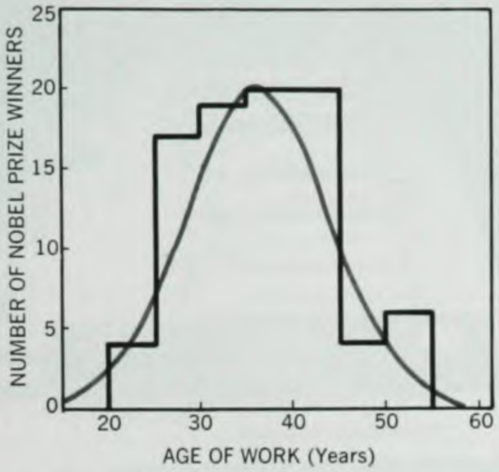
letters

Will zero-population growth hamper scientific creativity?

Now that the prospect of zero population growth in the United States is beginning to seem more real, concern is being expressed about its possible adverse social and economic consequences. Perhaps the most serious worry is about the effects of the altered age distribution zero population growth would bring with it. "The most conspicuous disadvantage is the age composition implied by a stationary population, especially at the low mortality that has been achieved in advanced countries ... A society with such an age structure is not likely to be receptive to change and indeed would have a strong tendency towards nostalgia and conservatism. A French writer has characterized a stationary population as a 'population of old people ruminating over old ideas of old houses.' "[1]

Is this worry well founded? Would the age distribution of a stationary population really be unfavorable from the point of view of creative work in science, the arts and the business world? The only way to answer this question is to look at the ages at which creative work is actually being done in various fields and compare that with the age structure of stationary and growing populations. If the stationary population has a notable deficiency of people in the most creative age brackets, the current concern can be considered justified; if not, it clearly is not well founded.

Fortunately, it is possible to pinpoint with considerable accuracy the age at which creative work has been done by one group of what would generally be conceded to be highly creative workers, namely the Nobel Prize winners in physics. The prize has been awarded annually since 1901, and the citation contains a description of the work for which the prize is given, so the determination of the date at which the work was performed is a straightforward matter. The age distribution for all recipients is shown in figure 1. It can be seen that it is Gaussian, with a mean age of 36.2 years and a standard deviation of 7.6 years. Its most striking features is the remarkably "old" age of 36 about which the distribution is centered. Even the subset of Nobel Prize winning theorists have an average age of 33 for their most creative work, while the average age of experimentalists is 38. Clearly the common notion that physicists are "burned out" by age 30 lacks factual foundation.



The distribution of ages of Nobel Prize winning work in physics. The histogram presents the data in 5-year bins. The curve is a Gaussian distribution with mean of 36.2 years and standard deviation of 7.6 years. Figure 1

How does a stationary population compare with a growing population in its ability to turn out work of Nobel Prize winning quality? An example of age distributions of hypothetical populations under various rates of growth is shown in figure 2, calculated on the basis of actual United States mortality tables for 1967. These are the steady-state age distributions that would be established several generations after a change in fertility. Note that the differences between the growing and stationary populations are most marked in the ages below 20 and above 50.

To utilize the data on age distribution of Nobel Prize winners, I assume that the Gaussian distribution in figure 1 gives the probability $N(A)$ that a person of age A will do work of Nobel Prize quality. Then the *per capita* probability N that during a given year someone in the population will do Nobel-quality work is just the integral over the entire population, or

$$N = \int_0^\infty N(A)P(A)dA$$

where $P(A)$ is the age distribution of the population. Using the age distributions given in figure 2, along with others calculated for the range of population growth from -1% to $+3\%$ per year, I have evaluated expression 1. The relative *per capita* probability N of Nobel-quality innovative work in physics has a broad maximum from zero to 1.5% per year growth, varying by only about 1%, although it falls off rapidly for growth rates less than -0.5% and more than 2% per year. Because the current (approximately 1% per year) US growth rate falls within the range of the broad maximum, our growth rate could drop to zero with no significant effect on the *per capita* likelihood of Nobel Prize quality work in physics.

This analysis is clearly crude, as its *ceteris paribus* assumptions about the structure of the scientific and general communities during the transition to zero population growth may be a bit unrealistic. For example, the physics community is currently young by demographic standards and will probably grow older in the next few years as its rate of growth decreases. It could also be argued that the Nobel Prize is not given for "typical" creative work in physics, so that figure 1 does not give an accurate indication of the creative ages of the typical physicist. Despite these caveats, however, it seems clear that there is little justification for fears that zero population growth in the total population would have a stultifying effect on the country's scientific creative activities.

One reason for the common misapprehension on this score is the failure to realize that a growing population is "young" primarily because so many of its members are under 20. The proportion in the crucial age groups—crucial, as indicated by the study of physics Nobel Prize winners, being about ages 28 through 44—is quite insensitive to demographic changes for growth rates from zero to 1.5% per year.

It would, of course, be necessary to have studies of other groups—artists, writers, businessmen, politicians—before firm conclusions could be drawn about the relation between age structure and innovative achievement in general. There is, however, a fairly strong presumption that youth is more important for creative work in physics than in these other fields. Consider the average ages of Nobel Prize winning work[2] in physics (36), chemistry (38), and medicine and physiology

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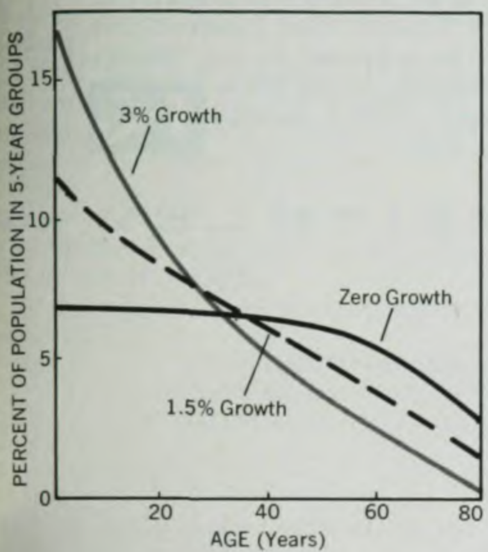
(41), which indicate a progression of "older" creative work as the research becomes more applied. Similarly, among the physicists, the experimentalists are five years older than their theoretical colleagues. It would appear clear that theoretical brilliance is *less* and empirical experience *more* of a factor in the success of businessmen and politicians than of physicists. An



Hypothetical age distributions under steady state with various rates of growth. The growth rates indicated are in percent per year. Figure 2

older average age of creativity clearly improves the desirability of a stationary population as opposed to a growing one, as is evident from figure 2. Of course, there are *some* areas in which the earlier years are most creative; athletics is an obvious example. But, considering the entire spectrum of innovative activities, fears that the age distribution of a stationary population will bring stagnation due to fewer creative people appear unjustified.

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Insecurity in industrial jobs

Gertrude Scharff-Goldhaber (February, page 9) has vividly and sympathetically described the plight and frustration experienced by many physicists, who, after a short career, are squeezed out of academic positions. This description is followed by many suggestions aimed at improving employment prospects.

I wish to draw attention to the fact that entirely similar problems exist for industrial physicists. Also at least one of the escape routes mentioned by Scharff-Goldhaber, that into medicine, is blocked by nearly insurmountable obstacles. Finally, I shall add some proposals of my own.

Let me start by briefly describing certain problems in the industrial employment of physicists. The managers of various industrial and semi-industrial laboratories have recently become concerned about increases in the average age of their technical staff. It has been advocated[1] that average age must be kept down in order to ensure vitality and productivity adequate for institutional survival. In addition, steps to achieve this goal have been proposed and apparently are being implemented.[1]

It is the nature of things that it is the older physicist who must pay the price.[2] My experience leads me to believe that this trend will develop into a major problem for industrial physicists. I am sure that any escape of academic physicists into industry is difficult; even if at first successful, it is bound to be a short-term solution.

I believe that the problem is serious enough to warrant the suggestion that an appropriate study be made of possible discrimination on account of age in the employment of physicsts. There is a Federal Law prohibiting such discrimination and this law is just as valid as that which prohibits discrimination on account of race. Any enforcement of that law, difficult as it may be, will be an important aid in alleviating some of the consequences of the present employment crisis.

Escape of physicists into medical careers is extremely difficult, if it is understood that a medical career is meant to imply any medical or dental practice. I have thoroughly explored this avenue and found that, even if all the necessary premedical requirements have been completely fulfilled, the doors to appropriate training remain closed. The reasons have been best summarized by a senior admissions officer at NYU medical school and are as follows:

- Age at entry is higher than usual and results in less service returned to the medical profession. This decreases the return upon dollars invested in education by the school in question.

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