years of tenured employment. Or, what is the same thing, the average of the total years of employment one could expect from all ten new hires, 380 years/10 hires, would be 38 years.

We then applied a lower probability to receiving the additional 32 years of tenured employment (p = .6 in the example), and the expected or average term of employment for all 10 new hires dropped from 38 to 25.2 (allowing 4 new hires per year to maintain a 100 person faculty). Everyone could expect the 6 years of probationary employment, but only 6 in 10 could expect the remaining 32 years of tenured employment, and the expected term of all 10, therefore, would be 1 x 6 plus .6 x 32 (19.2) or 25.2 years. Put differently, if one totalled the years of employment for all 10 (60 probationary years plus 6 x 32 or 192 tenured years) and divided that total (252 years) by 10, the average

*The subscripts in equation 2 denote the following: For the Quit Rates or q's, t and nt refer to tenured and non-tenured, respectively. For the durations of Employment or D's, qnt refers to the Non-Tenured Quits; nqnt refers to Non-Tenured Non-Quits; qt, to Tenured Quits (and Deaths); and nqt, to Tenured Non-Quits.

number of years employed for all 10 hires would be 25.2 which is the same as 1 x 6 plus .6 x 32. One could say, in short, that of the 10 new hires, those who remain probationers the full 6 years (all in this example) "contribute" 6 years to the expected or average term of employment for all 10, and the 6 of 10 who remain for an additional 32 years contribute the remaining 19.2 years to the expected or average term for all.

In this elaboration we now have <u>four</u> major sub-groups in the teaching-plus-leave faculty (or potentially, in any group of new hires): the Non-tenured Quits, the Non-Tenured Non-Quits, the Tenured Quits (or deaths), and the Tenured Non-Quits. And, each term in equation 2 tells how many years each sub-group contributes to the total expected or average term. The D values are the average terms of employment of those sub-groups, and the p and q values determine the probabilities of falling into those sub-groups. Thus, if the probability of quitting before tenure (q_{nt}) were .3 and the average term for the Non-Tenured Quit were 3 years, the Non-Tenured Quit would contribute .9 years to the expected or average term for the whole group of new hires, <u>i.e.</u>, 3 of any 10 new hires will remain employed only 3 years each and thereby contribute a sum of 9 years to the total years of all ten or an average of $9/10^{ths}$ of a year. Exactly the same is true for the second term in equation 2. The remaining 7 in 10 new hires, the Non-Tenured Non-Quits, would contribute .7 x 6 years or 4.2 years, <u>i.e.</u>, 42 years/10 on the average. Similarly, the third and fourth terms of equation 2 are the number of years contributed by those who have not quit before tenure, who successfully stand for tenure, and who either quit (or die) after tenure (the third term in equation 2) or who go on to retirement (the fourth term in equation 2).

Note, the probability of reaching retirement age, or what is the same thing, of enjoying a term of employment equal to the probationary period and the full term of tenured employment is conditional on many things and may be quite low even if tenure policies are very liberal. There is, first, a less than 100 per cent chance of not quitting before tenure, say 6 in 10 ($1-q_{nt}$) and a say 7 in 10 chance of receiving tenure ($p = .7$). Thus, only 4.2 of 10 ($p [1 - q_{nt}]$) will reach the first year of tenured employment. Moreover, if the chance of not quitting before retirement is only 8 in 10 ($1-q_t = .8$), then of the 4.2 of 10 granted tenure only 3.36 of 10 will reach retirement age ($p\ [1-q_{nt}]\ [1-q_t]$). In short, even without past growth in the faculty, the number retiring will normally be fairly small by contrast to the number of new hires solely because of the influence of quits and deaths.

Substituting equation 2 in equation 1 and rearranging terms, we have the basic computing formula for our p - H trade-off:

3) $N = H^t \cdot D^t + H^p\ [q_{nt} \cdot D^p{}_{qnt} + (1-q_{nt})(D^p{}_{nqnt}) + p\ (1-q_{nt})\ (q_t \cdot D^p{}_{qt} + [1-q_t]\ D^p{}_{nqt})]$

All the average terms of the faculty sub-groups (the D's) are known as well as the quit rates (q's) and the number of temporary hires, H^t. The problem is to pick p values and solve for the H^p which keeps N constant at whatever the desired teaching-plus-leave faculty size is to be.

To better explain our model a numerical example and a schematic description of the model may be useful. Our parameters' values are similar to those derived in Chapter II and suggestive of a steady-state faculty in a small liberal arts college like Carleton. Figure 1 clearly identifies the five sub-groups in the faculty, the four sub-groups of the permanent faculty plus the temporary faculty, as well as the ages and average terms of employment of each of those sub-groups. In fact, one might add a sixth sub-group: that part of the permanent teaching-plus-leave faculty which is on leave. This group will be eliminated, as we discussed in Chapter II, in describing the teaching faculty i.e., in determining % T, A, and W for the teaching faculty only. It is assumed to be 10 per cent of any age class in the leave eligible permanent faculty.

The average permanent faculty member is 30 in September of his first academic year of employment and if quitting will leave at 32 after 3 years of untenured employment. The probationary period is 6 years so that the Nontenured Non-Quit will stand for tenure at age 35 and either leave at that age or begin tenured employment the following year at age 36. Should he quit (or die) before retirement he will do so at age 55 after 20 years of tenured employment and should he not, he will be 64 in Septem-

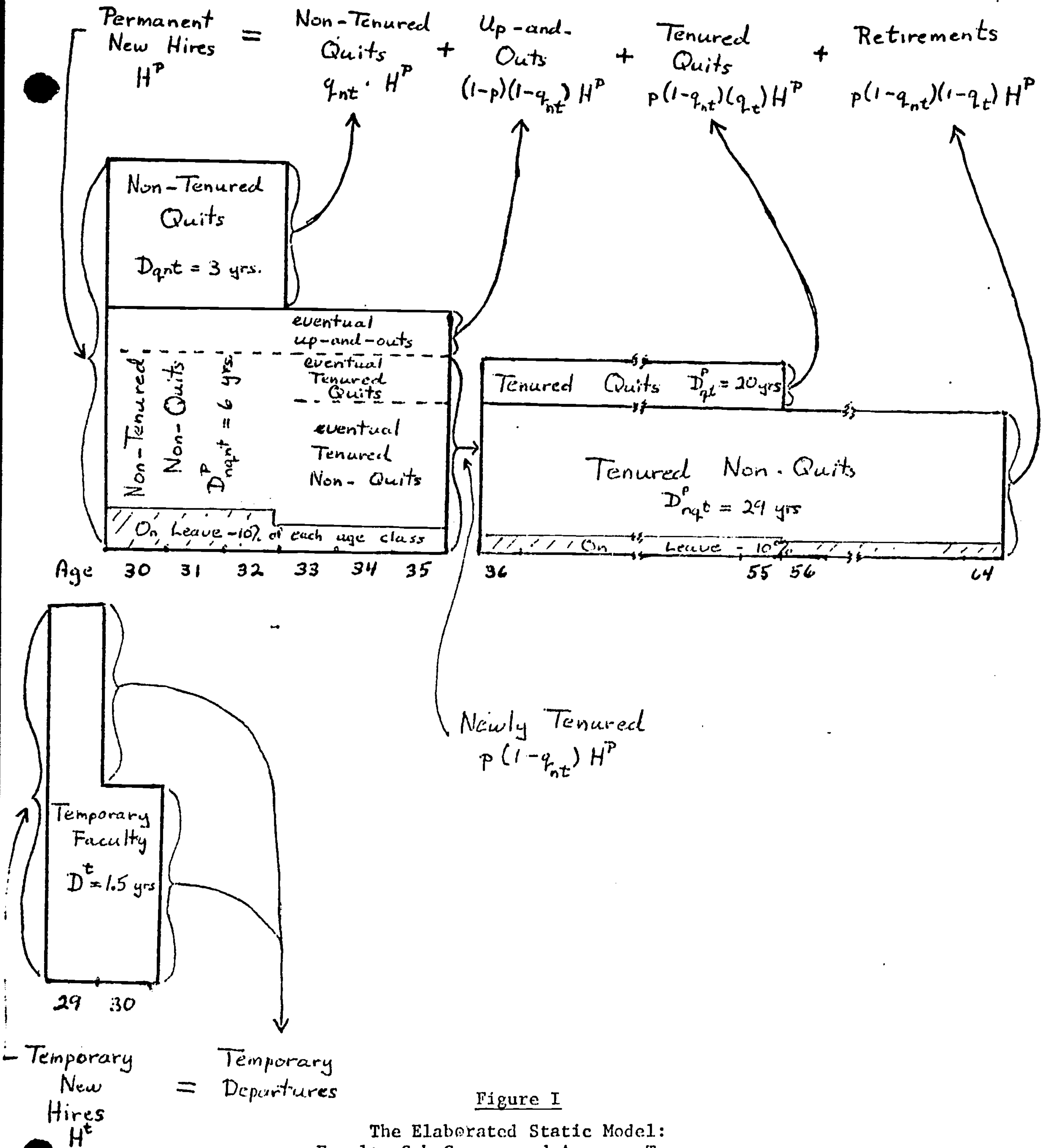


Figure I

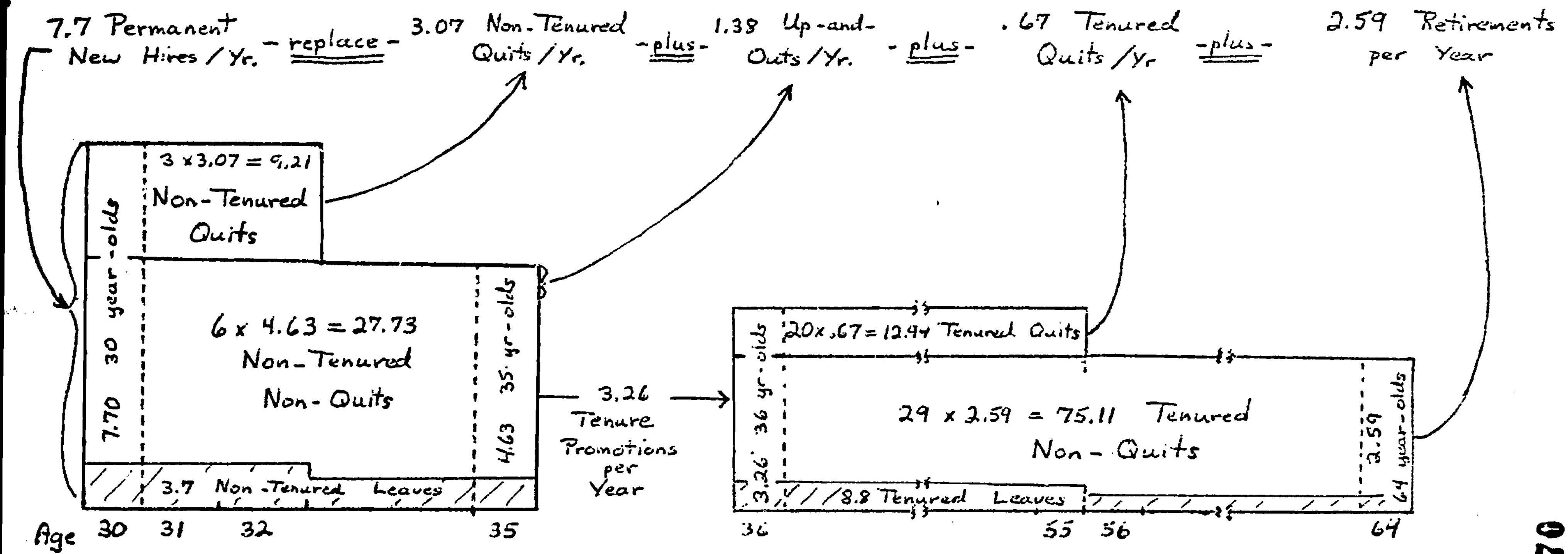
The Elaborated Static Model:
Faculty Sub-Groups and Average Terms
of Employment by Sub-Group in an
Idealized Carleton-Like Faculty

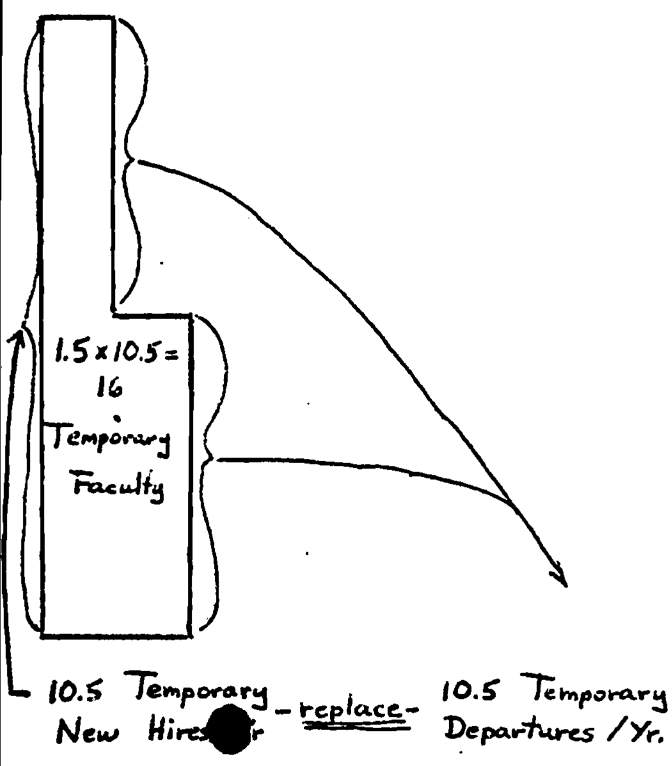
ber of that academic year when he turns 65 and retire after 29 years of tenured service. The average temporary faculty member is one year younger when hired than his permanent counter-part (29 years of age) and remains employed for 1.5 years. Put differently, of 2 temporary new hires one will leave after a year at age 29 and one after two years at age 30.

Assume the college wishes to maintain a 141 member teaching-plus-leave faculty which given its "leave rate" of 10 per cent of the permanent employees will produce a 128.5 member teaching faculty. Assuming Carleton's quit rate of .4 for Non-tenured Quits and .2 for Tenured Quits, a rate of Temporary new hires of 10.7 per year, and a p of .7 similar to Carleton's average; the only permanent new hire rate consistent with these parameters and a constant 141 member teaching-plus-leave faculty is 7.7 per year or roughly 23 every three years. Put differently, if p = .7 and our D's and q's are as stated, H^p = 7.7 per year is the only value which solves equation 3 when N = 141. With H^t = 10.7 per year and D^t = 1.5 years the number of temporary faculty is 16 and, therefore, the permanent faculty (teaching and on leave) cannot exceed 125. The expected or average term of employment for a permanent faculty member is 16.22 years* or a little less than half of the 35 year possible term for the full service faculty member (the 6 year probationary period plus the full term of tenured employment of 29 years). If the average permanent faculty member remains employed for 16.22 years and if there are to be 125 of these in the teaching-plus-leave faculty, new hires can be only 7.7 per year (7.7 x 16.22 = 125).

Figure 2,below, schematically describes the age distribution and new hire and attrition rates of the 141 member faculty. The 7.7 permanent new hires of any given year replace the 3.07 Non-tenured Quits of that year, the 1.38 Up-and-Outs (or 7 every 3 years), the .67 Tenured Quits or Deaths (or 3 every 5 years) and the 2.59 retirements of that year (or 5 every 2 years). The 10.7 temporary new hires replace the 5.35

*To verify this, solve for D^p in equation 2. The Non-Tenured Quit contributes 1.2 years to the total expected term; the Non-Tenured Non-Quit, 3.6 years; the Tenured Quit, 1.68 years, and the Tenured Non-Quit 9.74 years.





Non-Tenured		Less Leaves	Equals	Teaching
Temporary	16.00			16.00
Quits	9.21			
Non-Quits	27.73	3.7		33.24
Tenured				
Quits	12.94			
Non-Quits	75.11	8.8		79.25
	140.99			128.49

Figure 2

The Elaborated Static Model:
The Age Distribution and Annual New Hire And Attrition Levels in an Idealized 141 - Member, Carleton-Like Faculty

new hires of one year earlier whose one-year contracts are terminating and the 5.35 of two years earlier whose two-year contracts are terminating.

One can also verify the computation by examining the size of the various sub-groups in the faculty. There are obviously 16 temporary faculty, and the 125 permanent faculty members are sub-divided into: a) the 3.07 of the 7.7 new hires of this and past years in each of their three years of employment before quitting before tenure or 9.21 Non-Tenured Quits; b) the remaining 4.63 Non-Tenured Non Quits in each of their six years of employment before standing for tenure or 27.73 Non Tenured Non-Quits; the .67 Tenured Quits in each of their 20 years of tenured employment or 12.94; and the 2.59 Tenured Non Quits in each of their 29 years of tenured employment before retiring or 75.77. The sum of these four groups is 125 and if 12.5 are on leave the teaching faculty is 141 less 12.5 or 128.5. Finally the % T of the teaching faculty only is 61.7 or the sum of the two tenured groups, 88.05, less the 8.8 (10 per cent) on leave, divided by the 128.5 teaching faculty. This as we pointed out will be minimally below the % T of the teaching-plus-leave faculty of 62.4 or 88.05/ 141.

Even at this level of abstraction our example is suggestive of the kinds of problems faced by many colleges similar to Carleton. Most obviously, recent permanent new hires, 5 in 1973-74 and 7 in 1972-73, have been forced below the nearly 8 per year which would be possible if Carleton's age distribution approached the idealized one in Figure 2 and are considerably below their growth-period levels of from 10-18 per year in 1963-64 through 1967-68. This suggests that there are either "too few" quits or "too few" retirements from Carleton's actual faculty in contrast to an equal size faculty which is in long-run steady-state equilibrium.

The source of this problem becomes still clearer if one contrasts the age and rank distribution of Carleton's existing faculty with the ideal generated by a static model where a $p = .7$, $H^p = 7.7$ per year policy mix has been followed presumably for many years. As indicated in Figure 3 the existing and ideal distributions diverge in several important ways. Most obviously, there are too few tenured faculty members in the 56-64 age groups, or what is the same thing, too few retirements to be expected over the next 9 years --1 and a third per year rather than the 2.59 per year of our static model. While this seems a very small deviation we must emphasize that small deviations are important when one deals with small faculties spread over many age groups. It represents a little over 11 faculty members or 9 per cent of the permanent faculty "in the wrong place" (concentrated in younger untenured age groups), and to compensate for it over the next 9 years either 1.2 of the permanent faculty our model predicts could be hired each year cannot be hired (a drop in the turnover rate of permanent faculty from 6 per cent to 5.0 per cent!) or one of the 4.5 standing for tenure each year cannot be promoted (a drop in p from .7 to .45!).

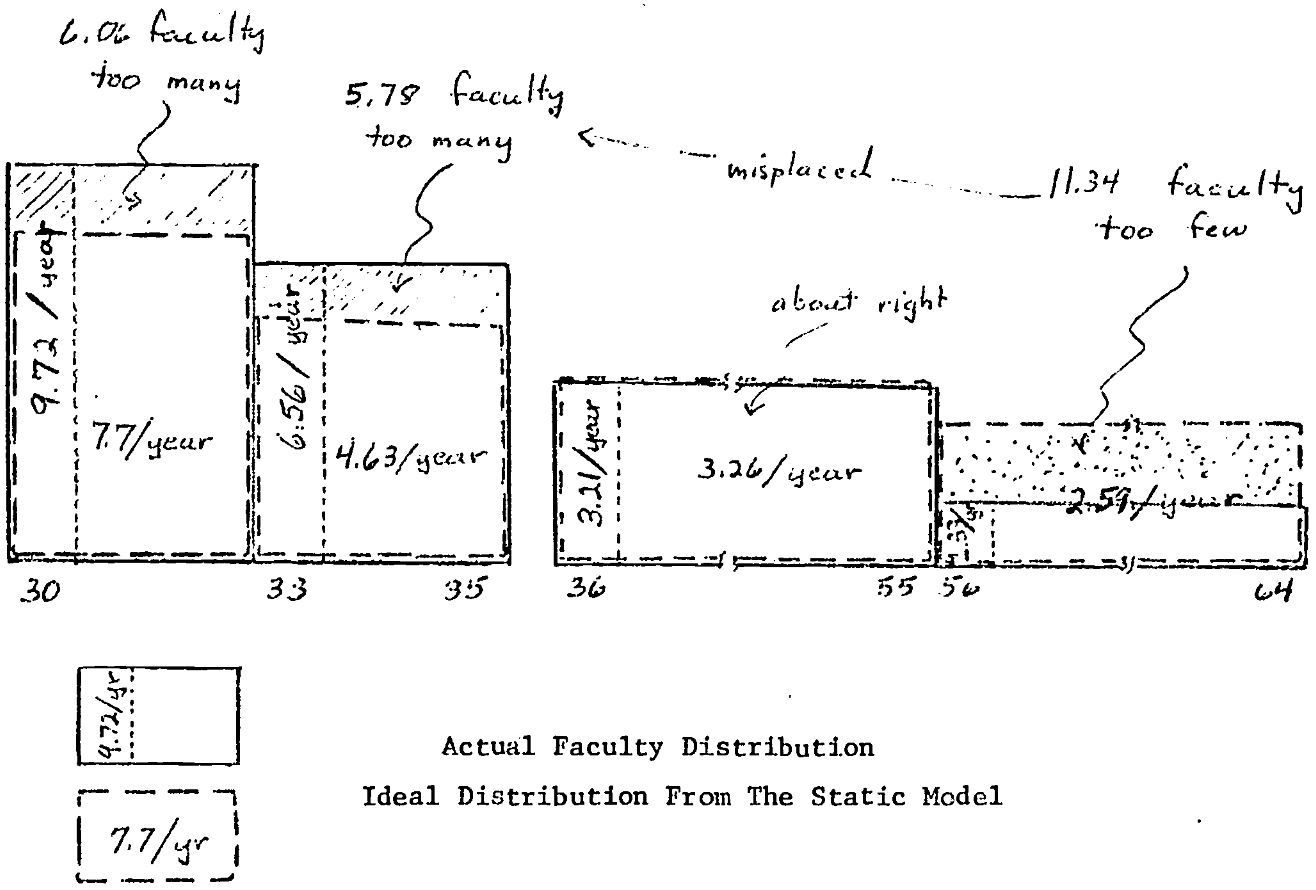


Figure 3

Actual and Ideal Distributions of the Permanent Teaching Plus Leave Faculty Contrasted

There are two possible explanations for the deviation, one which would imply no change in p - H policy, the other which would require such a change. This static model may have used quit and death rates which understate the actual rates one can anticipate. If in the "real world" the pre-tenure quit rate were actually .7 and the tenured quit .5 (instead of .4 and .2), then the H^P rate consistent with p = .7 would be about 13.6 per year, and of this annual group of new hires only 1.4 could expect to reach the ages 56-64, *i.e.*, of the 13.6 new hires per year 4.08 per year or 30 per cent would be left after 3 years, 2.86 (or .7 of 4.08) after the tenure decision, and 1.4 or 50 per cent after the date of tenured quits or deaths. Thus, Carleton's expected 1.33 per year retirement rate over the next 9 years may be consistent with a p = .7 H^P = 13.6 per year policy if actual quits are a little over 1 faculty member per year higher than the 3.75 per year (see Figure 2) our example assumes.

A good deal more likely, however, our example may be using the "correct" quit rates, and the low number of expected retirements at Carleton are instead due to the fact that they come from the hiring classes of between 27 and 35 years ago (1940-1948) when the new hires each year were to support a smaller faculty of about 85 on the average which is 53 per cent of the current 141 member faculty. Since 1.33 (the actual number retiring over the next 10 years) is approximately the same per cent of 2.59 (the ideal number retiring in a 141-member faculty using a .7 tenure policy) as the 1948-49 faculty is of the current faculty, there is strong support for the hypothesis that Carleton's staffing difficulties are due to its post-1948 growth (beginning actually in the early 1960's), the recent steady-state decree, and the consequent age bulge in the younger age groups.

In addition, Carleton's existing distribution of faculty is considerably less tenured than the ideal distribution of our example. As Figure 3 indicates, the average number of untenured faculty in the age groups 32 years or less is 9.72 per year rather than the 7.70 per year of our example and the average number in the 33 or more age group is 6.56 per year rather than the 4.63 per year of our example. Put differently, the 11 or so "displaced" older tenured faculty mentioned above are primarily untenured which explains Carleton's actual % T of 53 rather than the static steady-state % T of 62 in our example.

Table I

Years of Service of the Probationary Faculty At The End of The Academic Year 1973 - 74

	Years of Service						
	1	2	3	4	5	6	Total
Number of Probationary Faculty	6.83	4.00	10.50	10.84	8.50	7.17	47.84

At first glance this would appear to put immediate pressure on p or H or both. Since negative tenure decisions are traditionally not a major means of providing replacement openings for permanent new hires and since a large absolute number of untenured faculty are older than our assumed quitting age of 32, one would expect few "up-and-out" spots and few of the relatively more important pre-tenure quits. However, as Table I indicates, when we group the untenured faculty by years of service and not age, although many have passed the most likely quitting point and will be in their fifth or sixth year of service, the largest groups will be in their third or fourth year of service, the most likely quitting points. Our use of an expected quitting age of 32 years obscures this because it was rounded down from 32.5 years. Moreover, the untenured groups which will have completed three and four years of service by the end of 1973-74 come from two hiring classes whose average ages were above the 30 year figure we are using based on seven hiring classes. They, therefore, are older than the assumed quitting age but are at the quitting point in terms of years of service. In short, the pressure on p and H may be temporarily relieved by the probably larger number of pre-tenure quits over the next two years than the 3.07 per year our static model assumes. On the other hand, the next few years will provide an excellent test of our assumed Non-tenured Quit Rate of .4. Will four-tenths of the 21 soon to be in their quitting years or 9 people actually quit over the next two years?

The reason for the bunching in the pre-tenure age group is undoubtedly related to faculty size decisions, but in this case these decisions were in the recent rather than distant past. The sharp growth of the faculty between 1964-69 followed by slower growth between 1970-73 after the first budget deficit in many years is an obvious explanation.

Lower quits due to a tightening job market may further explain the bunching in the 33-35 age groups.

In short, Carleton's faculty in the mid-and late 50's probably looked very much like our Figure 2 idealized steady-state faculty with the exception that it was an 85 or so member faculty and not a 141 member faculty. The % T, A, W, p and turnover <u>rates</u> (Hp/N) were at "acceptable" levels, each consistent with the other and steady-state. Growth during the 1960's "artificially" <u>lowered</u> % T, A, and W (see Chapter II) via a higher than steady-state new hiring policy, but the Carleton faculty is now beginning to approach those values again as a steady-state policy at a 141 member faculty size is being followed. Insofar as tenure standards have remained the same (p = .7), the bulge of young untenured faculty is becoming a bulge of young tenureds and moves on in age and average wage. Table II (Chapter I) indicates that 4.4 faculty members per year have become tenured over the 1968-73 period rather than the 3.26 per year our static model argues is appropriate. And, as those of the remaining 17 member untenured bulge become tenured in years to come the % T, A and W values will begin to <u>exceed</u> their "acceptable" pre-growth levels. We shall postpone any detailed discussion of this until Chapter IV, but we should indicate in passing that the remaining 11 "displaced" faculty members would not seem to threaten Carleton's very viability.

To conclude this elaboration of our static model we can briefly outline the computations for our other measures of a healthy faculty: % T, A, and W. As we have discussed above, these measures are based on the <u>teaching</u> faculty only which is only 91.2 per cent of the teaching-plus-leave faculty. The % T is given by the following equation:

$$4)\quad \%\,T = \frac{.90[(1-q_{nt})\,p\cdot q\cdot H^{P}]\,D_{qt} + .90\,[(1-q_{nt})\,p\,(1-q_{t})\,H^{P}]\,D_{nqt}}{.912N}$$

The expressions within the brackets of the numerator are the number of any group of permanent new hires who will become either Tenured Quits (the first term) or Tenured Non-Quits (the second term). For example, the expression within the brackets of the second term in the numerator is 2.59 faculty members per year. As we described in our example above, only 3.36 in ten new hires can expect to reach retirement age; and if only 7.7 are hired per year, .336 of 7.7 is the 2.59 of any group of new hires who can expect to reach retirement. The D values are the average terms of employment in the tenured faculty sub-groups or what is the same thing the number of age groups of past new hires in that tenured faculty sub-group. Again as our example, if Tenured Non-Quits are employed from age 36 to 64 inclusive, there will be 29 such age groups. And, the product of the number of faculty members in each age group, 2.59 in the example, and the number of age groups, 29, is the total faculty members in that tenured faculty sub-group, or 75.11. Finally, only 90 per cent of those 75.11 or 67.6 will actually be teaching; the other 10 per cent will be on leave. The sum of the members of faculty in both tenured sub-groups, the Tenured Quits and Tenured Non-Quits less the leaves divided by the teaching faculty, .912 N, is the % T. Thus, having solved equation 3 for the appropriate values of H^p given p, the values of p and H^p can then be used in equation 4 to solve for % T.

The average age, A, is a weighted average of the average ages of each of the five faculty sub-groups where the weights are the proportions that the teaching component (less leaves) of those sub-groups are of the total teaching faculty or:

5) $$A = X^t \frac{{}^sA + {}^dA}{2} + X^p_{qnt} \frac{{}^sA + {}^dA}{2} + X^p_{nqnt} \frac{{}^sA + {}^dA}{2} + X^p_{qt} \frac{{}^sA + {}^dA}{2} + X^p_{nqt} \frac{{}^sA + {}^dA}{2}$$

where:

5a) $X^t = \frac{H^t \quad D^t}{.912N}$ Temporaries

5b) $X^p_{qnt} = .90\left[\frac{(q_{nt})(H^p)}{.912N}\right] D^p_{qnt}$ Non-Tenured Quits

5c) $X^p_{nqnt} = .90\left[\frac{(1 - q_{nt})(H^D)}{.912N}\right] D_{nqnt}$ Non-Tenured Non-Quits

5d) $X^p_{qt} = .90\left[\frac{(1 - q_{nt})(p)(q_t)(H^p)}{.912N}\right] D_q{}^t$ Tenured Quits

5e) $X^p_{nqt} = .90\left[\frac{(1 - q_{nt})p\ (1-q_t)(H^b)}{.912N}\right] D_{nqt}$ Tenured Non-Quits

The average age of each faculty sub-group is simply midway between the age (the ${}^sA$'s) at which a faculty member enters that group (29 for the temporaries, 30 for both Non-Tenured groups and 36 for the Tenured groups) and the age when the faculty member leaves the group (the ${}^dA$'s). The weights (the X's) are derived in exactly the same way we derived the % T above, by multiplying the number of any new hires that will fall into that sub-group times the number of age classes (the D values) in that sub-group; taking 90 per cent of that number if the sub-group is leave eligible, and dividing that product by .912 N the size of the teaching faculty. (Note how the weight for the younger temporary faculty is increased by our choice to deal with the A for the teaching faculty only. All the other sub-groups' numerators are reduced by .10 because they are leave eligible; the temporary sub-group is not.)

The influence of our 11 or so "displaced" faculty is also reflected in an actual average age for the Carleton faculty which is below the A of our ideal steady-state faculty of Figure 2. The static model generates an average age of 42.60. The temporary faculty is 12.4 per cent of the teaching faculty and its mean age is 29.75; the Non-Tenured Quits represent 7 per cent of the teaching faculty and their mean age is 31; the Non-Tenured Non-Quits are 19 per cent of the teaching faculty with a mean age of 37.5; the Tenured Quits, 9 per cent with a mean age of 45.5 and the Tenured Non-Quits, 53 per cent of the teaching faculty with a 50.5 mean age. The weighted average is 42.60. Carleton's existing teaching faculty is somewhat younger, about 39.42 years of age, due primarily to the fact that 10 per cent of the faculty is displaced and is not 60 but 32.5 years of age.

Finally, the average wage is computed in much the same way as the average age. It is a weighted average of the average wages in each of the five faculty sub-groups where the weights are the same as those for computing average age or:

6) $W = X^t(W_{29.75}) + X^p{}_{qnt}(W_{31}) + X^p{}_{nqnt}(W_{32.5}) + X^p{}_{qt}(W_{45.5}) + X^p{}_{nqt}\ (W_{50.5})$

The average wages for the sub-groups (the W's) are simply the wages at the mean age of those sub-groups (29.75 years for the temporaries, etc) computed directly from the Age-Income profile. Again, Carleton enjoys an artificially somewhat lower W than would be the case in our static model. The wage distribution produced by a long-term steady-state p = .7 H = 7.7 per year policy mix would have a mean of $15,958 whereas Carleton's actual mean wage is $15,051. This is, again, due to the fact that 11 faculty members earn $13,000 rather than $19,750.

B. The Trade-Offs And Some General Observations.

Table II (page 74) presents the quantitative relationship between tenure policy (p) and our dependent variables, the measures of faculty health: H^t, H^p, H^p/N, % T, $\bar{A}$

and W given the Carleton-like quit rates (q_{nt} = .4, q_t = .2), average terms, proportion of teaching faculty which is temporary (12.4 per cent), leave rates, and faculty size (141) discussed above and in Chapter II. Again, these relationships ignore past growth or for that matter, past variations in any of our other parameters' past values. Or, what is the same thing, they assume away the existing faculty's distribution by age, rank, and wage.

They may, nevertheless, serve as a quantitative benchmark for examining and interpreting a school's existing distribution of faculty. We, for example, usefully contrasted the age and rank distribution of Carleton's 1973-74 faculty with the idealized distribution implicit in the p = .7 row of Table II (see the outlined row in Table II) and found that 11 or 12 "displaced" faculty members were "artificially" depressing A, W, and % T below their idealized levels at the cost of an actual turnover rate for permanent faculty, $^{Hp}/N$, which was below what it would be in long-run equilibrium: 7.7 permanent new hires per year or 5.5 per cent of the total faculty. We know, too, from our intuitive understanding of the dynamics of faculty "aging" that given a continued p = .7 policy, should we perform the same contrast between ideal and actual distributions 10 years from now, that group of 11-12 displaced faculty will be older and more costly producing values of % T, W, and A above those of the idealized distribution implicit in Table II.

As we discussed in Chapter I (see Section B.3), these quantitative relationships are indicative of the precise p -- H, A, etc. trade-offs (given our decidedly uncertain assumptions!) only in the very long run -- over two hundred years. A change in tenure policy will produce an age dip or age bulge in the same way as a change in faculty size does, and the subsequent cycles will fully erode only after many years. They are, therefore, only grossly indicative of the trade-offs over the "normal" long-run (25-30 years). And they are indicative only of the direction and not magnitudes of changes in the short-run (5-10 years).

This is because the static model assumes a "plastic-like" faculty that could be instantaneously remolded when, in fact, any school has very long-term obligations to existing faculty which may be inconsistent with the new policy mix. Assume, for example, a school were to shift from a liberal p = .8 policy to a stricter p = .6 policy. First of all, it could not immediately raise H^P from 7.0 fully to 8.6 (see Table II). The pre-tenure quits would still be based on the 7 new hires of three years earlier under the old p = .8 regime, and the new stricter tenure standards could be applied only to those left of the 7 new hires of six years earlier. This would be partly offset, however, by the larger number of post-tenure quits and retirements that would be occuring because there would be an "excessive" (from the standpoint of a p = .6 policy) number of older tenured faculty which remains "in the pipeline" for another 25-30 years. It is this part of the faculty, the tenured group, which would be most difficult to "remold." They would have two influences. Most obviously, their existence would keep % T, A, and W from dropping toward their lower (p = .6) values immediately. However, they would also permit H^P to soon exceed its static steady-state values of 8.6 per year because of the excessive number of retirement spots they were providing. And, this would produce a drop in % T, A, and W in excess of those indicated in Table II by the 25th year, and a later cyclical rise above the Table II values.

To see this, let's look at the age distribution of the faculty in the 25th year after the policy change when the last of the pre-policy change faculty are about to retire. It would now have a "dip" near the older end of the age distribution and a "bulge" in the middle of the distribution. The dip would represent the initial failure to raise H^P fully to 8.6 per year because of the "relatively" small (7 per year) number of probationary faculty on which pre-tenure quits and negative tenure decisions were based. With a "too low" H^P there would be too few initially standing for tenure and, therefore, too few nearing retirement now, 25 years later. The bulge in the middle range of the age distribution would be due to the above 8.6 per year H^P rate beginning sometime after the 12th year following the policy change. By that time the new hires which replace pre-tenure quits and negative tenure decisions would have risen to nearly their p = .6 levels because in each of the preceeding eleven years the partly offsetting excess in retirements would allow for a small rise in H^P generating yet more non-tenure quits and negative tenure decisions, and still more new hires. Added to the p = .6 level of pre-tenure quits and up-and-out spots, however, would be the still excessive retirements from the p = .8 faculty. With H^P above 8.6 per year those being promoted to tenure after the twelth year would be excessive in terms of long-run steady-state, and this bulge of tenured faculty would be still fairly young in the 25th year after the policy change. The combination of an older dip and younger bulge (always in contrast to the ideal distribution!) would produce an A and W which were below their p = .6 levels in Table II and later cyclical behavior.

In short, the values in Table II are not fully indicative of long-run (25-30 year) policy options and would tend to understate the drop in % T, A, and W after the 25th year of a stricter tenure policy and overstate their rise following a more liberal policy. Moreover, they would more closely approximate the actual long-run values the less drastic was the change in p and therefore the smaller the later dip and bulge or bulge and dip.

Finally, these quantitative relationships may be useful for gross inter-school comparisons if neither school has a non-uniform age and rank distribution, or more reasonably, if both schools have similar past histories and, therefore, similar bulges in their existing age and rank distributions. It might be interesting for example to contrast schools with Yale-like p = .4-.5 policies (and past faculty growth) with Carleton-like p = .7-.8 policies (and similar past faculty growth). Would their % T values differ by the predicted 10 percentage points?

Table II

The Values of % T, A, W, Permanent New Hires, Permanent New Hires as a Proportion of Total Faculty, and Temporary New Hires Consistent With Differing Tenure Policies*

The Probability of Receiving Tenure P	Temporary New Hires H^t	Permanent New Hires H^P	Permanent New Hires As a Proportion of The Total Faculty H^P/N	% T	Average Age	Average Wage
0	10.5/Yr.	26.99/Yr.	18.5%	0.0	31.70	$12501
.1	10.5	19.47	13.8	22.17	35.68	$13750
.2	10.5	15.53	11.0	35.37	37.96	$14494
.3	10.5	12.91	9.1	44.12	39.51	$14987
.4	10.5	11.06	7.8	50.35	40.61	$15338
.5	10.5	9.66	6.8	55.01	41.45	$15601
.6	10.5	8.58	6.1	58.63	42.09	$15805
.7	10.5	7.72	5.5	61.52	42.50	$15968
.8	10.5	7.01	5.0	63.89	43.01	$16101
.9	10.5	6.43	4.5	65.85	43.37	$16212
1	10.5	5.93	4.1	67.51	43.65	$16306

These values were derived assuming a Non-Tenured Quit Rate of .4, a Tenured Quit Rate of .2 for a 141 member teaching plus leave faculty and a 128.5 member teaching faculty.

The most important value of the numbers in Table II, however, is in the generalizations they illustrate. There are many useful answers to general questions implicit in Table II, and these generalizations are probably as valid in a real world of faculty inertia and uneven existing age distributions as in our static idealized world. Just how sensitive are a faculty's characteristics to changes in tenure policy? Or put differently, how effective is tenure policy as a tool to control faculty characteristics? Very? Or, very little? What is the form of the relationship between p and % T? Linear. (one of proportionally) or non-linear? Put differently, does using tenure policy to control faculty characteristics become less effective the more liberal it becomes?. Why? Just how useful is % T as a proxy for H, A and W? Do changes in % T tend to overstate or under-state the change in H, A, and W? Is there a floor on H? Or, a ceiling on % T? Why? We shall seek to answer each of these questions below but hope that the alert reader has posed other questions and can find similar answers as well.

1. The Effectiveness of Changes in Tenure Policy vis-a-vis A and W. The range of A and W values consistant with the extreme values of p = 0 (no tenure promotions) and p = 1 (all granted tenure) is surprisingly small, from 31.7 years to 43.7 years and from $12,500 to $16,310. Moreover, over a "reasonable" range of p, from .3 to .9, the range of A and W values is even smaller, from 39.5 years to 43.4 years and $15,000 to $16,210. Finally, when one recognizes that any change of this sort will be spread over many years, the impact of changes in p on W is one of virtual insignificance. A rise in W of $1,200 spread over even 10 years (everything else constant) represents an average annual rate of growth in W (and, therefore, the total wage bill given faculty size constant) of less than a quarter per cent annually. In terms of the total wage bill (W x 141 faculty members), a change in W of $1,200 over 10 years represents a change of $170,000 or $17,000 on the average each year.

To explain the insensitivity of A and W to changes in p one must first understand how tenure policy affects these variables. Put simply, starting from an extreme, all tenure policy (p = 1) and then becoming stricter, the faculty becomes younger and thereby less costly because the younger and less costly probationary pool rises as a proportion of the total faculty due to the rising number of new appointments associated with less liberal (p less than 1) tenure policies. This process, however, eventually produces its own "automatic offsets." While more replacements are needed as more negative tenure decisions are made, fewer replacement spots are opened through retirements. As the probationary pool increases due to the larger number of negative tenure decisions, the tenured pool must drop eventually producing fewer retirement spots.

This is often overlooked because one is not accustomed to thinking in the very long-run. As our discussion of dips and bulge above indicated, a change in tenure policy will have a somewhat more dramatic impact on H^P, A, and W than indicated in Table II by the 25th year. This is because a stricter tenure policy does not immediately change the number of retirements which are based on the number of newly tenured faculty many years earlier when tenure standards were more liberal. However, this is not permanent. Eventually retirements must drop if the size of the tenured faculty has been reduced.

A second reason for the insensitivity of A and W to tenure policies is, put grossly, that the tenured faculty is on the average reasonably young, therefore fairly inexpensive, and never more than 70 per cent (given our assumptions) of the total. Or more precisely, the difference between the average ages (and therefore W) of the tenured and non-tenured faculty is much smaller than the stereotype would have it. The tenured faculty member (Quit and Non-Quit) is not a "doddering 73 years old" but, if uniformally distributed, is on the average, about 49. The untenured faculty (Temporary and Permanent) is not a fresh-out-of-grad school 28, but 32 on the average if uniformally distributed. Therefore, using tenure policy to vary the proportions of these groups in the total faculty cannot change A by more than 17 years in the limit. Moreover, since "reasonable" proportions lie between 44 per cent tenured and 67.5 per cent tenured (p = .3 and p = 1) the range is much smaller, i.e., The proportion of the 49 year old group cannot fall below 44 per cent so that A which is the weighted average of these two groups cannot fall below .44 x 49 plus .56 x 32 or 39.5 years of age and the proportion of the 49 year old group cannot rise above 68 per cent so that A cannot rise above .68 x 49 plus .32 x 32 or 43.5 years of age.

Given an A which is fairly insensitive to p and a W which rises less than proportionally with A, W will be even more insensitive to p than A. Raising A from 39.5 years to 43.5 years; a 10 per cent increase, would raise W by only $1,200 from $15,300 to $16,500 or a 7.8 per cent increase.

These generalizations would be altered only if the tenured faculty were to be distributed in an extremely (and unrealistically) uneven way. It is difficult to see how the average age and wage of the untenured faculty could ever be much below 32 unless hiring policies change drastically or grad schools begin producing 20-year-old PhD's. Moreover, it would take a very large "displacement" of tenured faculty to change its average age significantly above 49 years so that the difference between the two groups' ages was significantly greater than 17 years. For example, in our discussion of a Carleton-like faculty in Section A we found that with 9 per cent of the total faculty (15 per cent of the tenured faculty) displaced from the last nine years of the age distribution the mean age of the tenured faculty was reduced only 3 years; the actual mean age of Carleton's tenured faculty is currently 46 rather than 49. If the reverse is true (in 29 years) and the same 15 per cent of the tenured faculty (9 per cent of the total) is displaced, but is now in the upper end of the age distribution, the tenured faculty would be no older than 52.

2. The Effectiveness of Changes in Tenure Policy in the Upper Range of the p Values.

It is apparent that the higher p already is, the less impact a change in p will have on % T, A, W, and H. Or, the "incremental (extra) costs" in direct financial terms (W) and in qualitative terms (% T, A, and H) of a more liberal tenure policy diminishes as p rises. Put more formally, the relations between p and H,A,W, and % T are non-linear and have decreasing slopes. Therefore, since most schools now operate at fairly high p values, for tenure policy to have a significant impact it must be changed very sharply. Only those schools which have always operated with p = .3-.4 tenure policies can expect to have a significant impact on their measures of faculty health with relatively small changes in p.

The simplest way of explaining this is in terms of the size of the groups that tenure policy affects. If a school has a very liberal p = 1 policy and, therefore, has a very small probationary pool as a proportion of the total faculty, very few faculty members are standing for tenure. A 20 percentage point reduction in p, in turn, will have little impact because it affects such a small proportion of the faculty. On the other hand, if a school has a stricter p = .5 policy and, therefore, a larger probationary pool, the same 20 percentage point reduction in p will have a much greater impact because it acts on a fairly large proportion of the faculty. The same argument explains why a drop in pre-tenure quits makes tenure policy slightly more effective. The fewer the pre-tenure quits, the larger the proportion of the faculty standing for tenure and the more effective are changes in tenure policy whatever the p.

Another way of explaining this non-linearity depends on the different lengths of the probationary period versus the full term of tenured employment and on the relationship between post-tenured attrition and pre-tenured attrition as sources of replacement spots. A change in tenure policy can also be viewed as altering the size of the probationary pool by altering the source of replacement spots (and therefore new hires). The more liberal a tenure policy, the more a school depends on retirements and post-tenure quits and the less it depends on untenured quits and negative tenure decisions. The increase in retirements of a more liberal tenure policy moreover, never fully compensates for the drop in pre-tenured attrition because the retiree and Tenured Quit stay for so many years longer than the pre-tenured departure. For example, assume a school is following a p = 0 policy (the limiting case). Some stay no longer than 3 years, none stay beyond 6 years, and replacement spots are provided solely through pre-tenure quits and negative tenure decisions; no-one is hired to cover retirements. Now, permit a very small proportion, only 10 per cent (p = .1) of those standing for tenure to go on to tenured employment. This assures very few new hires of a, nevertheless, very long additional term of employment and requires a very sharp reduction in H^P and, therefore, in the size of the probationary pool.

However, as the school becomes more heavily dependent on retirements, i.e., has an increasingly liberal tenure policy, H^P and the probationary pool drop by less from further liberalization because the rise in retirements increasingly offsets the drop in pre-tenure attrition. Relatively few already can expect the short 6 years of probationary service and relatively many already enjoy the additional 29 years of tenured service. Therefore, permitting more to enjoy the additional long term of tenured employment reduces pre-tenure attrition by little more than it raises retirements and tenured quits.

The generalization holds true as well in a dynamic world. We observed above that the tenured faculty is far more difficult to "remold" than the untenured faculty and that retirements are little affected initially by changes in tenure policy. Therefore, the less this group bulks in the faculty, the larger and more immediate the impact of a change in tenure policy on % T, A, and W. Moreover, the less the group bulks in the faculty, the less will be the impact of the failure of its retirements to respond immediately to tenure policy changes and the closer will our Table II static values correspond to their long-run values in a dynamic world.

3. The p - H^P Trade-Off. We have just described the mechanics of tenure policy's impact on the composition of the attrition which provides openings for permanent new hires and its impact, therefore, on the number of permanent new hires. It is sufficient to add here that permanent new hires (H^P) are much more sensitive to tenure policy than A and W and that there is a floor on permanent new hires.

The greater sensitivity of H^P than A and W to changes in p is evident in Table II. The absolute number of permanent new hires can range from 6 to 26 per year from p = 0 to p = 1, and over the "reasonable" p = .3 - .9 range, H^P can still double from 6.4 to 13 per year. The same is true of the proportion of permanent new hires in the total faculty which ranges from 4 per cent to 9 per cent over the p = .3 - .9 range. Therefore, if one's primary measure of faculty vitality is the ability to make permanent new appointments and if ones primary concern is over the current diminishing rate of permanent new hires, tenure policy can have a significant impact even though it will affect A and W relatively much less.

The reason that A and W respond so much less than H^P to tenure policy is that attrition occurs over such a wide range of age and wage classes. Increasing attrition fairly sharply by a stricter tenure policy still results, in part, in the replacement of a larger number of only 35 year old up-and-outs and 32 year old pre-tenure quits with 30 year old new hires. This can change A and W very little. It's primary impact on A and W occurs only to the extent it replaces more 64 year retirees with 30 year old new hires.

Perhaps equally important, there is a "floor" on new hires which is very high by contrast to the maximum change that one could accomplish by a sharp change in p policy. At least a 4 per cent turnover of permanent new hires will occur "naturally" with an all tenure (p = 1) policy. The benefits of raising that number to 9 per cent at the cost of reducing the number of successful tenure applications from 10 in 10 to 3 in 10 might be doubtful particularly if a 4 per cent turnover were already deemed "sufficient;" 6 permanent new hires per year at Carleton, for example, would permit one new permanent appointee per department roughly every three years.

There are two important qualifications to this observation. A little over one-half of that "floor" is represented by quits (3.1 per year are quits and 2.9 are retirements) and some might view our even conservative estimate of these quit rates as too high in light of current market conditions. We should point out, however, that if quits are reduced then retirements will rise. Unfortunately, this partially compensating increase in retirements will occur only many years later in a dynamic world.

In addition, if the existing distribution of faculty is extremely uneven, this floor could be considerably lower. Our discussion of the Carleton-like faculty, for example, pointed out that only 4 will retire over the next three years or 1.33 per year. This, and the recent 3 per year quit rate might be deemed a sufficient number of replacement spots. Without the 3 per year quits, however, it would probably not be sufficient.

4. <u>Changes in % T Tend to Overstate the Effects of Changes in p and A and W.</u> We have already remarked that % T is merely a <u>proxy</u> for these more important measures of faculty health and tends to be followed by them only with a long lag. Table II indicates, moreover, that it tends to be a fairly "heavy-handed" proxy which if rising

makes matters look somewhat worse than in fact they are, and if falling, somewhat better. In different terms, % T is much more sensitive to tenure policy than A and W, and the absolute and percentage change in its value will considerably overstate both the percentage and absolute change in A and W.

We have, in effect, already explained this in our Section B 1 discussion of the insensitivity of A and W to p. The difference between the ages of the tenured and untenured groups is only 17 years and that between their wages is only $5,507. Therefore, a fairly large 10 percentage point increase in % T can increase A by no more than 1.7 years and W by no more than $551. That is, A and W are simply the weighted average of the age and wages for each group where the weights are % T and 1 - % T or: A = % T (49) + (1 - % T) (32) and W = % T ($18,128) + (1 - % T)($12,615). These can be rewritten as A = % T (17) + 32 and W = % T ($5,510) + $12,615. Therefore, if % T changes by .10, A changes by .10 (17) or 1.7 years and W changes by .10 ($5,510) or $551. One wonders whether such a 1.7 year change in A justifies the talk in some schools of tenure moratoriums that have resulted from anticipated 10 point rises in % T.

This observation should, again, be qualified for the case of an uneven age distribution. A 10 percentage point rise in % T might represent the passage to tenure of a "displaced" bulge of untenured faculty, and as we described above, if it is 9 per cent of the faculty, it could initially reduce the average age of the tenured faculty below its 49 year level to say 46 and then raise it later to 52 or 53 years yielding a larger change in A than 1.7 years from the time that the bulge first became tenured to the time it finally retires. We still think, however, that the bulge must be extremely large for a 10 point change in % T to be associated with a change in A (the average age of the whole faculty) of much more than 3 to 4 years.

5. A Ceiling On % T. To conclude we should point out that there is a ceiling on % T, (68 per cent in Table II); no matter how liberal the tenure policy a faculty can never become 100 per cent tenured. The temporary appointee and tenured quits both assure that not all are tenured. Even more basic, there is a probationary period of six years, and unless there are no new hires for a period of six years or all new hires are hired with tenure there must be some untenured probationers.

C. The Influence of Variations in Quit Rates.

As indicated in Table III, variations in quit rates can have fully as important an impact on our measures of faculty health and vitality as tenure policy. They are, moreover, the "jokers" in any mathematicsl "deck" which purports to predict future faculty characteristics because of their own unpredictability. For example, in Chapter II we made the case that given 1963-68 faculty labor market conditions, Non-tenured and Tenured Quit Rates could be as high as .6 and .4 (compare rows 2 and 4 in Table III). Given a rise in quit rates to those values from their current .4 and .2 values, and assuming tenure policy constant at p = .7, H^P would rise from 7.7 to 11.5 per year and % T, A, and W would drop from 62 to 54, 42.6 years to 40.45 years, and $15,967 to $15,309 respectively. To produce the same changes with the application of a stricter tenure policy, quit rates constant at .4 and .2 (see Table II), would require a sharp drop in p from .7 to .4. Similarly, one could make the case that Non-Tenured Quit Rates might be as low as .2 (the part of Non-Tenured Quits which are essentially early informal tenure decisions) and that the Tenured Quit Rate might be .15, the floor represented by mortality (compare rows 4 and 6 in Table III). Assuming tenure policy constant at p = .7, this would lower H^P from 7.7 to 6 per year and raise % T from 62 to 65, A from 42.6 to 43.3 and W from $15,967 to $16,208. The same results would occur if given quit rates constant at q_{nt} = .4 and q_t = .2, p were raised from .7 to .9.

This similarity in the quantitative impact of variations in quit rates and the impact of changes in tenure policy is not surprising given the similarity in their mechanics. Raising the Non-Tenured Quit Rate operates almost exactly the same way as lowering p. It raises the proportion of the probationary pool in the total by raising new hires; pre-tenure attrition rises and becomes a more important source of replacement spots because it is not fully offset by the drop in retirements. Put differently, it reduces the number going on for long periods of employment and retiring and replaces them with faculty who will stay only 3 or 6 years and will quit or become up-and-outs. It does not have a striking impact on A and W because although it can change % T and the size of the non-tenured and tenured groups substantially, these groups are not strikingly different in either average age or average wage. Finally, the lower the quit rate already is, the less an impact further drops in quitting will have (compare the changes between row 4 and row 5 with those between row 4 and row 3). The relationships between Non-Tenured Quit Rates and the dependent variables are non-linear because the smaller the pool from which Non-Tenured Quits comes, the less of an impact a further rise in quitting will have. About the only difference between Non-Tenured Quitting and tenure policy is that the quitting occurs slightly earlier; a quit replaces a 32-year-old with a 30-year-old rather than replacing a 35-year-old with a 30-year-old. This makes it ever so slightly more effective than tenure policy in changing A and W.

Table III

The Impact of Variations in Quit Rates

Row Number	Non-Tenured Quit Rate	Tenured Quit Rate	Permanent New Hires	H^P/N	% T	A	W
	A.	Assuming p = .7					
1	.7	.5	14.7/Year	10.4	47.4%	39.0 Yr.	$14,859
2	.6	.4	11.5	8.2	53.5	40.5	$15,309
3	.6	.2	10.6	7.5	56.3	41.6	$15,640
4	.4	.2	7.7	5.5	61.5	42.6	$15,967
5	.2	.2	6.6	4.5	63.8	43.2	$16,127
6	.2	.15	5.9	4.2	65.0	43.4	$16,208
7		.15	5.0	3.5	66.4	43.5	$16,267
	B.	Assuming p = .5					
8	.2	.15	7.5	5.3	59.0	42.3	$15,871

The Tenured Quit operates in somewhat the same way as the Untenured Quit although it is considerably less effective. It also permits more permanent new hires and enlarges the probationary pool if it rises because it reduces retirements by less than it raises pre-retirement attrition. However, this effect is not as significant as in the case of tenure policy or Non-Tenured Quitting because the average term of the Tenured Quit is so near that of the full service retiree. As Table IV indicates a 20 percentage point rise in the Tenured Quit Rate from .2 to .4 (p and Non-Tenured Quitting constant) raises H^P by only .9 new hires per year contrasted with a change of 3.1 new hires for a similar 20 percentage point rise in the Non-Tenured Quit Rate. Similarly, it reduces % T by only 2.7 points by contrast to a 5.2 point drop for a similar increase in Non-tenured Quitting. This, we observed, is the primary reason why early retirement programs will not have a significant impact on faculty characteristics.

On the other hand, Tenured quitting has a further impact which is not obvious from Table III and which compensates somewhat for its failure to affect H^P and % T as significantly as Non-Tenured quitting. It also reduces the average age and average wage of the tenured faculty itself, i.e., its impact on A and W is not solely via changing H^P and, therefore, the proportion of the older tenured faculty in the total; it also directly changes the average age and wage of the tenured faculty because it changes the proportion of the tenured faculty which goes on to retirement. While this does not alter the fact that tenured quitting (at age 55) is not as effective in changing A and W as tenure policy (at age 36) or Non-tenured quitting (at age 32), it does suggest that to make an early retirement program truly effective those early retirements must occur much sooner than at 63 years of age.

Table IV
The Relative Impact of A
Rise in Non-Tenured Quit Rates
Versus The Same Rise in the
Tenured Quit Rate

Non-Tenured Quit Rate	Tenured Quit Rate	Permanent New Hires	H^P/N	% T	A	W
.6	.2	10.6	7.5	56.3	41.6	15,640
.4	.2	7.7	5.5	61.5	42.6	15,967
.4	.4	8.6	6.1	58.8	42.0	15,850

We should point out, finally, that changes in quit rates need not be compensated for by changing new appointments policy and, therefore, the size of the probationary pool, % T, A, and W. In most of our experiments in Table III we held tenure policy constant at p = .7 and treated a rise in quit rates as a "windfall" gain which allowed us to raise new hires and reduce % T, A, and W. Similarly, the drop in quit rates was compensated for by an "unfortunate" drop in new hire and consequent rise in % T, A, and W. Alternately, one might seek to <u>maintain</u> the existing size of the probationary pool and tenured faculty, and offset the change in quit rates by variations in tenure policy (see row 8 Table III). For example, the drop in the Non-tenured Quit rate from .4 to .2 and the Tenured Quit Rate from .2 to .15 could be almost offset by a drop in p from .7 to .5. Similarly, tenure standards could be liberalized rather than changing New Hires % T, A, and W in the case of an increase in quit rates.

D. <u>The Temporary Faculty</u>.

To conclude, we must examine the influence of the temporary appointee and the effects of variations in the number of temporary appointees on the number of permanent new hires and on the A, W, and % T of the teaching faculty. We should first point out that the floor on <u>permanent</u> faculty renewal is, of course, augmented by the 10.5 <u>temporary</u> new hires per year that we have assumed are possible given an average term for the temporary appointee of 1.5 years and 16 temporary appointees in a total teaching-plus-leave faculty of 141. Moreover, the <u>maximum</u> change in permanent new hires per year that could be produced by lowering p from 1 to .3 is still less than the number of "new faces" provided simply through the maintenance of this short-term temporary pool. One, however, could certainly question whether these many temporary new faces are the equivalent of even a few permanent new hires.

We have performed two simple experiments in Table V: we have raised the temporary faculty from its current 12.4 per cent of the teaching faculty to 20 per cent and lowered it to 5 per cent. Two conclusions are obvious: 1) One can sharply increase the number of temporary new hires (by 6.6 per year) and, therefore, total new hires with little compensating reduction in permanent new hires (from 7.7 to 7.1). The obvious explanation is that temporary new hires do not remain employed very long and therefore do not "crowd out" many of the permanent faculty. 2) At the same time, sharply increasing the proportion of temporary faculty does not significantly change % T, A, or W. for exactly the same reason. They, obviously, lower the A, W, and % T but by very little (one year and $200) because they haven't crowded out many of the permanent faculty. In short, if ones' sole concern is increasing the number of new faces (quality unchanged?), enlarging the pool of temporaries is very effective; one can acquire 7 temporaries at the "cost" of 1 permanent new hire. However, significantly altering the teaching faculty's general characteristics (% T, A, and W) cannot be purchased as cheaply.

Table V
The Effects of Variations in the
Temporary Pool

Proportion of Temporaries in the Teaching Faculty	Temporary New Hires	Permanent New Hires	% T	A	W
5.0	4.28	8.3	56.6	41.8	15,714
(current) 12.4	10.5	7.7	61.5	42.6	15,968
20.0	17.1	7.1	66.1	43.3	16,205

We should, finally, remind the reader that one can also vary the number of temporary new hires without changing the size or characteristics of the permanent faculty at all. One can raise or lower the number of temporary new hires with compensating decreases and increases in the length of temporary contracts which change neither the stock of temporaries (16) nor the proportion of temporaries in the total. Indeed, this has been the historically most common means of changing the number of temporary new hires. Intuition suggests, however, that increasing temporary new hires through a compression in the average term of temporary employment is less and less feasible. A combination of half one year contracts and half two year contracts would seem an academic minimum, and as we observed in Chapter II temporary durations have increased markedly in the most recent years.

Chapter IV

The Dynamic Model With An Existing Age Distribution

The dynamic model is not difficult to describe conceptually. It starts with an existing stock of faculty, call it the "1973 faculty," suitably arranged or organized by age group and other analytically useful sub-classes such as tenured, temporary, untenured in the first year of service, in the second year of service, etc. That stock can be characterized or described by the set of "stock measures" of faculty health we have been using: the A, W, and % T for 1973. One, then, performs a series of operations that represent the changes in the composition of that stock that occur during that academic year. Most obviously, the faculty ages by one year producing retirements by the end of the academic year. Quits and deaths occur. Faculty members stand for tenure, and some are rejected while others are promoted. Finally, new replacements are hired to maintain the stock constant and to add new faces to the coming year's faculty. These operations which change the stock's composition can be viewed as "flows," and one of these flows is our fourth important measure of faculty health, the permanent new hires (H^P) for the "1974 faculty." At the beginning of the following academic year, then, one has a new, slightly different stock of faculty which can again be characterized by our stock measures, A, W, and % T (now for 1974) and on which a second year's aging, attrition, advancement, and replacement operations will be performed yielding a second year's (1975) H^P rate and a third, "1975 faculty."

This process is performed intuitively by thousands of academic administrators every year, and we emphasize its familiarity and conceptual simplicity. For example: "This year's 100-member stock of faculty is 50 per cent tenured. By the end of the year, two of its tenured members will be a year older and retire and 3 of the 4 untenured members standing for tenure will be promoted. Therefore, I must begin seeking 3 permanent new hires for next year, and by next year I will have a slightly altered stock of faculty which is 51 per cent tenured." While conceptually simple we have added sufficient detail to the process and have sought a long enough time horizon to render performing it by hand virtually impossible. We wish to know average age and average wage for "next year," for example, and to find this our hypothetical administrator must first laboriously add up the current ages plus one year of 100 faculty members being sure not to include the two retirees and one rejected tenure applicant and being sure to add the ages of the 3 new hires for next year. He, then, divides by 100 and performs the same laborious operation for average wages. We have, moreover, added the details of quits and deaths. This would not pose insurmountable difficulties for a one-year hand-performed simulation, but what if one wanted to simulate conditions 20 years hence? While there may now be 4 tenured faculty members who are due to retire in 20 years, one member may be removed in the interim by a decision (really, an "estimate") that one quit or death will occur at some point in any group of four faculty members with 20 years of service remaining before retirement. Would our hypothetical administrator remember this? And if he did, would he not possibly overlook that one of his earlier new hires had been assumed to be somewhat older than the average, had been promoted to tenure, and had been added to his correctly quit-diminished group due to retire in 20 years restoring it to its initial 4 member size?

In short, the detail and time horizon we desire in our model require the computer or a literal army of Ass't Deans with excellent memories which is generally unavailable. And, it may be well to describe the computer's workings even if it involves a short foray into the peculiar language of the computer.

A. An Heuristic Description of the Computer Model And A Comparison With the Static Model And The 12-College Survey.

1. An Overview. Figure 1 describes the flow of information through the computer model. Here, we will briefly characterize the entire process and will provide more detail of the operation of the process in Section B below.

The first step in the process is known as the "Initialization" or the preparations for the simulation. This is, first of all, organizing the age and rank distributions of the 141-member teaching-plus-leave faculty (see Table IX Chapter II) in a meaningful way useful for later operations. The faculty is first broken down into its familiar sub-classes, the temporary appointments, non-tenured permanent faculty, and the tenured faculty. The non-tenured permanent faculty, however, is further sub-divided into groups by year of service or longevity. This was not necessary in the static model; we simply assumed that the 30-year-old untenured permanent faculty member was in his first year of service and the 35-year-old, in his sixth year of service. This is clearly imprecise because many faculty members in their sixth year, for example, are in fact younger than 35, and some are even over forty. This yields, then, eight sub-classes: tenured, temporary, and the six sub-classes of probationers by year of service. Finally, each of these sub-classes is further distributed by age as of Sept. 1, 1973. There are, for example, 2.17 FTE, 32-year-olds in the non-tenured permanent faculty in their fourth year of service (see Table I below).

An additional part of the process of preparing for a simulation is choosing the tenure policy (p) and quit rates to apply in that simulation and deciding where (at what ages and/or years of service) in the faculty distribution quits, deaths, retirements, tenure decisions, leaves, and new hires are to occur i.e., determining from which part of the stock of faculty, outflows will occur and to what parts compensating inflows will occur. As we discussed in Chapter II, for example, one cannot pretend to accuracy and still "lump" all new hires into the 30-year age group of the untenured first-year-of-service sub-class even though that has been the mean hiring age. If new hires were lumped into one age group, the model would overstate real world retirements 35 years later because many new hires are, in fact, older and younger than thirty.* In the case

*Note, "lumping" new hires would not distort our estimates of non-tenured quits or number standing for tenure and being promoted or rejected. Non-tenured Quits and tenure decisions occur at points based on years of service and not age. Therefore, whether a group of new hires is distributed over a range of age groups in the first-year-of-service sub-class or lumped at 30 years of age in the same first-year-of-service sub-class they still correctly stand for tenure in their sixth year of service and quit in their third and fourth years of service.

of new hires, therefore, in this particular initialization we decided to distribute new hires uniformly across the age groups 27 to 31, i.e., of 5 new hires, one each would enter the first-year-of service sub-class in each of the 5 age groups from 27 through 31 inclusive. Or, we decided that all would stand for tenure (whatever their age) in their sixth year of service. These, and all other similar decisions on "flow locations" are presented in full detail below (Section B-1).

The second step in the process is to take measurements of various indicators. At the beginning of the first year of the simulation this is limited to the measurements of the composition of the existing faculty such as % T, A, W -- our "stock measurements." This is because all flows are assured to take place, in effect, during the following summer and are reported for the following year even though they are based on the first year's faculty. This is not altogether unreasonable.

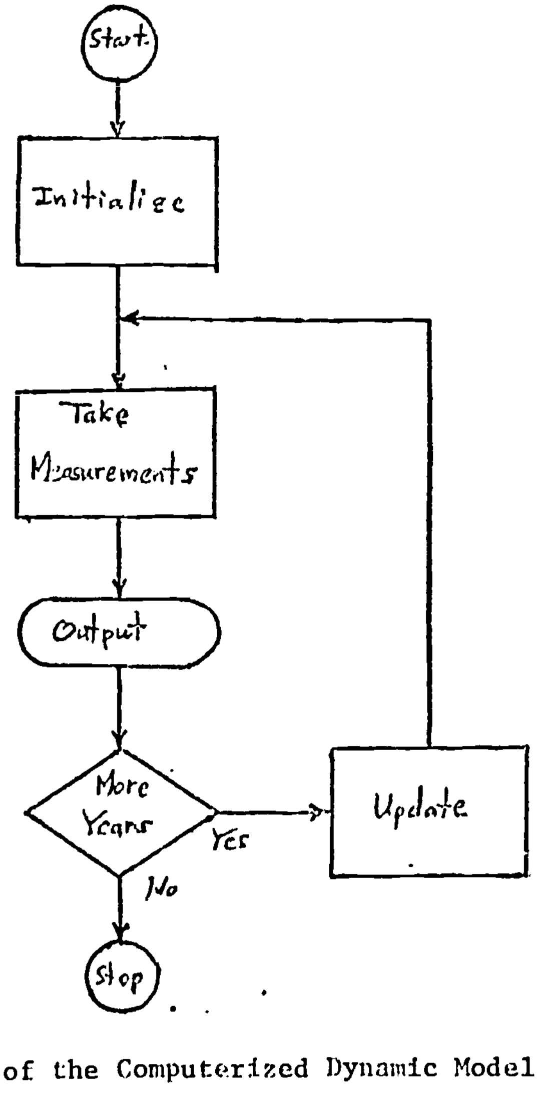


Figure 1, Flowchart of the Computerized Dynamic Model

The "1974 new hires," in fact, enter the "1974 faculty" (the 1974-75 academic year) even though they replace quits, deaths, etc. from the "1973 faculty" (1973-74 academic year). In subsequent years of the simulation (or subsequent "loops" -- see Figure 1) after the outflows and inflows begin to occur, other "flow indicators" that can be measured will be obtained: primarily the new hire rates and the composition of the attrition which they replace.

After the values of such measurments are communicated to the external world (the computer's "Output") we reach the "Up-dating" portion of the model, the point where the faculty is aged and the flows occur. This is the most critical step because this is where computations other than simple counting are performed and where modelling errors, i.e., differences between the model and real world, are most abundant. The ages are advanced by one year for the permanent classes only. The temporary class, in the absence of more information, is assumed to be constant in size and average age. The retirements, tenured quits, and deaths take effect based on these new ages. In addition, those probationers who are now completing their third and fourth years of service (whatever their age) either quit or continue on toward tenure and those completing their sixth year of service stand for tenure and leave the faculty or move on to the tenured class. At this point, the years of service for the untenured permanent class are increased by one to make room for a flow of new hires. The sum of all these sources of attrition, in turn, determines the flow of new hires that can be added to the following year's faculty to begin their first year of service. Once entered, new measurments can be taken for % T, A, and W for this now modified faculty. The process continues for as many years as are of interest with up-dating flows, measurment of both the new stocks and the flows which altered them (reported in the same year), and more up-dating, measurment, and so on. Our computer says "No" to "More Years" and "Stops" 50 years from its start in 2023.

2. Comparisons With the Static And Twelve-College Models. Our static and dynamic model share a basic similarity. They both seek to provide an insight into the importance and direction of the impact that variations in tenure standards (p) and quit rates have on the values of A, W, and % T, and H^P consistent with both these p and quit rates and

steady-state. Their basic difference lies in the fact that the static model generates its values through a sort of enforced consistency which ignores the existing distribution of faculty as well as time, whereas the dynamic model determines its values by yearly counts based on an assumed distribution approximating the one at Carleton. We have pointed out several times, however, that the values in the dynamic models do converge with those of the static model after the passage of many years. In our discussion of the Chapter I hypothetical college we took a fixed probability of tenure (p = .6) and an initial distribution of 124 faculty members inconsistent with it and found that oscillations in % T, A, and H^P occured for many years with a slow approach to an unchanging distribution of faculty which yielded values of % T, A, and H^P that were consistant with a p = .6 policy in the static model. This is some support for a conclusion that whatever generalizations are valid for the static model are also valid for the dynamic model.

In some ways our dynamic model is similar to the model developed in the Twelve College Survey. Both are dynamic and use initial realistic distributions to predict year-by-year changes. The Twelve College model, however, is more of a true simulation in that it is based largely on random events. It deals first with "whole" faculty members, not parts of FTE's, and generates a random number -- figuratively, flips a coin or throws a die -- to determine whether that faculty member is promoted or leaves. Our model is much more deterministic in that it is very explicit about the sources and amount of attrition and when and to whom that attrition occurs.

For example, take the two models' approach to the first six years of service. We would follow a group of new hires into their seventh year by removing a certain number of quits, usually partial FTE, in their third and fourth years of service and a certain number more of tenure rejections in their sixth year. If there were initially 10 in the group distributed evenly with 2 in each of the age groups from 27 through 31, if the probability of quitting were .40 and if the probability of a negative tenure decision were one in six (.167), our model would predict that after six years 5 newly tenured faculty members would remain from that group of 10 new hires and that they would be distributed evenly, one in each of the age groups, 32 through 36. The 12-College model, on the other hand would flip a coin ten times and promote anyone receiving a "head" and remove anyone receiving a "tail." This random approach might produce the same result, but then again it might not. Many more or many fewer than half might be promoted as anyone who has flipped a coin but ten times can verify. Or, all five might come from the initial 29-31 age groups and none from the initial 27-29 age groups producing a later dip in retirements and then a bulge.

Both approaches have pros and cons. Ours makes very explicit the sources of attrition and permits, therefore, more detailed real world analysis of variations in those sources. It moreover, is not susceptible to randomness which might skew measurments such as a "run" of 8 "heads" in 10 coin flips. Finally, it can account for faculty who do not teach full loads. On the other hand, the real world is more random than our approach implies and we artificially smooth that randomness somewhat. There may well be long "runs" of negative tenure decisions in the real world with all concentrated in a particular small age range.

A stronger criticism of the 12-College Model is its attempt to predict money wage rates and its inclusion, therefore, of inflation and other economy-wide influences on faculty wages. This is undesirable if not slightly dishonest. An excellent way of frightening any buyer of a product is to apply a 5 per cent growth rate to the price of that product for ten years; the figures soon cease to have any meaning at all, and the buyer often forgets that the price of the product he sells may rise at an equal rate. Tenure and other staffing policies are the variables at issue in both models, and these obviously have no impact on the rate of inflation. Adding a particular rate of growth (and a large one at that) to faculty wages to account for inflation, then, can only obscure the independent or "pure" impact of a staffing policy which produces variations in faculty age, and therefore, faculty wages.

A final criticism of the 12-College model is its imposition of a ten-year time horizon. As we have observed, staffing characteristics are often cyclical in nature, and limiting observations to only ten years of a roughly forty-year cycle both begs the question of an appropriate time horizon and limits the observer's appreciation of that cycle. Ten years may well be "realistic" as a horizon for academic staff planning, but it should not be imposed by the model builder. Nor, should the model obscure that current trends in staff characteristics have their roots in past decisions and will ultimately be reversed in the future.

B. The Model Elaborated And Formalized.

1. The Initial Values and Preparation for the Simulation. Again, we start with our stock of "1973 faculty" of 141 members subdivided into 8 sub-classes and distributed across 48 age groups (from 21 years of age to 68). Let N_{ij} denote the number of FTE faculty at age i = from 21-68 years and of sub-class j where j = 8 for the temporary group; j = 7, the tenured; and j = 1 to 6 for the untenured permanent groups beginning each of their six years of probationary service. The distribution of N_{ij} for j = 7 (the temporaries) and j = 8 (the tenured) was provided in Table IX of Chapter II. For j = 1 to 6, *i.e.*, the breakdown of the Untenured permanent class by age and year of service, the reader should refer to Table I below. (Note, again, the strikingly large number of untenured permanent faculty in their third and fourth year of service.)

We should emphasize the importance of having accuracy in these initial values. If they were much in error, the errors would be propagated especially during the first few years, and although basically sound, the model would be immediately questioned. For example, we found that a small number of untenured faculty members were beginning their seventh years of service in the academic year 1973-74 or more precisely had been hired more than six years ago. How should they be treated? We decided to assume that they had taken a year's leave of absence, and the counting of years before the conventional tenure decision in the sixth year of service had ceased during that year on leave; they were, therefore, lumped together with those actually beginning their sixth year in 1973-74. If this decision is unjustified, the number standing for tenure will be over-stated as well as the number rejected and being promoted, and consequently the number of new hires -- and all this, only one year hence. (Perhaps, our one Dean with even a poor memory could

Table I

Distribution of the Untenured Permanent
Faculty (Teaching-plus-Leave) by
Age and Year of Service 1973-74

Year of Service in 1973-74

	1	2	3	4	5	6
26	1					
27		2				
28			4.17	2		
29	1.83	1	2	2	1	
30	1		.33	2	1	
31	1			1		.67
32				2.17	1	1
33			2		2	.5
34		1			1	2
35	1		1			1
36					1	
37						
38						
39	1		1			
40				1		
41						1
42						1
43				.67		
44						
45						
46					1.5	

do better than our computer model?) We have already alluded to these sources of inaccuracies in Chapter II -- the ill-defined boundary between temporary and permanent and the problems posed for our years of service sub-classes by leaves of absence -- but we alert the reader now to the errors they can produce.

Our decisions on the "locations" of the various flows that also form a major part of the preparation for the simulations are even more uncertain although they are still grossly based on our historical and mortality data in Chapter II:

Retirements: at age 65 as of Sept. 1 (or 64 in the last academic year of service before "update").

Deaths: applied between the ages of 46 and 64 inclusive at a rate consistent with mortality tables. The probability of a 46-year-old professor not reaching his 65th birthday is .15.

Tenured Quits: applied between the ages of 36 to 54 inclusive at a rate which accumulates to the Tenured Quit Rate chosen for the particular simulation (see Section B 4 below on Up-Dating for more detail).

Untenured Quits: applied to all untenured faculty in their third and fourth year of service (whatever their ages) such that the rate accumulates to the Untenured Quit Rate and, such that equal absolute members quit from any hiring group in each of the two years. Thus, if the Untenured Quit Rate chosen for the simulations were .4, and ten were entering their third year, two-tenths or 2 of those hired three years earlier could quit in the third year and .25 or 2 of the remaining 8 would quit in the following year of the simulation. The sum of the quits from the initial hiring class would be four, and the quit rate, therefore, .4.

Standing for Tenure: in the sixth year of service whatever the age.

New Hires: distributed uniformly from ages 27 through 31 in the first year of service sub-class.

Leaves: 10 per cent of the tenured and untenured permanent faculty.

Temporaries: constant size, 16.76 members and age, 32.4 years.

Although these values were fixed in all simulations, it would be possible to vary them and study the effects of changing them. A more accurate distribution of new hires, for example, would be skewed toward the younger age classes, 27-29, combined with a compensating addition of some new hires at ages above 31, rather than being uniformly distributed between 27 through 31. Or, one could have half the tenure decisions occur in the fifth year of service and half in the sixth.

Finally, as preparation for each simulation we had to choose the particular tenure policy (p) and Untenured and Tenured Quit Rates that would be applied. The values of p chosen were p = 0, .4, .5, .6, .7, .8, .9, 1.0. Most simulations were run with an Untenured Quit Rate of .4 and a Tenured Quit Rate of .05. However, we also used a low quit simulation fairly often with an Untenured Quit Rate of .2 and a Tenured Quit Rate of 0, as well as other higher and lower rates.

2. Measurment and Output. Given the initial distribution, N_{ij}, as well as any changes that occur through later flows, it is an easy matter to compute the total of each of the three major sub-classes -- temporary, tenured, and permanent untenured -- and thereby the % T. Also available are various averages such as the average age of the permanents only and A and W for the teaching faculty. The term "teaching" indicates that the number in every age group of the permanent faculty has been reduced by 10 per cent to account for leaves. For determining the average salary of the permanent faculty the relationship between age and salary from Chapter II was used. The average wage of the permanent faculty was the weighted average of the salaries at every age (from 21-68) where the weights were the proportion of the permanent faculty any particular age group represents. The weighted average of this value and the wage of the 32.4-year-old temporary faculty (account taken of leaves) is W for the teaching faculty.

As we have mentioned, these stock measures of the composition of the faculty are supplemented after the first year's up-date by the flow information that the up-date generates. Moreover, this flow information is presented for the same year as the stock measures for the new faculty it helped create.

3. Up-dating: the Operations Performed on the Faculty Each Year. In this portion of the model the values of the flow are computed and the composition of the faculty is altered and aged accordingly.

The first action taken is to age all the permanent FTE faculty by one year. Those who become 65 as a result of this aging are retired. The death rate and Tenured Quit Rate are, in turn, applied to the remaining tenured faculty over the ages mentioned above, e.g., deaths from 46 through 64 years, etc. These rates are applied by reducing each age group over which tenured quits or deaths occur by multiplying it by the factor:

$$(1 - r)^{1/n}$$

where r is the quit or death rate and n is the number of years over which that rate is applied. This approach will have the cumulative effect of reducing the size of any particular age group passing through the entire quitting or dying age range by the factor of the quit or death rate, r. That is, given a Tenured Quit Rate of .2 and given a group of 5 tenured entering and passing through the quitting ages of 36 through 54, each year a few hundredths of an FTE will be "lopped off" that group to account for quitting, and the total amount "lopped off" over the whole period will equal 1 FTE or .2 of 5 FTE.

Up to this point, we have accounted for three of the five sources of attrition, deaths, tenured quits, and retirements. There remain untenured quits and negative tenure decisions both of which occur at points based on years of service rather than age.

For untenured quits the quit rate is applied to those age groups in the two subclasses of faculty completing their third and fourth years of probationary service as described above (see Section B 1). Those finishing their sixth year of probationary service will be standing for tenure, and the tenure probability (p) will be applied to each age class in that sixth year group. The promotions are added into the tenured class at the same ages. The negative decisions are added to the flow of attrition.

The final operations are to advance the years of service of the remaining probationers by one year to "make room for" the flow of permanent new hires which in a steady-state faculty necessarily equals the flow of the five sources of attrition (i.e., $N_{ij} \rightarrow N_{ij-1}$ for j = 6,5,4,3,2 and all i). The new hires are inserted into the distribution, N_{ij} using the uniform distribution over the ages 27 through 31 mentioned above. With this, the updating or alteration of the faculty is complete. It is older or younger, more or less costly, more or less tenured depending on the size of the flows and from whence they occured.*

We should conclude with several warnings. The manner in which we insert our new hires can have a fairly significant impact over the long-term on the age of the permanent faculty. If the whole new hire distribution were to be shifted up by just one year from the range 27-31 to 28-32, the average age of the permanent faculty would inevitably rise by a year and of the teaching faculty by almost that amount. And, while we have been treating this distribution as unvarying in all simulations (see Section B 1 above), we should remind the reader of the extreme volatility of the average age of new hires mentioned in Chapter II. We should also warn that the permanent new hire rate should not be confused with total new hires which includes turnover in the temporary class.

C. Some Extensions and Limitations.

Recall that the main use for the model is to provide insights into the effects of changes in p and quits. Also, the model can be used, very cautiously, as a predictor. By making the model more complex its performance in each of these roles might be improved. The ages over which deaths and quits apply could be broadened and the distribution of these occurances could be brought more closely to "reality." Similarly, the age distributions of new hires, leaves, tenure decisions, and even retirements, might be improved. The role of the temporary class could be modelled more realistically allowing changing contract lengths and different hiring ages as well as the oft-mentioned probable interaction with the permanent faculty. A better relationship between faculty composition and salary could be sought, perhaps including salary's dependance on rank and years of service as well as age. Finally, movement between ranks (Instructor, Ass't Prof, Associate, Full) could be modelled and studied as well as the effects of an influx of female and minority members or of early retirement proposals.

The worth of such extensions (and no less our results!), however, are perhaps best judged after one is fully aware of the model's limitations. Very important (and, for

*The ordering of the flows could be called "top-down", beginning at the top of the faculty age distribution and working down. The actual implementation of the computer model uses a slightly different ordering which might yield slightly different values. For example, promotions occur before tenured quits, not after as we have described above.

the n^{th} time!), there are errors in the data gathered for the timing and amounts of past attrition and the timing of new hires, to say nothing of their future unpredictability. Counting is a straight-forward task but uncovering the past and classifying it are not, and predicting the future is even less so. All of our historical work in Chapter II indicates that both the age distributions of new hires and the rates of non-tenured attrition and its timing (i.e., distribution across age classes) are subject to wide fluctuations and to influences both internal and external to the college which would be extremely difficult to model.

A second problem, more internal to the model, is its treatment of the faculty in fractional parts when, in fact, faculty members must be treated individually. One cannot "accumulate" four years worth of .25 FTE leaves and then hire a full FTE replacement. We should add a further warning to those interpreting our year-by-year attrition and new hire flows. They are composed of many fractional parts adding up to larger whole numbers plus fractions. Therefore, the annual flows of attrition and new hires in the model will undoubtedly be less volatile than in the real world, i.e., our model might have two-fifths of an FTE dying in each of every five years whereas in the real world two full faculty members will die at some point in every five years.

Perhaps even more fundamental, we have not emphasized enough the possible lack of control a school really has over even apparently controllable policy instruments. To be sure,deaths are acts of God and retirements are nearly automatic except for the small degree of leverage possible through the most generous early retirement programs. No school claims any powers of control in these fields. However, it does assume some influence over quits, still greater influence over tenure policy and wage rates, and virtually complete influence over the amount and age distribution of permanent new hires.

Realistically, however, there are limits on the amount of control that the college has in nearly all of these areas which we have tended to obscure by our very methodology. We vary the value of a parameter like p over what we call a "reasonable" range and then watch a machine react. The probability of tenure, however, is not predetermined by some deus ex machina but rather determined year-by-year by the action of the Departments, the Dean, the President, and the Trustees. Moreover, even if all could act in concert to predetermine such a variable as wage rates or tenure standards or the rank and age of new hires, there are clearly limits. Just where are they and what provides them? The school is very much like a blind and deaf bidder in an auction who could be shouting "8 dollars'" when the bidding was now at $10. Moreover, by the time he was somehow alerted to this the bidding could be long over. It might be politically possible to figuratively "shout out" (or perhaps better, whisper!) a drastic drop in salary to reduce instructional costs. Or, to agree to a tenure quota. Or, to begin hiring only Associate and Full Professors to "fill in" the age distribution. How quickly and how much would the quality and spirit of the faculty suffer? Our own experience with the historical volatility of many staffing variables suggest that it would be at least a while before whatever effects these "shouts" were having would become apparent.

This points to a common oversight in quantitative models. One can optimize a quantifiable objective function with respect to even partially controllable variables only to find that some function not accounted for suffers. All too often, moreover, these functions are of the qualitative variety involving human elements that are almost impossible to grasp, fully understand, or to observe immediately.

D. Results

In the Introduction we outlined two basic dynamic options that remain available to Carleton: retaining traditional tenure policies and allowing new hires to drop and A, W and % T to rise with the passage of the young untenured age bulge or following stricter tenure standards thereby raising new hire rates and avoiding somewhat the aging, more costly and more highly tenured faculty approach to steady-state. Our first task, then should be to examine the likely behavior of our dependent variables over time given current tenure standards (p = .7). We will, then, examine the general nature of the changes in our dependent variables over time with varying tenure standards. We will conclude with a discussion of the general impact of variations in quit rates similar to our discussion of the impact of varying tenure standards. We will not consider the two "subsidiary" dynamic options mentioned in the Introduction, a violation of the steady-state decree and a conscious hiring policy to spread new hires more widely across the age distribution but should remind the reader of their existence. We should, finally, point out as a gross generalization that the observations we made in Chapter III on the basis of our examination of the static model remain no less valid for the dynamic model.

1. The Carleton Faculty Over the Next Fifty Years With No Change in Tenure Policy: Two Views Based On Differing Quit Rates. One's view of the future faculty, of course, depends crucially on one's expectations of the behavior of quit rates, and there are sure to be differing opinions about this behavior. Rather than impose a single judgement of our own we are presenting two simulations, one with an "optimistic" view of quits based on our Chapter II examination of the 1968-73 data with a Non-Tenured Quit Rate of .4, a Tenured Quit Rate of .05, and a mortality rate of .15 and a more "pessimistic" view with no Tenured Quits ($q_t = 0$), a mortality rate of .15, and a Non-Tenured Quit Rate of .2 representing the floor that we characterized as the "early, informal tenure decision." Tables II A and II B below are the results of these similations. They present all the "flow information" on the right: the annual retirements, deaths, tenured and untenured quits, and negative tenure decisions which add up to the FTE replacement spots that permit permanent new hires of an equal amount, plus the number in their sixth year standing for tenure. On the left is the "stock information," the composition of the 128.44 member teaching faculty and the % T, A, and W information which "measure" its health and vitality plus the average age of the permanent teaching-plus-leave faculty which provides some notion of the influence of the replacement of older permanent faculty on leave by younger temporary appointments.

a. The General Form of the Time Paths: The Cycle. The growth produced cycle discussed in the Introduction is still evident although obscured somewhat by other historical episodes whose nature we can only speculate about (see Figure 2). In both simulations permanent new hires drop fairly sharply initially due to the lack of retirements based on the small faculties of the late 40's and early 50's and due to the apparently high rate of quits from those hiring classes. The drop is not immediate, however, because the last of the bulge of probationers produced by recent growth provide a large number of replace-

Table II A

The Behavior of the Carleton Faculty Over the Next Fifty Years Assuming No Change in Tenure Policy (p = .7), and Assuming Low Quit Rates (Non-Tenured Quit Rate = .2, No Tenured Quits, and the Mortality Rate = .15)

Year	Tenured	Untenured	Temporary	Total	% T	Average age of permanent	Average age of teaching faculty	Wage	Standing for tenure	Promotions	Rejections	Retirements	Deaths	Untenured Quits	Tenured Quits	Permanent Hires
1973	68.62	43.06	16.76	128.44	53.43	40.84	39.74	15051								
1974	69.10	42.58	16.76	128.44	53.80	40.34	39.30	14949	7.170	5.019	2.151	4.000	0.339	4.810	0.152	11.45
1975	73.11	38.57	16.76	128.44	56.92	40.72	39.64	15052	8.500	5.950	2.550	0.991	0.336	2.900	0.167	6.944
1976	77.76	33.93	16.76	128.44	60.54	41.44	40.26	15241	8.130	5.691	2.439	0.000	0.370	2.166	0.160	5.136
1977	81.22	30.46	16.76	128.44	63.24	42.13	40.86	15407	6.300	4.410	1.890	0.000	0.389	3.656	0.171	6.107
1978	82.19	29.49	16.76	128.44	63.99	42.88	41.51	15591	2.400	1.680	0.720	0.000	0.430	3.679	0.172	5.001
1979	83.38	28.30	16.76	128.44	64.92	43.34	41.92	15703	4.098	2.869	1.229	0.958	0.422	2.416	0.170	5.195
1980	85.45	26.23	16.76	128.44	66.53	43.52	42.07	15743	6.871	4.810	2.061	1.900	0.434	2.248	0.172	6.815
1981	85.00	26.68	16.76	128.44	66.18	43.47	42.03	15735	4.167	2.917	1.250	2.826	0.414	2.221	0.179	6.890
1982	85.55	26.13	16.76	128.44	65.61	43.99	42.47	15859	3.081	2.156	0.924	0.934	0.427	2.039	0.180	4.506
1983	85.63	26.05	16.76	128.44	65.67	44.22	42.67	15910	3.664	2.565	1.099	1.852	0.451	2.402	0.174	5.978
1984	85.28	26.40	16.76	128.44	66.40	44.44	42.87	15955	3.001	2.100	0.900	1.836	0.477	2.741	0.179	6.134
1985	84.99	26.69	16.76	128.44	66.17	44.68	43.08	16[illegible]09	3.117	2.182	0.935	1.815	0.511	2.279	0.174	5.714
1986	82.93	28.75	16.76	128.44	64.57	44.14	42.61	15881	4.089	2.862	1.227	4.488	0.489	2.096	0.173	8.473
1987	87.73	27.95	16.76	128.44	65.19	44.50	42.92	15960	4.134	2.894	1.240	1.331	0.511	2.422	0.165	5.670
1988	84.03	27.65	16.76	128.44	65.43	45.01	43.37	16072	2.702	1.892	0.811	0.878	0.510	2.370	0.169	4.737
1989	82.57	29.11	16.76	128.44	64.28	44.75	43.14	16002	3.587	2.511	1.076	3.471	0.502	2.837	0.166	8.053
1990	80.61	31.07	16.76	128.44	62.76	44.30	42.75	15892	3.580	2.576	1.104	4.076	0.507	2.829	0.169	8.684
1991	80.62	31.06	16.76	128.44	62.77	44.57	42.98	15951	3.428	2.400	1.029	1.697	0.527	2.081	0.167	5.501
1992	81.02	30.66	16.76	128.44	63.08	44.60	43.00	15948	5.084	3.559	1.525	2.426	0.528	2.558	0.161	7.199
1993	78.21	33.47	16.76	128.44	60.89	43.93	42.42	15786	3.402	2.382	1.021	4.837	0.510	3.347	0.153	9.868
1994	79.40	32.28	16.76	128.44	61.82	44.67	43.07	15956	2.842	1.990	0.853	0.000	0.524	2.837	0.143	4.358
1995	78.62	33.06	16.76	128.44	61.21	44.37	42.81	15877	4.832	3.382	1.450	3.592	0.508	2.540	0.144	8.234
1996	79.33	32.35	16.76	128.44	61.76	44.43	42.86	15881	5.211	3.647	1.563	2.222	0.505	3.413	0.141	7.844
1997	76.87	34.81	16.76	128.44	59.85	43.90	42.40	15755	3.300	2.310	0.990	4.407	0.483	2.845	0.144	8.869
1998	78.63	33.05	16.76	128.44	61.22	44.52	42.94	15895	4.319	3.023	1.296	0.432	0.495	2.518	0.143	4.884
1999	78.97	32.71	16.76	128.44	61.49	44.31	42.75	15835	5.921	4.144	1.776	3.142	0.484	3.216	0.139	8.757
2000	79.32	32.36	16.76	128.44	61.76	44.82	43.20	15947	2.615	1.830	0.784	0.814	0.493	3.343	0.134	5.568
2001	79.69	32.00	16.76	128.44	62.04	44.83	43.21	15940	4.941	3.453	1.482	2.436	0.489	2.751	0.133	7.291
2002	78.19	33.49	16.76	128.44	60.88	44.31	42.76	15812	4.707	3.295	1.412	4.350	0.470	2.728	0.133	9.093
2003	76.99	34.69	16.76	128.44	59.94	43.74	42.26	15674	5.321	3.725	1.596	4.481	0.449	2.865	0.135	9.526
2004	73.59	38.09	16.76	128.44	57.29	42.99	41.61	15507	2.930	2.051	0.879	5.268	0.422	2.572	0.137	9.277
2005	74.51	37.17	16.76	128.44	58.01	43.10	41.71	15537	5.254	3.678	1.576	2.093	0.425	3.277	0.139	7.510
2006	72.82	38.86	16.76	128.44	56.69	42.78	41.43	15467	3.341	2.338	1.002	3.665	0.412	3.724	0.140	8.944
2007	74.04	37.64	16.76	128.44	57.64	43.17	41.77	15560	4.375	3.062	1.312	1.143	0.422	3.761	0.141	6.779
2008	74.59	37.09	16.76	128.44	58.07	43.12	41.73	15549	5.456	3.819	1.637	2.643	0.423	3.357	0.143	8.203
2009	73.82	37.86	16.76	128.44	57.47	42.60	41.27	15430	5.716	4.001	1.715	4.300	0.407	3.291	0.145	9.858
2010	73.36	38.32	16.76	128.44	57.12	42.21	40.93	15347	5.566	3.897	1.670	3.859	0.395	3.145	0.148	9.217
2011	73.29	38.39	16.76	128.44	57.06	42.18	40.90	15352	4.506	3.156	1.352	2.690	0.394	2.996	0.151	7.583
2012	73.76	37.92	16.76	128.44	57.43	42.12	40.85	15347	5.366	3.756	1.610	2.690	0.395	3.612	0.154	8.460
2013	74.09	37.59	16.76	128.44	57.68	42.30	41.00	15396	4.067	2.847	1.220	1.926	0.398	3.815	0.155	7.515
2014	74.96	36.72	16.76	128.44	58.36	42.47	41.16	15443	4.922	3.445	1.477	1.918	0.405	3.360	0.156	7.315
2015	76.34	35.34	16.76	128.44	59.44	42.60	41.27	15479	5.915	4.141	1.775	2.037	0.408	3.209	0.158	7.587
2016	77.58	34.10	16.76	128.44	60.40	42.77	41.41	15521	5.530	3.871	1.659	1.928	0.412	3.195	0.160	7.354
2017	78.13	33.55	16.76	128.44	60.83	42.93	41.56	15566	4.550	3.185	1.365	1.994	0.416	2.966	0.161	6.902
2018	78.95	32.73	16.76	128.44	61.47	43.07	41.68	15601	5.076	3.553	1.523	2.058	0.423	2.980	0.163	7.166
2019	79.47	32.21	16.76	128.44	61.87	43.24	41.82	15643	4.509	3.156	1.353	1.983	0.430	2.988	0.164	6.918
2020	79.81	31.87	16.76	128.44	62.14	43.38	41.94	15677	4.389	3.072	1.317	2.091	0.438	2.851	0.164	6.861
2021	80.18	31.50	16.76	128.44	62.42	43.49	42.04	15705	4.552	3.186	1.366	2.170	0.446	2.810	0.164	6.954
	80.52	31.16	16.76	128.44	62.69	43.63	42.16	15737	4.413	3.089	1.324	2.085	0.453	2.813	0.164	6.839
	80.58	31.10	16.76	128.44	62.74	43.73	42.25	15761	4.141	2.899	1.242	2.216	0.458	2.756	0.164	6.835

Table II — The Behavior of the Carleton Faculty Over the Next Fifty Years Assuming No Change in Tenure Policy (p = .7) and Assuming Higher Quit Rates (Non-Tenured Quit Rate = .4; Tenured Quit Rate = .05, and Mortality Rate = .15)

Year	Tenured	Untenured	Temporary	Total	% T	Average age of permanent	Average age of teaching faculty	Wage	Standing for tenure	Promotions	Rejection	Retirements	Deaths	Untenured Quits	Tenured Quits	Permanent Hires
1973	68.62	43.06	16.76	128.44	53.43	40.83	39.74	15051								
1974	69.24	42.44	16.76	128.44	53.91	40.42	39.38	14979	7.170	5.019	2.151	4.000	0.340	2.254	0.000	8.745
1975	73.39	38.29	16.76	128.44	57.14	40.87	39.77	15106	8.500	5.950	2.550	0.991	0.338	1.450	0.000	5.329
1976	79.13	32.55	16.76	128.44	61.61	41.63	40.42	15301	9.635	6.746	2.891	0.000	0.372	1.083	0.000	4.346
1977	84.07	27.61	16.76	128.44	65.45	42.37	41.07	15487	8.400	5.880	2.520	0.000	0.392	1.558	0.000	4.470
1978	85.69	25.99	16.76	128.44	66.72	43.21	41.30	15696	3.200	2.240	0.960	0.000	0.435	1.407	0.000	2.832
1979	87.89	23.79	16.76	128.44	68.43	43.70	42.23	15817	5.465	3.825	1.639	0.958	0.428	0.957	0.000	3.933
1980	90.19	21.49	16.76	128.44	70.22	43.96	42.43	15873	5.995	4.197	2.099	1.900	0.443	0.882	0.000	5.324
1981	89.95	21.73	16.76	128.44	70.03	43.95	42.44	15882	4.263	2.984	1.279	2.826	0.425	0.727	0.000	5.256
1982	90.91	20.78	16.76	128.44	70.78	44.52	42.73	16020	3.477	2.434	1.043	0.934	0.438	0.679	0.000	3.094
1983	91.07	20.61	16.76	128.44	70.91	44.81	43.19	16089	3.576	2.503	1.073	1.852	0.464	0.932	0.000	4.320
1984	90.39	21.29	16.76	128.44	70.37	45.11	43.45	16160	2.242	1.569	0.672	1.836	0.494	1.058	0.000	4.050
1985	90.28	21.40	16.76	128.44	70.29	45.41	43.71	15225	3.195	2.236	0.958	1.820	0.530	0.835	0.000	4.145
1986	88.45	23.24	16.76	128.44	68.86	44.91	43.28	15107	4.259	2.981	1.273	4.512	0.510	0.741	0.000	7.044
1987	89.40	22.28	16.76	128.44	69.61	45.33	43.64	16199	4.205	2.943	1.261	1.342	0.537	0.638	0.000	3.979
1988	89.68	22.00	16.76	128.44	69.82	45.90	44.14	16327	2.475	1.733	0.743	0.887	0.539	0.821	0.000	2.939
1989	88.21	23.47	16.76	128.44	68.68	45.69	43.76	16269	3.455	2.419	1.037	3.518	0.536	1.119	0.000	6.210
1990	86.03	25.65	16.76	128.44	66.98	45.30	43.62	15172	3.243	2.274	0.975	4.142	0.549	1.102	0.000	6.768
1991	86.04	25.64	16.76	128.44	66.99	45.62	43.39	16240	3.316	2.321	0.995	1.729	0.578	0.697	0.000	3.929
1992	86.84	24.84	16.76	128.44	67.61	45.67	43.94	16242	5.635	3.945	1.691	2.477	0.583	0.920	0.000	5.670
1993	83.88	27.80	16.76	128.44	65.30	45.04	43.39	16089	3.183	2.228	0.955	4.955	0.566	1.298	0.000	7.773
1994	84.86	26.82	16.76	128.44	66.07	45.85	44.10	16273	2.392	1.674	0.718	0.000	0.580	1.077	0.000	2.374
1995	84.11	27.58	16.76	128.44	65.48	45.55	43.83	16191	4.963	3.474	1.490	3.754	0.563	0.957	0.000	6.775
1996	84.95	26.73	16.76	128.44	66.14	45.65	43.92	16203	5.415	3.790	1.624	2.295	0.560	1.344	0.000	5.824
1997	82.37	29.31	16.76	128.44	64.13	45.14	43.48	16079	3.199	2.239	0.960	4.564	0.536	1.015	0.000	7.075
1998	84.26	27.42	16.76	128.44	65.60	45.73	44.03	16220	4.536	3.175	1.361	0.529	0.548	0.915	0.000	3.352
1999	84.55	27.13	16.76	128.44	65.83	45.52	43.31	16147	5.219	3.653	1.566	3.502	0.536	1.260	0.000	7.152
2000	84.49	27.19	16.76	128.44	65.78	46.09	44.31	16272	1.900	1.330	0.570	0.850	0.542	1.290	0.000	3.252
2001	85.13	26.56	16.76	128.44	65.28	46.13	43.33	16265	5.429	3.794	1.625	2.550	0.538	1.043	0.000	5.756
2002	83.49	28.19	16.76	128.44	65.00	45.59	43.37	16131	4.659	3.261	1.398	4.564	0.510	1.051	0.000	7.530
2003	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.693	4.947	0.491	1.041	0.000	8.178
2004	78.34	33.34	16.76	128.44	60.99	44.13	42.50	15790	2.682	1.877	0.805	5.661	0.462	0.901	0.000	7.828
2005	79.33	32.35	16.76	128.44	61.77	44.20	42.56	15807	5.720	4.011	1.719	2.439	0.469	1.329	0.000	5.950
2006	76.94	34.74	16.76	128.44	59.90	43.85	42.36	15733	2.602	1.821	0.780	4.038	0.448	1.571	0.000	6.837
2007	78.15	33.52	16.76	128.44	60.86	44.24	42.59	15824	4.605	3.224	1.382	1.404	0.456	1.601	0.000	4.842
2008	78.74	32.94	16.76	128.44	61.31	44.11	42.58	15796	6.024	4.217	1.807	3.118	0.455	1.378	0.000	6.758
2009	77.71	33.97	16.76	128.44	60.51	43.35	41.92	15622	6.542	4.579	1.963	5.292	0.431	1.279	0.000	8.954
2010	76.97	34.71	16.76	128.44	59.93	42.75	41.40	15492	5.263	3.684	1.579	4.796	0.412	1.168	0.000	8.255
2011	76.78	34.90	16.76	128.44	59.78	42.65	41.32	15486	4.760	3.332	1.428	3.131	0.409	1.160	0.000	6.128
2012	77.23	34.45	16.76	128.44	60.13	42.60	41.27	15487	5.469	3.828	1.641	2.922	0.409	1.572	0.000	6.544
2013	77.51	34.17	16.76	128.44	60.34	42.84	41.47	15555	3.874	2.712	1.162	1.993	0.419	1.722	0.000	5.290
2014	78.74	32.94	16.76	128.44	61.31	43.05	41.56	15616	5.407	3.785	1.622	1.993	0.429	1.438	0.000	5.474
2015	81.00	30.68	16.76	128.44	63.07	43.22	41.31	15662	7.171	5.020	2.151	2.079	0.425	1.267	0.000	5.924
2016	83.02	28.66	16.76	128.44	64.64	43.44	42.00	15718	6.504	4.523	1.981	1.949	0.431	1.183	0.000	5.544
2017	83.84	27.84	16.76	128.44	65.27	43.64	42.18	15773	4.903	3.432	1.471	2.093	0.435	1.076	0.000	5.075
2018	84.85	26.83	16.76	128.44	66.06	43.84	42.34	15823	5.235	3.665	1.571	2.100	0.445	1.140	0.000	5.264
2019	85.32	26.36	16.76	128.44	66.42	44.07	42.55	15883	4.232	2.963	1.270	1.987	0.454	1.147	0.000	4.858
2020	85.71	25.97	16.76	128.44	66.73	44.25	42.71	15929	4.380	3.066	1.314	2.158	0.465	1.062	0.000	4.939
2021	86.25	25.43	16.76	128.44	67.15	44.41	42.35	15966	4.738	3.317	1.422	2.242	0.479	1.033	0.000	5.173
2022	86.70	24.98	16.76	128.44	67.51	44.61	43.02	16012	4.435	3.105	1.331	2.115	0.487	1.011	0.000	4.944
2023	86.73	24.95	16.76	128.44	67.53	44.75	43.14	16044	4.060	2.842	1.218	2.320	0.494	0.986	0.000	5.017

ment spots from negative tenure decisions and non-tenured quitting for two years. As anticipated, the declining hiring cycle is sharply reversed roughly 30 years later in 2002 as the large number of new hires (7 - 18 per year) beginning after 1963-64 begin retiring. The hiring cycle is, as expected, roughly the full length of tenured service plus the probationary period or 35 years.

The hiring cycle, however, is obscured somewhat by an increase in new hires associated with the retirement of larger groups of faculty who are now 49 years old beginning after 1988-89. These groups were not apparent in our discussion of Carleton's age distribution in Chapters II or III and the reason for their existence is a matter of historical speculation. If these groups were 30 years old on the average at the date of hire, the "episode" which placed them in the current age distribution began in 1952 or 1953 just after the Korean War. Therefore, the faculty may have expanded somewhat in the early and mid fifties, and the "growth" which we characterized in our Chapter I hypothetical school as occuring over a short six-year period may be less well defined, more gradual, and/or have occured in two "spurts," one in the early and mid-1950's and one in the mid- and late-1960's. Other speculation is possible as well. These groups may not be associated with growth at all and may instead be the replacement of an unusually large number of quits from the immediate post-war hiring classes. Or, they may be the consequences of hiring policies in the mid- and late-1950's or even early 1960's which were designed to draw older more, experienced faculty into a faculty which was both excessively young and excessively old at the time --- a policy of hiring at ages of least concentration. At any rate, their existence provides significant relief beginning with 1989-90. The new hire cycle rather than being characterized by a gradual decline after the initial growth spurt to another replacement spurt 35 years later, is instead characterized by an almost immediate drop to low levels for the next 15 years, a rise in 1989-90 to a higher plateau and a later spurt in 2002.

The A, W, and % T cycles are also evident. All drop quite sharply after the year 2002 to minimum values in 2010 - 12 --- roughly 40 years from today and 45 years or so from their probable minimum values in the growth period of the mid-1960's. However, unlike our Chapter I hypothetical school, they do not rise gradually until 2002 when they drop sharply. Rather, the unexplained episode which produces a rise in retirements, and, therefore, in new hires in 1989-90 brings A and W to their maximum values much earlier in 1988-89 from which they gradually decline or remain at a plateau until 2002 when they begin to drop more sharply. The % T reaches a maximum even earlier, 1983-84, and also declines very slowly thereafter until 2002 when it drops more rapidly. As expected, it is a leading indicator of A and W.

b. The Maxima and Minima. As anticipated in our discussion of the static model, neither A nor W are very sensitive to the passage of Carleton's growth-produced age bulge of untenured faculty. The % T is substantially more sensitive and tends to overstate the changes in A and W. Permanent new hires are also quite sensitive and in the low quit rate simulation fall to levels which are possibly below minimum acceptable levels.

TABLE III

Maxima and Minima From the Two Simulations in Table I (Years they occur in parentheses)

	A Average Age	A^P Average Age of Permanent Faculty	W Average Wage	% T The % T	H^P Permanent New Hires per Year
A. Maxima of A, A^P, W, and % T and Minima of H^P					
Current	39.74(1973)	40.84(1973)	$15,051(1973	53.4(1973)	
Low Quit Simulation	44.14(1988)	45.90(1988)	$16,327(1988)	70.9(1983)	2.80(1978) 2.87(1994)
High Quit Simulation	43.37(1988)	45.01(1988)	$16,072(1988)	66.7(1983)	4.50(1981) 4.36(1994)
B. Minima of A, A^P, W, and % T and Maxima of H^P					
Current	39.74(1973)	40.84(1973)	$15,051(1973)	53.4(1973)	
Low Quit Simulation	41.27(2012)	42.60(2012)	$15,486(2011)	59.8(2011)	8.18(2003) 8.96(2009) 8.26(2010)
High Quit Simulation	40.85(2012)	42.12(2012)	$15,347(2010) (2012)	57.1(2011)	9.53(2003) 9.86(2009) 9.22(2010)

Abstracting from economy-wide or market-wide influences, the rise in average wage due to the changing composition of the faculty alone is small enough to be virtually ignored, $1,276 in the low quit simulation and $1,021 in the high quit simulation. (see Table III). The maxima occurs in 1988, fifteen years from today. In terms of the total wage bill, these represent absolute increases of $179,900 (141 X $1,276) or $144,000 (141 X $1,021) spread over fifteen years. Even these may be slight overstatements because not all of those on leave are paid full salaries; on the other hand, this tendancy to overstatement is offset by the fact that the average wage of the teaching faculty (that number derived in our simulation) will be slightly lower than the average of the teaching-plus-leave faculty. The two effects presumably cancel out. These increases, in turn, represent average annual rates of growth in the average and total wage 3.6 tenths of one per cent for the low quit simulation and 4.2 tenths of one per cent for the higher quit simulations. It seems unnecessary to complicate our simulation with "experimental" shifts downward in the age-income profile to simulate depressed faculty labor market conditions. Suffice it to say, minimal drops in the faculty real wage (again, abstracting from economy-wide influences such as inflation) would easily offset any tendancy to an increasing financial burden due to an aging faculty. We should also remind the reader that such drops did occur in 1970-71 and undoubtedly will be registered soon for the most recent academic year, 1972-73.

Average age of the teaching faculty also rises relatively little to their maxima in 1988 in both simulations; the low-quit simulation yields an increase of 4.4 years and the high-quit simulation, an increase of 3.63 years (see Table III). While these increases seem relatively unimportant in both absolute and percentage terms (11 and 9 per cent respectively), such changes in the mean of a distribution may have little intuitive meaning in and of themselves; the mean is often a poor descriptive statistic particularly for distributions that are spread over such a wide range of points --- in this case 35 different years. A 4.4 year rise in the mean age of a 128 member faculty means simply that 563 "additional" years (128 X 4.4) have been added to the total years of age of that faculty. This might be accomplished in a number of ways. As a limiting case, one might consider the following: if one took a group of 21 thirty-year-olds (16.4 per cent of the 128 member teaching faculty) and aged them overnight by 27 years, i.e., turned them into

57-year-olds, the average age of the total would rise by roughly 4.4 years, the increase in the low-quit simulation. Or, if one took a group of 16 thirty-year-olds (13 per cent of the teaching faculty) and did the same, the average ages of the total would rise by roughly 3.6 years, the increase for the high-quit simulation. In neither case does the change seem a reason for great alarm; 57-year-olds can be still excellent teachers and the changes involve no more than 13 to 16.4 per cent of the faculty. Moreover, the 3.63 and 4.4 year rises are in fact, produced by much smaller changes in age for a much larger group of the faculty and give yet less reason for alarm.

The % T figures rise to their maximum ten years from today (in 1983) of 70.9 for the low-quit simulation and 66.7 for the high-quit simulation. The changes are, of course, substantial --- 17.5 percentage points and 13.7 percentage points respectively--- but they clearly overstate the impact of the passage of the bulge of young untenured faculty to tenured status on A and W. Moreover, even where discussion remains obsessed with % T alone rather than with other more direct measures of faculty health, the typical "ceilings" for % T that are discussed are rarely less than 75, and Carleton's faculty should miss this by at least 4 percentage points.

We have already explained the reason for the sluggishness of A and W: the tenured and untenured faculty are not drastically different in either age or wage and they could not change substantially as a proportion of the total unless the untenured bulge were truly exceptional. We should note in passing that the school with an age and rank distribution that poses fundamental difficulties is the stereotypic,"new school" in a state university system which grew from nothing to a 150-200 member faculty in four years and did not succeed in hiring across the full range of age classes either because of market difficulties or financial short-sightedness. Carleton is decidedly <u>not</u> such a school and <u>has</u> a history and therefore a "reasonably" distributed faculty. We should, finally, underline again the influence of the temporary pool of 17 faculty members. It not only places a ceiling on % T and reduces the A and W of the teaching faculty below that of the permanent faculty but it <u>isolates the teaching faculty somewhat from the effect of aging in the permanent faculty</u>. Note that the age of the <u>permanent</u> teaching-plus-leave faculty rises by more than the age of the teaching faculty, 5.06 years in the low-quit simulation and 4.17 years in the high-quit simulation; these increases are roughly one-half a year greater than the rises for the teaching faculty only. This is because, while the permanent (teaching-plus-leave) faculty is always aging until 1989, ten per cent of them are also always on leave and are replaced (in the simulation) by constant aged 32.4-year-olds. This tends to produce an ever-widening (but small) divergence between the age of the permanent faculty and the teaching faculty until 1989.

The one direct indicator of faculty health and vitality which seems substantially affected by the passage to tenure of the existing age bulge (or its converse, the lack of retirements and drop in untenured quitting and negative tenure decisions) is the permanent new hire rate. It is very volatile, of course, because of the historical accidents which yield Carleton currently no 62-year-olds, for example. However, permanent new hires between 1975 and 1989 clearly, will be substantially below the 10-17 per year levels of the mid-1960's growth period and somewhat below the 8 per year average levels of the early 1970's. The 1975-88 minima are 2.80 in the low-quit simulation in 1978 and 4.50 in 1981 in the high-quit simulation. Another minimum is reached in 1994 (2.37 in the low-quit simulation and 4.36 in the high-quit simulation), but this is aberrant and is surrounded by considerably higher permanent new hire levels in both simulations. As we discussed, substantial "relief" occurs after 1988-89 because of the retirement of the somewhat larger size age groups which are now 49 years or under.

These minima are not wholly descriptive of the new hire situation in the depressed period of 1975-88. The range of new hire levels and the mean new hire levels over the thirteen-year period may tell more. In the low-quit simulation, permanent new hires range from 2.8 to 7.0 and have a mean annual value of 3.77 new hires per year over the period 1975-88. In the high-quit simulation, permanent new hires range from 4.5 to 8.47 and have a mean annual value of 5.8 per year.

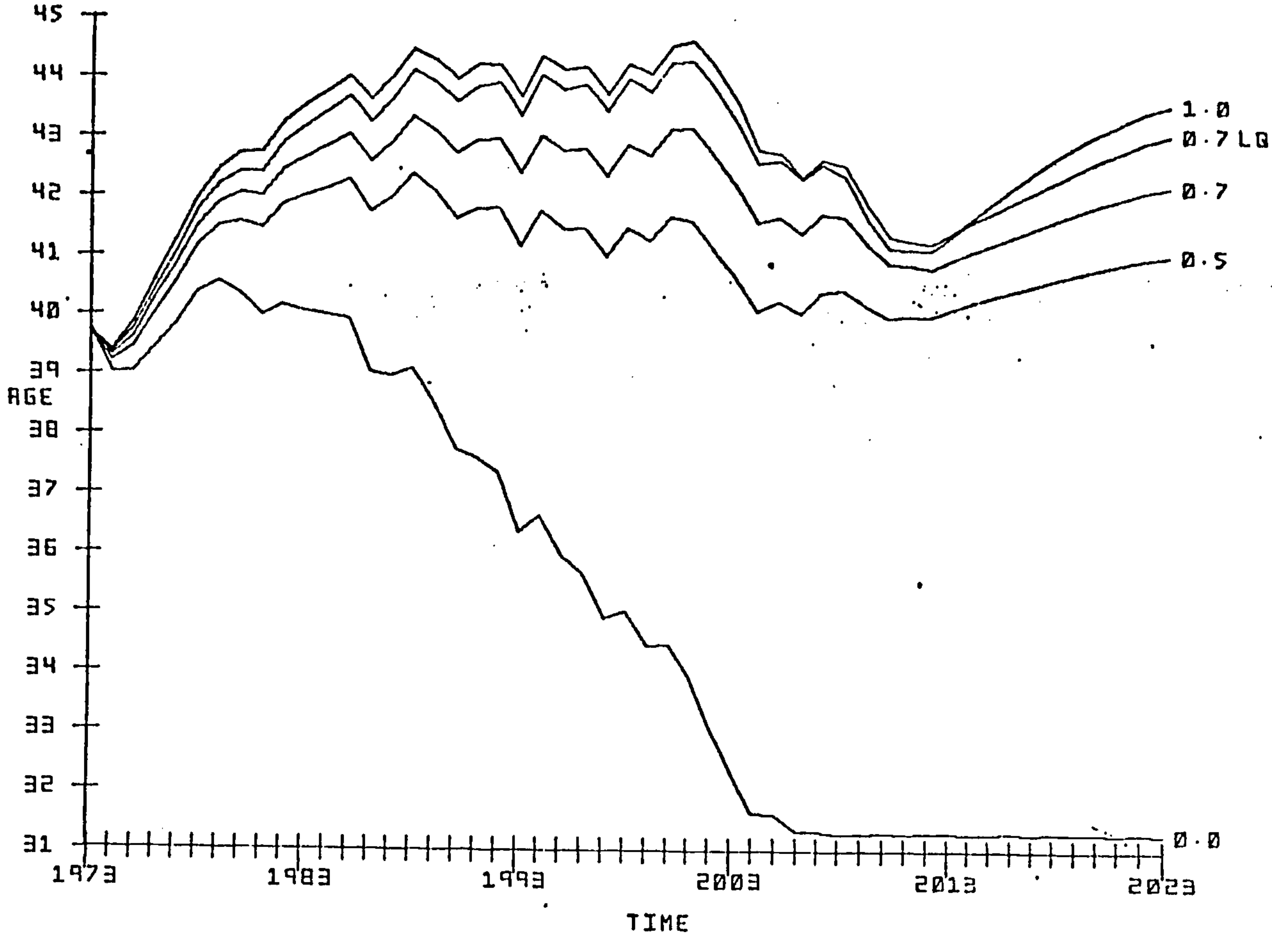
To conclude we should point out that the 50 per cent drop in Untenured Quit Rates between the two simulations (from .4 to .2) has a significantly smaller impact on new hires than 50 per cent (contrast the two average new hire rates for 1975-88). This is because if fewer quit, more stand for tenure, and there is a compensating rise in replacement spots from negative tenure decisions. There is, of course, a further compensating rise in retirements, but this occurs 30 years later. This is an important generalization to be remembered: any drop in attrition at any point will bring a partially compensating rise in the other sources of attrition that occur at later dates. Moreover, the more quickly the later compensating attrition normally occurs (in this case only 3 years after) and the more important it is, the less the impact of the drop in attrition on the measures of faculty health and the more immediate it is.

2. Variations in Tenure Standards. We should emphasize that the following experiments in no way imply a need for stricter or easier tenure standards based on some implicit judgement derived from the data in the previous section. We have experimented with p values ranging from 0 (no tenure) and from .4 to 1.0 in steps of 10 percentage points. For each of these simulations we used the "high quit" values of .4 for Untenured Quits, .05 for Tenured Quits, and a mortality rate of .15. All of our generalizations remain valid, however, for the lower quit values (.2, 0 and .15 respectively). As we discussed in Chapter III, varying tenure standards has a slightly greater impact if more are standing for tenure, i.e., if untenured quits are lower. However, the orders of magnitude are minimal.

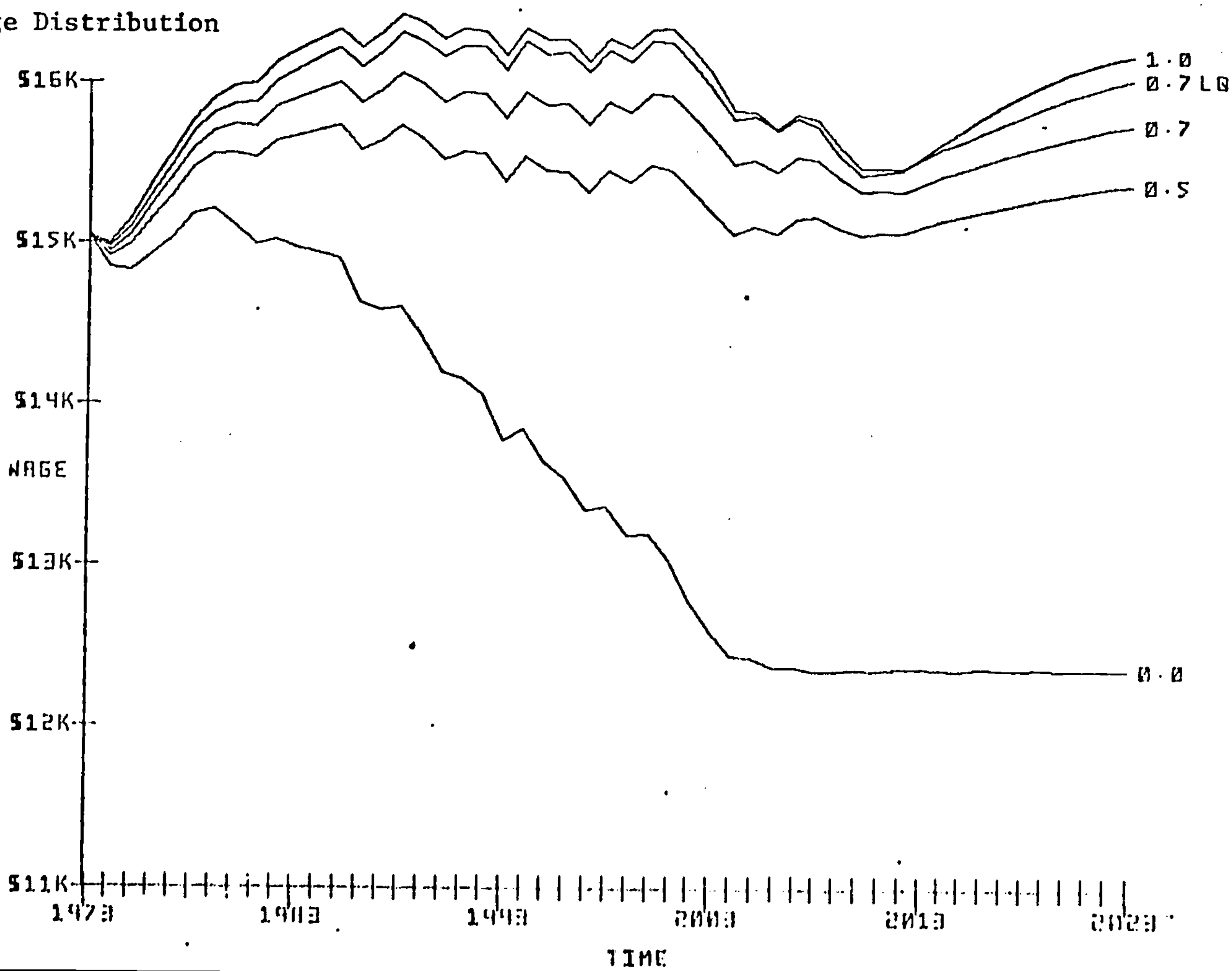
a. The Tenure - A, W, and % T Relationship. Obviously, tightening tenure standards below p = .7 shifts down the time paths of A, W, and % T and, liberalizing tenure standards above p = .7 shifts up those time paths (see Figure 2). After all our earlier observations, it should come as no surprise that tenure policy over "reasonable" values, p = .4 to 1.0, has only a slight impact on the behavior of A and W over time and only a moderate impact on % T. If, as we observed in the previous section, A and W are fairly insensitive to the passage of a medium-sized untenured age bulge which changes % T moderately given a particular tenure policy, they should be no less insensitive to variations in p and their only moderate changes in % T. Only in the limiting case of no tenure (p = 0) did tenure policy have a striking impact. Under this policy the school effectively eliminates its tenured sub-class --- the last currently tenured faculty member retiring in 2005-6 --- and A and W fall to the levels for a rapidly turning over pool of temporaries and probationers only, by about the turn of the century.

Figure 2
Time Paths for A, W, % T, and H^P
Under Various Tenure Regimes

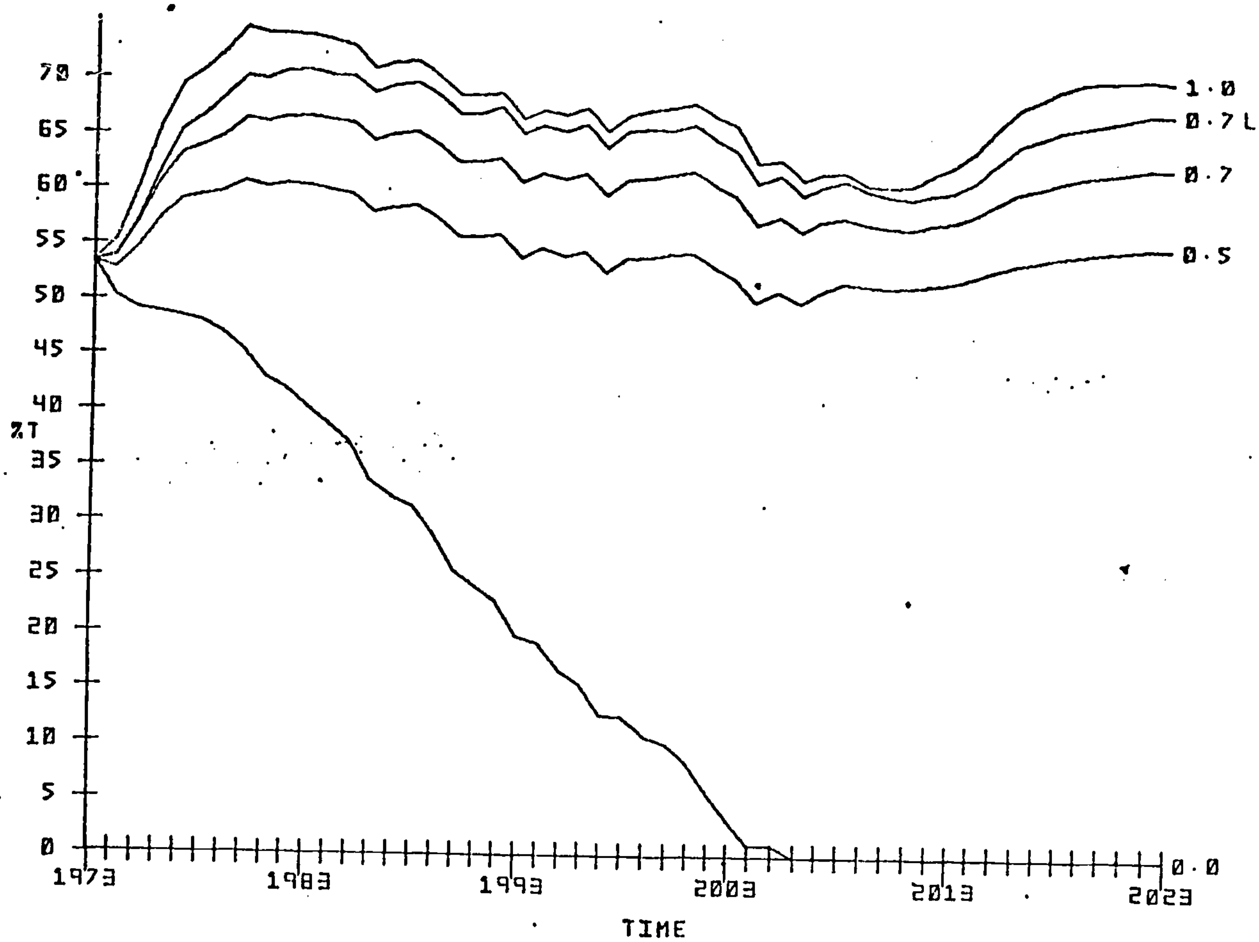
A. Age Distribution



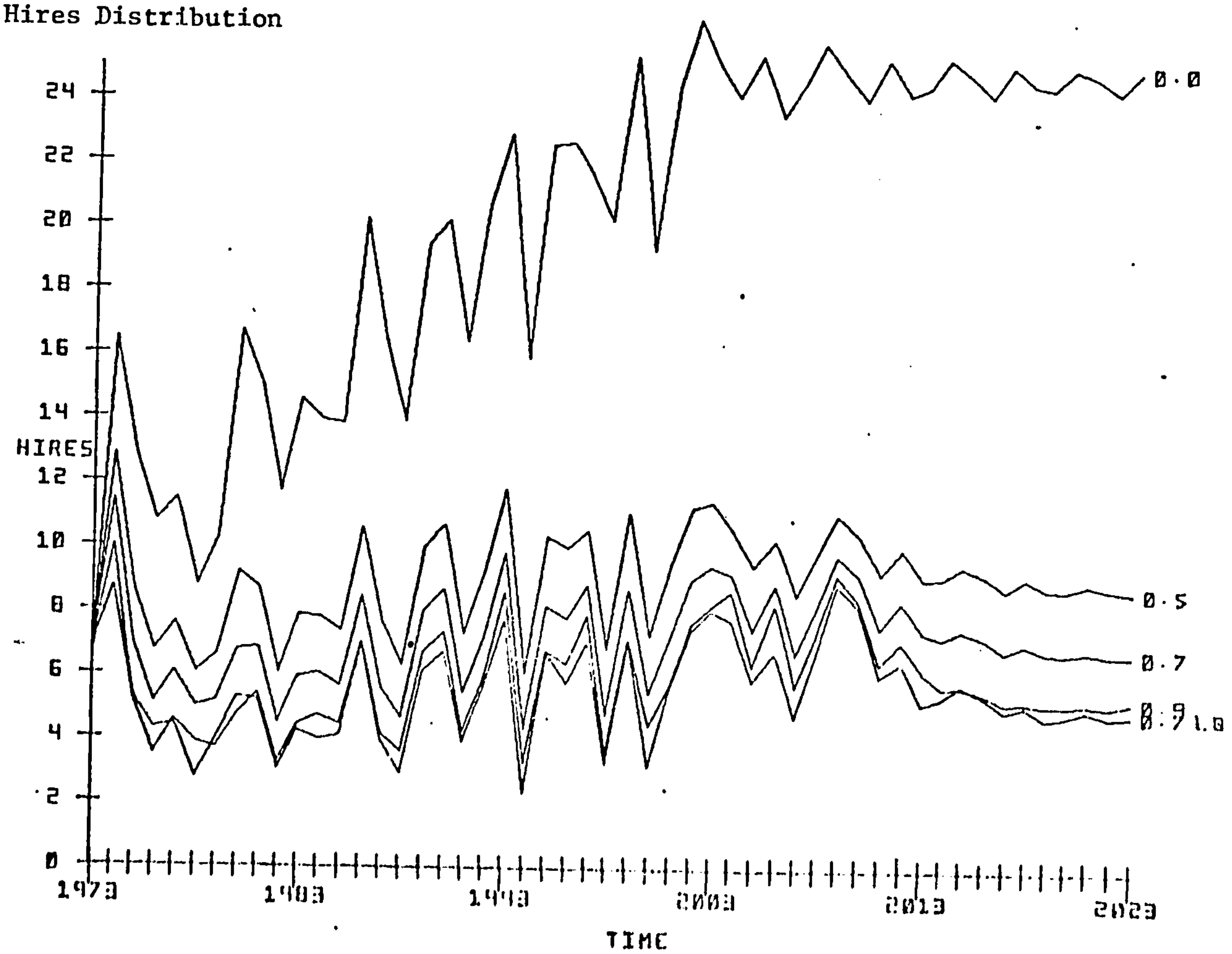
B. Wage Distribution



C. Per Cent Tenured Distribution



D. New Hires Distribution



The insensitivity of A and W to variations in p over a more reasonable range is evident in Table IV which presents the maximum and minimum values that % T, A, and W attain given that a particular p policy is chosen "today" and followed consistantly over the next 50 years. The maximum in A can be altered by no more than 2.78 years between following a

TABLE IV

Maxima and Minima of A, W, and % T
Over Time Given Differing Tenure Standards

p	% T	Year	A	Year	W	Year
			Maxima			
0	53.43	1973	39.74	1973	$15,051	1973
.4	57.86	1980	41.89	1985	$15,596	1985
.5	60.61	1982	42.40	1988	$15,749	1988
.6	63.72	1983	42.91	1988	$15,919	1988
.7	66.67	1983	43.37	1988	$16,072	1988
.8	69.36	1983	43.78	1988	$16,210	1988
			43.79	2001		
.9	72.01	1980	44.16	1988	$16,333	1988
			44.27	2001		
1.0	74.66	1980	44.50	1988	$16,352	1988
			44.67	2001		
			Minima			
0	0.00	2006	31.30	2009	$12,354	2009
.4	45.06	2004	39.07	2004	$14,763	2004
.5	50.32	2004	40.04	2010-12	$15,074	2010
.6	54.00	2006	40.54	2012	$15,245	2012
.7	56.69	2006	40.85	2012	$15,354	2012
.8	58.67	2011	41.03	2012	$15,412	2012
.9	60.17	2006	41.13	2012	$15,440	2010
1.0	60.82	2010	41.16	2011	$15,463	2011

very strict p = .4 and very liberal p = 1.0 (all tenure) policy. Similarly, W's maximum can be altered no more than $756 by following a very liberal or very strict policy. Again, the fundamental reason is that the tenured and nontenured classes do not differ in age and wage enough for the only moderate changes in their proportions, from 57.9 per cent tenured to 75.7 per cent tenured, to have a significant impact on the average of the two groups combined. This is no less true for the later minima; varying tenure policy today will have relatively little impact on the minimum values of A and W achieved after the last of the current age bulge retires and are fully replaced by younger less costly faculty in 2010-12. Again, this generalization is as valid in the low-quit case as in this, the higher quit case. In the low-quit case the maxima and minima reached by A, W, and % T are higher for every p policy but the difference between them produced by changing tenure standards substantially is almost exactly the same as in the higher quit case.

It is also interesting that the form of the time paths is not altered substantially by varying tenure policy; they merely shift up (with easier policies) or down (with stricter policies) in an almost parallel fashion except for the limiting p = 0 case. They all rise above current levels to a maximum or near-maximum in the late 1980's, remain at high levels until a little after the turn of the century, and fall rapidly to minimum values in 2004 or 2010-12. The plateau of high values is "tipped" slightly upward for the higher p values so that the maxima occur at the turn of the century and is tipped slightly downward for the lower p values so that the maxima occur in 1988 instead.

In any event, there is no noticeable "smoothing" of the cycle from the application of stricter tenure policies as we would have anticipated. Tightening tenure policy, for example, permanently enlarges the size of the fairly rapidly turning over pool of probationers and thereby lowers the eventual maxima of A and W. One would have expected, however, that with fewer going on to tenure there would be fewer retirements after 2006-12 and, therefore, a tendancy for the later minima of A and W to rise or at the least not to drop i.e., a smoothing of the cycle. Instead, the minima do drop by nearly as much as the maxima drop (to values in this high quit case which are still above the current values). We cannot fully explain this. One hypotheses is that many in the growth bulge have already passed the point of standing for tenure so that the stricter tenure standards are being applied only to the few remaining, and there will be a large bulge of retirements starting after 2002 regardless of the policy now followed. In addition, while retirements do drop after 2006-12 in the stricter tenure policy simulations, they apparently do not drop enough to affect the very sluggish A and W values. As we observed above, a drop in attrition at an early point in the full term of employment (here, at the point of the tenure decision) necessarily produces greater attrition flows later (at the retirement point and at the point of tenured quits and deaths). However, these later sources of attrition normally permit such a long further term of employment that A and W are little affected.

We should warn, too, that the apparent smoothing after 2010 in the behavior of all variables for all tenure policies (see the discussion below on New Hires) is largely "machine-made." By that time all of the retirees are earlier hypothetical new hires "created" by our model and not real world people currently employed at Carleton. The machine apparently inserts these people in a more uniform fashion than they come in a real world of random bunching of new hires at widely varying ages and at different times, or random bunching in quitting, and even of small, random growth spurts.

There is some evidence in these time paths of the non-linearity in the effectiveness of tenure policy that we discussed in Chapter III, i.e., the diminishing effectiveness of varying tenure standards the more liberal the tenure policy already is. Given the sluggishness of A and W to changes in tenure policy, this non-linearity can be obscured somewhat by random factors but it is still there. For example, tightening tenure policy by 10 percentage points where the current policy is p = .5 reduces the maximum W (reached in 1988) by $153. Tightening tenure policy by the same 10 percentage points when the current policy is all-tenure (p = 1) reduces the maximum W (reached, again in 1988) by $19. (see Table V) The same is true for A and % T and for the changes in the minimum values or end values for the time paths.

Table V

Changes in Maxima, Minima, and End Values
for the Time Paths of A, W, and % T
Produced by Variations in Tenure Policy

Changes in p from:

Change in Maximum of % T	2.75	3.11	3.95	2.69	2.65	2.65
Change in Maximum of A	.51 yrs.	.51	.46	.41	.38	.31
Change in Maximum of W	$153	$170	$152	$138	$123	$19
Change in Minimum of % T	5.26	3.68	2.69	1.98	1.50	.65
Changes in Minimum of A	.97 yrs.	.50	.31	.18	.10	.03
Change in Minimum of W	$311	$171	$109	$58	$28	$23
Change in End Value of % T	4.75	3.84	3.31	2.93	2.61	2.25
Change in End Value of A	.81 yrs.	.63	.53	.49	.46	.24
Change in End Value of W	$253	$200	$170	$155	$146	$138

To conclude, we should indicate that experimenting with the impact of changes in tenure standards given an only "medium-sized" untenured age bulge is not as revealing of the nature of this impact, particularly on % T, A, and W, as experiments on an existing age distribution with an extremely large age bulge e.g., the new school. Where the expected changes in A and W are extremely small given current tenure policy, one can expect no more than small changes from variations in tenure policy. We can only speculate on the nature of the changes and not model them; after all, the basis for the dynamic model is the school's existing distribution of faculty. However, we would suspect that A and W would still not be strikingly sensitive to tenure policy, and changes in that policy would still be less effective the more liberal it already was.

b. The Tenure - New Hires Relationship: Variations in Our Flow Variables From Changes in Tenure Policy. Permanent new hire rates, as expected, are much more sensitive to tenure policy than A and W. While it is difficult to characterize the new hires time paths for any given tenure policy by a single number because of the year-to-year volatility of new hires, it is clear that applying stricter tenure standards shifts up the new hire time paths substantially (see Figure 2). This is more obvious at the end of the 50 year period long after all current faculty have retired because of the smoothing of new hires produced by our model's more uniform "insertion" of new hires and more uniform departure of quits than the real world. It is, therefore, somewhat artificial and might obscure reality. Table V, however, contrasts minimum new hires in the early low hire period when the real world faculty is still employed, and these minima could be more than doubled by reducing p from 1.0 (all tenure) to .4. Slightly lower increases in the much later maximum values can be produced by the same drop of p from 1.0 to .4.

Table VI

Maximum, Minimum, and End of Simulation

Values of New Hires Consistant With Varying Tenure Standards

	Minima		Maxima		End Values (2023)
p	H^P	Year	H^P	Year	H^P
0	8.81	1978	26.60	2002	25.09
.4	6.63	1978	13.02	2002	10.15
.5	6.08	1978	11.50	2003	8.81
	6.08	1982			
.6	5.25	1982	10.76	1993	7.74
	5.13	1994	10.39	2003	
.7	4.50	1882	9.86	1993	6.84
	4.30	1994	9.52	2003	
.8	3.85	1982	9.18	1993	6.06
	3.75	1994	9.57	2009	
.9	3.31	1982	8.74	1993	5.41
	3.29	1994	9.27	2009	
1.0	2.86	1982	8.64	1993	4.83
	2.92	1994	9.11	2009	

It is instructive to analyze the varying sources of the replacement spots which permit new hires under varying tenure standards. Retirements, tenured, quits and deaths are virtually unaffected until nearly all of those currently tenured have retired in 2001. Thereafter, the stricter the tenure policy being applied over the first 27 years, the fewer the number of replacement spots from retirements, tenured quits, and deaths. The changing behavior of new hires under differing tenure regimes, therefore, is due almost solely to the variations in untenured quits and the flow of negative tenure decisions until 2001. Clearly, the stricter the tenure policy, the more the replacement openings due to negative tenure decisions. This, however, is reinforced by a nearly equivalent increase in the flow of untenured quits. Any policy which enlarges the probationary pool has a double impact on the inflows and outflows which maintain that pool. It raises the number of new hires necessary to replace those not granted tenure, but it raises the number of new hires necessary to maintain the pool due to quits as well.* After 2001, the interaction between the higher untenured quits and negative tenure decisions of a stricter tenure policy and its lower retirement, deaths, and tenures quits, levels begin to occur. There is a slight drop, thereafter, in the effectiveness of a stricter tenure policy on new hires.

This implies, of course, a certain smoothing of the new hires time paths as one moves from a more to a less liberal tenure policy. (Note, this is not the "machine-made" smoothing of a given time path for a particular tenure policy). Careful inspection of Figure 2 reveals that the "early" part of the p = .4 time path shifts up more by comparison to the p = 1.0 time path than the post - 2001 part of that time path. This can be verified by comparing average new hire levels for both the strict (p = .4) and liberal (p = 1.0) time paths in each of the two time periods. The average new hires over the period 1974-88 for the p = .4 policy is 8.8 per year rising to 11.2 per year in the later time period, 2002 - 2015, a difference of 2.4 per year. In the p = 1.0 simulation the average for the early period is 3.9 per year rising by somewhat more, 3.0 new hires per year on the average, to 6.9 per year in the later period. In short, one acquires "relief" from a lack of retirements (when it is needed) at a relatively small cost of somewhat fewer re-

*It is here that our assumption of independence between tenure standards and quit rates might be questioned. Conceivably a tighter tenure policy might reduce untenured quit rates to the extent the assurance of some eventual very strict quality control reduced the need for early informal tenure decisions. On the other hand, untenured quit rates might well rise due to the high probability of no tenure.

tirements many years later.

This minor qualification not withstanding, tenure policy clearly does have an important impact on the ability to make new hires and may be a potential option to be considered in the school which foresees a flow of replacement spots below desired levels.

3. The Influence of Quits. Our discussion of quits in Chapter III concluded with the general observation that variations in the Untenured Quit Rate had virtually the same qualitative and quantitative impact on all our measuring of faculty health as the same percentage point variations in p. This implies, in turn, that a drop in untenured quitting can be offset by a similar percentage point drop in p as long as neither is near its extreme values. We experimented with this in a rather gross way by comparing our high quit --- p = .7 simulation of Section D 1 above with a simulation using the lower values of .2 for the Untenured Quit Rate and 0 for the Tenured Quit Rate (the "low quit" case) but compensating with a stricter p = .5 policy. A careful comparison of Table IB in Section D1 above and Table VII below shows the striking similarity in time paths for all variables. Given the insensitivity of A and W to any attrition flow, it is not surprising that these should be similar in both simulations. However, the more sensitive % T and new hires measures of faculty health are also strikingly similar for both simulations. The % T value in the "low quit -- compensating low p" simulation does not rise quite as high as in the "high quit -- high p" simulation, and new hires for the former are a little larger on the average in the former than in the latter. We slightly "over-compensated" by reducing p on a point-for-point basis with quit rates.

To conclude, we should add one further generalization that was not apparent from our examinations of the static model. The key to eliminating or at least smoothing significantly the cycle in all our variables is not varying tenure policy but higher attrition rates in the Tenured faculty, i.e., reducing now the bulge of tenured faculty currently aged 36 through 49 rather than waiting for them to retire beginning after 1988-89. Tenured quitting in the model is applied uniformly over the ages 36-54, almost those very "ages of most concentration" in the tenured faculty that will help to produce the low new hire rates and rising % T, A, and W values until 1988-89. Applying more such tenured

TABLE VII

The Low Quit Case (Untenured Quit Rate = .2; Tenured Quit Rate = 0; Mortality Rate = .5)
With a compensating drop in p from .7 to .5

Year	Tenured	Untenured	Temporary	Total	Z T	Average age of permanent	Average age of teaching faculty	Wage	Standing for tenure	Promotions	Rejections	Retirements	Deaths	Untenured Quits	Tenured Quits	Permanent Hires
1973	68.62	43.06	16.76	128.44	53.43	40.84	39.74	15051								
1974	67.95	43.74	16.76	128.44	52.90	40.34	39.30	14949	7.170	3.585	3.585	4.000	0.340	2.254	0.000	10.18
1975	70.58	41.10	16.76	128.44	54.95	40.68	39.60	15042	8.500	4.250	4.250	0.991	0.335	1.450	0.000	7.026
1976	74.58	37.10	16.76	128.44	58.07	41.35	40.18	15209	9.635	4.818	4.818	0.000	0.369	1.083	0.000	6.269
1977	78.01	33.67	16.76	128.44	60.74	42.01	40.76	15368	8.400	4.200	4.200	0.000	0.389	1.701	0.000	6.288
1978	79.07	32.61	16.76	128.44	61.56	42.81	41.45	15568	3.200	1.600	1.600	0.000	0.428	1.721	0.000	3.748
1979	80.29	31.39	16.76	128.44	62.51	43.22	41.81	15664	5.464	2.732	2.732	0.958	0.420	1.330	0.000	5.439
1980	81.85	29.83	16.76	128.44	63.73	43.35	41.92	15687	8.143	4.072	4.072	1.900	0.432	1.256	0.000	7.660
1981	81.47	30.21	16.76	128.44	63.43	43.28	41.86	15673	5.621	2.811	2.811	2.826	0.413	1.004	0.000	7.053
1982	82.50	29.18	16.76	128.44	64.23	43.77	42.29	15790	5.016	2.508	2.508	0.934	0.427	0.919	0.000	4.737
1983	82.69	28.99	16.76	128.44	64.38	43.99	42.47	15837	5.030	2.515	2.515	1.852	0.452	1.310	0.000	6.129
1984	81.96	29.72	16.76	128.44	63.81	44.24	42.70	15897	2.999	1.499	1.499	1.836	0.477	1.471	0.000	5.284
1985	81.82	29.86	16.76	128.44	63.70	44.47	42.90	15946	4.351	2.176	2.176	1.820	0.508	1.184	0.000	5.638
1986	80.08	31.60	16.76	128.44	62.35	43.89	42.39	15804	6.128	3.064	3.064	4.512	0.483	1.092	0.000	9.150
1987	80.96	30.72	16.76	128.44	63.03	44.23	42.68	15877	5.642	2.821	2.821	1.362	0.504	1.141	0.000	5.825
1988	81.44	30.24	16.76	128.44	63.40	44.74	43.13	15993	3.830	1.915	1.915	0.887	0.499	1.097	0.000	4.398
1989	80.04	31.64	16.76	128.44	62.32	44.46	42.89	15919	4.903	2.451	2.451	3.518	0.488	1.484	0.000	7.942
1990	77.77	33.91	16.76	128.44	60.55	44.01	42.50	15812	4.227	2.114	2.114	4.142	0.489	1.496	0.000	8.260
1991	77.81	33.87	16.76	128.44	60.58	44.27	42.72	15869	4.550	2.275	2.275	1.729	0.508	1.020	0.000	5.533
1992	78.64	33.04	16.76	128.44	61.23	44.31	42.76	15866	7.320	3.660	3.660	2.217	0.512	1.234	0.000	7.623
1993	75.83	35.85	16.76	128.44	59.04	43.62	42.15	15702	4.644	2.322	2.322	4.955	0.491	1.618	0.000	9.337
1994	76.96	34.72	16.76	128.44	59.92	44.39	42.32	15880	3.518	1.759	1.759	0.000	0.507	1.377	0.000	3.643
1995	76.09	35.59	16.76	128.44	59.24	44.03	42.52	15790	6.353	3.177	3.177	3.653	0.491	1.316	0.000	8.637
1996	76.70	34.98	16.76	128.44	59.72	44.11	42.58	15797	6.592	3.296	3.296	2.125	0.490	1.701	0.000	7.612
1997	74.32	37.36	16.76	128.44	57.86	43.59	42.13	15676	4.425	2.213	2.213	4.394	0.468	1.303	0.000	8.378
1999	76.34	35.34	16.76	128.44	59.43	43.93	42.43	15738	7.510	3.755	3.755	3.230	0.471	1.625	0.000	9.061
2000	76.45	35.23	16.76	128.44	59.52	44.47	42.59	15862	2.915	1.457	1.457	0.850	0.479	1.599	0.000	4.386
2001	76.84	34.84	16.76	128.44	59.83	44.42	42.35	15838	6.909	3.455	3.455	2.550	0.475	1.351	0.000	7.831
2002	75.22	36.47	16.76	128.44	58.56	43.85	42.36	15701	6.089	3.045	3.045	4.394	0.455	1.422	0.000	9.316
2003	73.79	37.89	16.76	128.44	57.45	43.25	41.84	15558	6.702	3.351	3.351	4.505	0.434	1.347	0.000	9.636
2004	70.75	40.93	16.76	128.44	55.09	42.53	41.25	15432	4.109	2.055	2.055	5.015	0.410	1.222	0.000	8.731
2005	72.08	39.60	16.76	128.44	56.12	42.76	41.41	15454	7.264	3.632	3.632	1.742	0.415	1.715	0.000	7.505
2006	70.26	41.42	16.76	128.44	54.70	42.56	41.24	15419	3.508	1.754	1.754	3.370	0.405	1.895	0.000	7.424
2007	71.80	39.88	16.76	128.44	55.91	42.98	41.60	15517	6.265	3.132	3.132	1.003	0.416	1.834	0.000	6.385
2008	72.69	38.99	16.76	128.44	56.59	42.99	41.61	15517	7.453	3.726	3.726	2.325	0.419	1.621	0.000	8.091
2009	72.20	39.48	16.76	128.44	56.21	42.52	41.20	15406	7.709	3.855	3.855	3.993	0.405	1.493	0.000	9.765
2010	71.59	40.09	16.76	128.44	55.73	42.14	40.87	15323	6.961	3.480	3.480	3.770	0.393	1.381	0.000	9.024
2011	71.50	40.18	16.76	128.44	55.67	42.09	40.82	15321	6.004	3.002	3.002	2.704	0.392	1.448	0.000	7.555
2012	71.46	40.22	16.76	128.44	55.64	42.05	40.79	15323	5.939	2.970	2.970	2.619	0.392	1.784	0.000	7.764
2013	71.65	40.03	16.76	128.44	55.78	42.23	40.95	15373	5.108	2.554	2.554	1.956	0.396	1.877	0.000	6.782
2014	72.40	39.28	16.76	128.44	56.37	42.36	41.06	15410	6.473	3.236	3.236	1.999	0.401	1.657	0.000	7.294
2015	73.70	37.98	16.76	128.44	57.38	42.45	41.14	15432	7.795	3.898	3.898	2.053	0.403	1.531	0.000	7.885
2016	74.82	36.86	16.76	128.44	58.26	42.59	41.26	15466	7.219	3.610	3.610	1.951	0.407	1.455	0.000	7.422
2017	75.27	36.41	16.76	128.44	58.60	42.71	41.36	15498	6.035	3.018	3.018	2.113	0.410	1.408	0.000	6.948
2018	75.80	35.88	16.76	128.44	59.01	42.82	41.46	15527	6.211	3.106	3.106	2.102	0.416	1.518	0.000	7.141
2019	76.09	35.59	16.76	128.44	59.24	42.99	41.60	15570	5.425	2.713	2.713	1.968	0.423	1.531	0.000	6.634
2020	76.43	35.25	16.76	128.44	59.50	43.10	41.71	15599	5.835	2.917	2.917	2.111	0.431	1.437	0.000	6.896
2021	76.91	34.77	16.76	128.44	59.88	43.19	41.78	15619	6.308	3.154	3.154	2.180	0.437	1.409	0.000	7.180
2022	77.33	34.35	16.76	128.44	60.21	43.32	41.89	15649	5.938	2.969	2.969	2.062	0.443	1.378	0.000	6.852
2023	77.41	34.27	16.76	128.44	60.27	43.40	41.97	15669	5.559	2.779	2.779	2.243	0.446	1.353	0.000	6.821

quitting to these age classes, then, has the effect of bringing the relief of 1988-89 closer to the present. To test this, we performed a simulation using the "very high quit" --- p = .7, Untenured Quits = .6, Tenured Quits = .25, and Mortality rate = .15 --- values that could be justified as possible given our 1963-68 data in Chapter II. The cycle was nearly eliminated. The % T rose from its current 53.4 to no higher than 59.6 in 1980 and then fell gradually back to fluctuate between 49 and 52 after 1990. Average age over the whole 50 years fluctuated between 39.7 and 41.5, and wage, between $15,051 and $15,494. New hires, our most sensitive indicator, fluctuated between 7.6 and 15.1 per year, and the difference between the average hires per year of the low hire period, 1975-88, (9.6 per year) and the later period of improvement, 1888 -- onward, (11.3 per year) was only 1.7 per year. To test whether this "smoothing" was due to the rise in Untenured Quits rather than the rise in Tenured Quits, we reduced Tenured Quits again to .05. The cycle returned, or better, became much more evident again. The two truly sensitive indicators, % T and New Hires, fluctuated much more widely with % T rising to 63 in 1980 and dropping to a low of 50.5 in 2006 and with the average of the new hires during the "low hire" 1973-88 period dropping to 8.0 per year contrasted with 10.8 per year during the period 1988 - onward, a considerably larger difference of 2.8 per year.

This underlines the paradoxical nature of at least part of the staffing "problems" at the more mature school like Carleton. Apart from the untenured age bulge there often tends to be a concentration of the tenured faculty in the 40-49 age groups. Put a bit strongly for emphasis, some schools have too many of the best faculty. One wonders, then, at the grossness of our measures of faculty health or the degree of Carleton's "problems" if part of their "solution" involves inducing some of its best faculty to depart.

Chapter V

Summary and Conclusions

1. Carleton, like many schools, experienced moderate growth in faculty size during the period 1963-68 followed by attempts to approach steady state in the early 1970's. This approach to steady-state has taken the form of "replacement only" hiring policies which restrict permanent new hiring to the rate of retirements,quits, deaths, and negative tenure decisions. Since retirement rates are still based on the smaller faculty of the 1950's, since voluntary quit rates have dropped with depressed faculty labor market conditions, and since traditional, fairly liberal tenure policies continue to be followed, the rate of new hiring is being reduced. This reduction, moreover, is not yet fully complete because untenured quits and negative tenure decisions are still being based on the last of the large new hiring classes which helped expand the faculty in the late 1960's.

2. These policies have also produced a concentration of younger faculty, largely untenured, which if current tenure policies continue to be followed will produce, in turn, a gradually more tenured, older, and more costly faculty over the next 25 to 30 years. Many schools have chosen so far not to alter their tenure standards or to use them to control faculty characteristics other than quality. Our major task was to examine the most likely behavior of the teaching faculty's average age, average wage, proportion tenured, and permanent new hire rate given traditional tenure standards and to experiment with alternate, largely stricter tenure standards. We observed that if tenure policy is to serve other than its traditional roles, it must be changed very soon before the current four-year bulge of young untenured faculty are promoted and become assured of quasi-automatic contract renewal.

3. We emphasized that much current discussion of the need for tenure quotas and the like was obscured by ill-informed interpretation of sketchy empirical data, by an overemphasis on the proportion tenured which we found a somewhat faulty, heavy handed, and

easily disguised proxy for the more important indices of faculty health and vitality --- the ability to make new permanent appointments, the faculty's average age, and its average wage --- and by a lack of appreciation of the cyclical nature of the problems posed by an age bulge in the faculty following growth and a steady-state decree.

a. Many are alarmed after their initial and only casual acquaintance with data on expected retirements per year contrasted with recent new hire rates. The fact that one can expect only 1.33 retirements per year at Carleton seems on the face of it a strong case for stricter tenure standards. How can one expect to maintain new hire rates at 7 and 8 per year and to maintain faculty age and wage at reasonable levels unless many more replacement spots are created through negative tenure decisions? While the disparity is evidence of a real problem and can be partly attributed to the difference between the small faculties of the 1940's and 1950's when current retirees were first hired and the much larger current faculties which have been created and were maintained until recently by very high new hire rates, much of the disparity can be explained alternately by "natural" attrition and the application of traditional tenure standards.

We made a case on the basis of admittedly outdated 1963-68 data that of 10 new hires no more than 1.68 could expect to reach retirement age at Carleton because of the high rate of pre- and post-tenure quitting, the relatively strict tenure standards conventionally followed at schools like Carleton, and the oft-forgotten influence of mortality. An examination of more recent 1968-73 data suggested that of 10 new hires still only 3.36 could expect to reach retirement. We, finally, argued that there was a floor on the untenured quit rate at Carleton and many schools like it representing what we characterized as the "early, informal tenure decision." Given this floor, still only 4.76 of 10 new hires could expect to reach retirement age at Carleton. True "alarm," then, seems appropriate only in schools which have conventionally applied almost no quality controls to their faculty and where the disparity between recent hiring rates and expected retirements are apparently due to literal doublings on triplings of faculty sizes in recent years contrasted with Carleton's 52 per cent growth between 1958 and 1973.

We also warned that the extreme uncertainty over the future rate of pre-tenure quitting, a conventionally more important source of replacement spots at Carleton than negative tenure decisions, rendered any mathematical modelling which sought to provide firm "predictions" decidedly suspect.

b. We found that the proportion of a faculty which was tenured (% T) tended to be far more sensitive to the passage to tenure of a growth-produced age bulge than two of the three more relevant measure of faculty health and vitality, its average age and average wage. Therefore, those in fact concerned with expected age and wage changes may be unduly alarmed by rising % T rates which overstate the later rises in age and wage. The % T was, moreover, an indicator which was considerably lagged by average age and average wage. We found that the behavior of % T did mirror more closely the magnitude of variations in new hire rates caused by the passage of an age bulge although it lagged somewhat these changes in new hire rates. We warned, finally, that policy changes designed to "relabel" the faculty which changed % T without changing the likely behavior of average age, average wage, or the rate of permanent new hires (essentially, longer probationary periods but no change in the expected duration of employment or what is the same thing, the rate of attrition) should be treated with some skepticism. While they provide somewhat more flexibility for the later exercise of alternate policies, to the extent those alternate policies are never followed they change nothing but the label.

c. Few appreciate the cyclical nature of the behavior of indices of faculty health and vitality following disturbances of a faculty in long-run equilibrium. This has led to both misinterpretation and a lack of perspective in analyzing current data and a failure to recognize that any observed trend has a definite limit and will be eventually reversed assuming no further disturbances (sic?!). Most obviously, the nation-wide rises in % T, age, and wage and drop in new hire rates which have produced such recent alarm are, in part, merely a return to conditions which prevailed and were presumably appropriate before the growth disturbance of the late 1950's and 1960's. Faculty growth in any given school would seem neither the normal state of affairs nor sustainable forever. Therefore, the low values of age, wage, and % T and high values for new hire rates of the 1960's were "artificial" in some sense, and the reversal of these trends in the early 1970's could be interpreted, in part, as a return to normalcy.

Moreover, to the extent there is now a bulge of young faculty whch will gradually age beyond the pre-growth "normal" levels in the years ahead, there must necessarily be a bulge of retirements in the distant future, a consequent rise in new hires, and a corresponding drop in age, wage, and % T. If the growth disturbance was well defined and short-lived, the full cycle from initial hiring maximum to later hiring maximum and age, wage, and % T minimum is the expected full term of service, the probationary period plus the full term of tenured employment. Given Carleton's surprisingly high average age at date of hire of 30 years and retirement age of 64, the full cycle, then, should be 35 years. We found, however, that at Carleton the growth bulge is not quite as well defined as expected and that the current faculty age distribution has been disturbed by other less obvious events such as variations in quit rates, the Sputnik-era hiring of older, experienced faculty, and the like. Expected new hires, therefore, are highly volatile, and although they rise sharply as expected after the year 2000 (roughly 35 years from the mid-1960 growth period), they will also have risen from the depressed levels of the mid-1970's to fluctuate about a somewhat higher average by as early as the late 1980's. This, in turn, produces earlier than expected maxima in age, wage, and % T in the late 1980's, a very gradual decline in these indices through the turn of the century, and then sharp declines to minimum values in the years 2010-12.

We could only make the obvious observation that the degree of comfort or alarm one takes in the knowledge that conditions eventually reverse themselves in the absense of further disturbances depends on one's judgement of how long an institution can remain viable with indices of faculty health at other than desired levels and on one's judgement of how far those indices can diverge from desired levels before threatening viability. At the least, we hope, this will stimulate thoughtful discussion of an appropriate time horizon and of desirable maxima for age, wage, and % T and a minimum for permanent new hires.

4. A faculty's average wage and average age are surprisingly insensitive to any but the most exceptional age bulges. We examined two Carleton-specific simulations in detail, the "pessimistic view" with a non-tenured quit rate of 2 in 10, a tenured quit rate of 0, and a death rate of .15 and an "optimistic view" (based on 1968-73 quit data) with

a non-tenured quit rate of 4 in 10, a tenured quit rate of .05 (½ an FTE in 10), and a death rate of .15. Both simulations assumed Carleton's traditional tenure policies are followed over the next 50 years and that 7 in 10 standing for tenure may expect to receive it on the average.

In both simulations the rise in average wage abstracting from economy wide influences (inflation and productivity increases) was inconsequential. With the lower quit rates, average wage rose from its current level of $15,051 to a maximum in 1988, fifteen years later, of $16,327. With the higher quit rates average wage rose to a maximum of $16,072, also in 1988. Assuming the same average wages are paid each of the teaching-plus-leave faculty (141 faculty members), the total wage bills rise then by $179,900 or $144,000 respectively over the whole 15 year period. These, in turn, represent average annual rates of increase in average and total wage bills of 5.6 tenths of one per cent and 4.2 tenths of one per cent, respectively. Thus, the financial impact of expected changes in the age composition of the faculty (only!) may be virtually ignored. Moreover, it would take only the smallest erosion in the faculty real wage (abstracting also from economy-wide influences) to offset any rise in average wages due to the impact of changes in the age composition of the faculty; one does not need a computer simulated experiment to see that. Whether such an erosion will take place is a matter of opinion, but we should indicate that the national faculty's real wage rose at an average of 9 tenths of one per cent annually over the three academic years 1969-70 through 1971-72, but actually dropped by one-tenth of one per cent in 1970-71 (see AAUP, Annual Report of the Economic Status of the Profession, 1972-73). The 1972 real wage, moreover, will almost certainly show a larger percentage drop.

The rise in average age was also surprisingly small, and the maxima ocurred in the same year as for average wage, 1988, in both simulations. These maxima were 44.14 years for the lower quit rate simulation and 43.37 years for the higher quit rate simulation, or increases of 4.40 years and 3.63 years respectively from the current average age of 39.74 years. To give more intuitive meaning to the changes in average age, we pointed out as limiting cases that equivalent changes could be produced if one were to instantaneously substitute 57 year olds for a group of 30 year olds who represented either 16.4 per cent or 13 per cent of the teaching faculty respectively.

The most important reason for the sluggishness of average age and wage is simply that the difference between the ages and wages of the tenured and untenured permanent faculty is relatively small. Tenured faculty are not doddering 82-year-olds nor are untenured permanent faculty bright-eyed 26-year-olds. The difference in their mean ages currently is only 14 years and rises to approximately 18 years at a maximum in 1988-90. Therefore, changing quite substantially the proportions of 46-50 year old tenured faculty and 31-33 year old untenured permanent faculty in the total, changes the mean age of the combined groups relatively little. Moreover, to the extent mean wage rises less than proportionally with age, the financial impact of this only moderate aging is minimal.

In addition, leaves help depress the rate of growth in the age of the teaching faculty. The mean age of the permanent (teaching plus leave) faculty rises by 5.06 years to its maximum (in 1988) in the low quit rate simulation and by 4.17 years (also in 1988) in the high quit simulation. These increases slightly exceed the increases of the teaching-faculty-only because of the influence of leave substitution with temporary appointments. This is because whatever the average age of the permanent (teaching-plus-leave) faculty (40.84 years in 1973 or 45.0 or 45.9 years in 1988) 10 per cent of those permanent faculty are always on leave and are replaced by constant aged, 32.4 year old temporary faculty. Put simply, the age of the permanent faculty rises until 1988 but the age of the people who replace those permanents on leave remain constant so that the age of the teaching faculty rises by slightly less.

5. The % T is a good deal more sensitive to the passage of a young untenured age bulge and, as we observed, tends to "overstate" changes in age and wage. At Carleton % T rises from its current 53.4 level to 70.9 in 1983 in the low quit rate simulation and to 66.67 in 1983 in the high quit rate simulation. While substantial, the current untenured age bulge and the passage to tenure that these rises in % T indicate, must be significantly larger to affect age and wage substantially.

Many things have contributed to the relatively small size of the bulge and the only moderate, therefore, rise in % T. Growth in the Carleton faculty was probably different from that in the national teaching faculty as a whole. It was undoubtedly smaller, somewhat less well-defined and more gradual, and was characterized by new hiring across a relatively wide range of age classes. Moreover, some episode, probably in the mid-1950's, placed a substantial group of faculty in the age classes which will begin to retire in 1989 and after somewhat offsetting the current untenured age bulge. Finally, growth was accomplished, in part, by a substantial expansion of the temporary pool which can produce an age bulge only to the extent temporary appointments "slip" into the permanent faculty. Even without this growth in the temporary faculty, % T, age, and wage are necessarily depressed by a policy to simply maintain a given stock of temporaries.

Many observers of national faculty data overlook that the aggregate history of the many institutions that data now mirror is almost necessarily different from that of most ongoing institutions like Carleton. The national age bulge of young untenured and tenured faculty in large part reflects the establishment of whole new schools both public and private which sprang up each over no more than four year periods and the truly remarkable expansion of the state university systems. Moreover, while the new schools and expanding state systems undoubtedly sought a balanced age distribution, casual empiricism suggests they did not fully succeed; most of the PhD's of just one decade, the 1960's, staffed whole new schools or schools which doubled in size rather than schools like Carleton which expanded moderately. In short, while these are largely untested assertions, the national age bulge of young untenured faculty is far larger than Carleton's, and as it ages will produce sharper rises in % T, and in the average age and wage for which % T is a proxy.

6. While extremely volatile and subject to many random disturbances, permanent new hire rates seemed the most sensitive indicator of Carleton's uneven age distribution and was the one index of faculty health and vitality that might fall below acceptable levels in the intermediate term. How drastic was that expected fall depended very much on how optimistic one was about the floor provided by untenured quits; the retirement floor of 1.33 per year was minimal. Clearly, the 10 - 18 per year permanent new hire rates that characterized the 1960 growth period are no longer possible and after the 1974-75 academic year when the current bulge of probationers have ceased providing large

numbers of replacement spots from non-tenured quitting and negative tenure decisions, the rate of permanent new hires will drop substantially from its current 7-8 per year levels. Assuming a non-tenured quit rate of .2 and no tenured quits, the rates of permanent new hires possible from 1975-76 through 1987-88 range from a low of 2.8 in 1978 to 7.0 in 1986 with an average of 3.77 per year over the whole period. Assuming a higher non-tenured quit rate of .4 and the tenured quit rate of .05, the range was considerably higher, from 4.5 in 1982 to 8.5 in 1986 with an average of 5.8 per year over the whole period.

We have already outlined the cyclical nature of the behavior of permanent new hires and the permanent relief that begins after the year 2002 in both simulations when permanent new hires rise to 7 - 9 per year levels. We have also mentioned and should underline again the unexplained "episode" in Carleton's past history which produced a relatively large number of tenured faculty now 49 or under who begin retiring after 1988-89. As a consequence, the measures of faculty health and vitality reach their "worst" levels much earlier than if the age bulge were well defined and due to a single short growth episode. Moreover, they remain at a plateau for a decade-long period until the turn of the century rather than falling immediately. Finally, we should remind the reader that temporary new hires provide a further floor on "new faces" seen at Carleton each year. Assuming a constant temporary stock of nearly 17 faculty members, a maximum of 17 new faces per year would be possible although one wonders whether even the whole group would substitute for even 3 or 4 permanent new appointments in terms of the renewal they provided. We often assumed a more realistic 10.5 per year temporary appointment rate with half being provided one-year contracts and half, two-year contracts. An alternate assumption with possibly more academic merit might be 7.3 temporary appointments per year with two-thirds being granted two-year appointments and one-third being granted three-year appointments. While this would tend to equalize the teaching and "renewal" value of the temporary and permanent appointment, it might not be feasible from a market standpoint and would surely put upward pressure on faculty size.

7. We experimented with alternate tenure policies although these experiments in no way implied a need for alterations in policy:

a. Age, Wage, and % T. Tightening tenure policies, of course, reduced the maximum values of these variables reached in 1988-89 and easing tenure policies raised those maximum values. However, age (A) and wage (W) were extremely insensitive to varying tenure policies or p (the probability of receiving tenure), and % T was only moderately sensitive. The maximum in A could be altered by no more than 2.78 years by following a very strict p = .4 versus a very liberal p = 1.0 (all tenure) policy, and the maximum in W, by no more than $756. The % T varied by somewhat more, between 58 and 75 for a p = .4 and p = 1.0 tenure policy, respectively. This insensitivity of A and W to tenure policy came as no surprise. If, as we observed above, A and W are fairly insensitive to the passage of a medium-sized untenured age bulge which changes % T only moderately given the current p = .7 policy, they should be no less insensitive to variations in tenure policy that change % T only moderately. Only in the limiting case of no tenure (p = 0) did tenure policy have a striking impact. Under that policy the school effectively eliminates its tenured sub-class when the last currently tenured faculty retires in 2006, and A and W fall to the levels for a rapidly turning over pool of temporaries and "probationers."

We also discovered that the effectiveness of changes in tenure policy tended to diminish the more liberal the tenure policy already was. That is, a still stricter policy given an already strict policy, say a drop of p from .5 to .4, had more of an impact on A, W, and % T than dropping p from 1.0 to .9. This we attributed to the fact that tenure policy must act on a fairly large number of faculty before it is effective. Given an extremely liberal tenure policy, the pool of probationers is very small because with so many assured of long durations of employment reflectively few new hires are possible each year. This means, in turn, that applying stricter tenure standards to that only small number standing for tenure would have little impact. Schools with stricter tenure standards and, therefore, larger numbers normally standing for tenure can have a somewhat more striking impact by varying tenure standards than schools with liberal tenure policies.

b. New hire rates were, as expected, substantially more affected by variations in tenure standards, and applying stricter tenure standards might be a potential option to be considered in the school which foresees a flow of replacement openings below desired levels. For example, the minimum values for new hires during the depressed new hiring period, 1975-88, could be more than doubled by reducing p from all-tenure (p = 1.0) to .4. There was one minor qualification to the apparent effectiveness of stricter tenure policy in raising new hire rates. The stricter a tenure policy now and the larger the volume of replacement openings from negative tenure decisions and untenured quits, the smaller the volume of retirements after 2006 when those few currently standing for tenure who receive it begin to retire. This eventually offsets somewhat the higher level of replacement spots provided by pre-tenured attrition and negative tenure decision and produces a slight smoothing of the time paths for new hires at low p values by contrast to those at high p value.

c. Stricter tenure policies did not eliminate the cycle in our measures of faculty health with the exception of this slight smoothing of the new hires cycle. While maxima were reduced for A, W, and % T so, too, were the minima.

8. We emphasized, again and again, that quits were the "joker" in our mathematical "deck" which made prediction extremely difficult and suggested only the most cautious use of our simulations as predictors of the real world. We found that untenured quitting had roughly the same quantitative and directional impact as tenure policy. This suggested, in turn, that a drop in the untenured quit rate of 20 percentage points, for example, could be offset by an equivalent 20 percentage point drop in the probability of receiving tenure as long as neither quit rates nor p were near extreme values. We experimented with the specific case of a drop in the untenured quit rate from .4 to .2 (our high and low quit examples above) which was compensated for by a drop of p from .7 to .5. The .4 --- p = .7 combination and the .2 --- p = .5 combination produced nearly the same time paths for all variables. This similarity in the impact of untenured quitting and the tenure decision is not surprising given that both occur at nearly the same time after the date of new hire and thereby restrict the expected duration of employment for those quitting and unsuccessfully standing for tenure to approximately the same number of years.

We also found that rises in tenured quitting could significantly smooth the cycle. A special characteristic of the Carleton age distribution beside the untenured age bulge is the relatively large number of tenured faculty in the 40-49 age group whose expected retirement after 1988-89 brings significant relief in the new hires situation and produces the "early" maxima of A, W, and % T that we mentioned earlier. Clearly, one way of bringing yet earlier "relief" and eliminating the cycle is to raise tenured quit rates which are typically applied to these very age groups. In a simulation where the tenured quit rate was raised from 0 and .05 to .25, the cycle was all but eliminated. We wondered, however, at the grossness of our measures of faculty health or the degree of Carleton's staffing "problems" if part of their "solution" required the departure of Carleton's best faculty.

9. We should conclude with an explicit recognition of two major limitations on the use of mathematical modelling. First, mathematical models are generally constructed assuming a greater degree of control over some policy variable like tenure policy than in fact, exists. Realistically, the probability of tenure cannot be predetermined by some deus ex machina but is determined year-by-year by the action of the Departments, the Dean, the President, and the Trustees. Moreover, even if all could act in concert to predetermine such a variable, it is likely that the real world behavior of our measures of faculty health would not fully describe the impact of this policy. Some other unaccounted for function would surely suffer. It takes no intuition to see that more than H, % T, A and W are involved in measuring a faculty's health and vitality when one is dealing with the extreme case of a p = 0 (no tenure policy). If a school could agree on a no tenure (p = 0) policy, and succeeded thereby in minimizing % T, A, and W and maximizing new hires per year, it would very soon cease to exist.