Introduction
An issue of paramount interest to United States industry is the supply and quality of human resources available for this country’s scientific and technological activities. Science and engineering personnel are vital in meeting national challenges in the areas of scientific research, education, technological competitiveness and national security. The changing composition of the workforce, and the attendant responsibilities that an organization has to assure equal opportunity, give rise to various issues. This paper discusses some of the issues associated with the scientific and technical workforce. Specifically, it explores some of the questions pertaining to workforce composition and the measures of workforce composition. It is hoped that this paper will be useful to those responsible for developing and implementing personnel policies for the scientific and technical workforce.

Demographics
A clear and factual picture of the current situation and recent trends in workforce demographics is very important to rational and effective policy formulation. Workforce 2000, a Labor Department study produced by the Hudson Institute in 1987, predicted dramatic changes in the American workforce by the year 2000. The paper stated that “only 15% of the new entrants to the labor force over the next 13 years will be native white males, compared to 47% in that category today.” These projections, widely disseminated and extremely influential, were simply a mistake. The paper was actually referring to a new measure, “Net New Worker", that was developed in that paper. The Net New Worker measure can be thought of in the following manner. Consider the total pool of new entrants into the workforce - new graduates, immigrants, etc. That group defines the New Workers. Now, make replacements from these New Workers to account for exits from the workforce - retirements, deaths, etc., but do so with direct gender/ethnic replacements. That is, for each white male that exits the workforce, replace him with a white male from the New Workers group. After all exits from the total workforce have been replaced in this manner, the people remaining in the New Workers group are the Net New Workers - the group that is only 15% white male. Thus, the Net New Worker measure can be thought of as a sort of “first (or perhaps second) derivative” of the workforce composition.

Workforce Analysis
Measurement of the characteristics of the current workforce is required by the Department of Labor (DOL) for many employers. To detect possible bias in hiring or promotion practices, the DOL expects companies to monitor the percentages of women and minorities in a given job classification (on-roll percentages or utilization) and in hires and promotions, and compare those values to reference values called availabilities. Availability is calculated from recent hiring and promotion data and from external data such as census data for the specific job classification. This process is illustrated in Figure 1. It shows the 70 - 30 mix of internal movements to external hires with the indicated percentages of women. This mix and set of pool compositions leads to the 18.5 % reference value for the group of interest.

Figure 1. Calculation of availability
Workforce compositions can be thought of in terms of process flow with “pools” representing job classifications and “pipes” representing hiring and promotion. To understand the dynamics of the processes that determine workforce composition, it is useful to visualize internal personnel movements in terms of “flows”. By using these flow analogies, insights can be gained with respect to hiring and promotion of women and minorities within job classifications. A flow diagram illustrating this concept is shown in Figure 2.

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
Figure 2. Pools and Pipes Illustration

The “pipes” and “pools” indicate sources, pathways, and destinations for entries to and exits from these populations. The synergy between the two job classifications is clearly illustrated in this manner. Changes in the utilization (on-roll percentage) of a targeted group in one “pool” can affect the availability in job classifications that are fed by that “pool” as illustrated in the availability calculation described in Figure 1. For example, aggressive hiring of women into an entry level position may result in the appearance of bias against women in the next higher level since the calculated availability of women for the higher level would suddenly increase but it would take time for the new-hire women to attain the required experience to be considered for advancement.

If the goal is for utilization to equal availability, there can be a problem. In a static situation, the percentages of a targeted group (women or minorities) among new graduates and the on-roll population, in the absence of bias in the organization, are equal and unchanging. That is, the two expected compositions, hiring and on-roll, would be the same. If, however, the hiring availability changes rapidly and there is a low turnover of the on-roll population, the two compositions can differ substantially just due to the inertia of the system. This needs to be recognized when a company performs its workforce analysis.

The Hypothetical Corporation

There are a number of things that can disturb the balance between utilization and availability, but most of these are related to changing availabilities. Rapidly rising availabilities will result in rising utilization, but at a much slower rate, especially if people remain in the same job classification for a long time. Most technical people are hired into a job classification and expect to retire from that same job classification since only about 10% are typically promoted into supervisory ranks. In comparison to this rather static job classification, women are being awarded advanced degrees in the physical sciences and engineering in rapidly increasing numbers. In the physical sciences 18.8% of the PhDs awarded in 1992 went to women, whereas they made up only 15.2% of the PhDs in 1989. In engineering, the numbers went from 5.9% to 8.8% over the same period.

A simple model was constructed to get an idea of just how much the utilization of women would lag their availability (measured in new graduates) in the absence of any preference. No experienced hires were considered since they were assumed to be balanced by attrition. In this manner a Hypothetical Corporation was established in the year 1960 consisting of 2000 scientists and engineers ranging in age from 25 to 59 with 1.5% being women. Attrition, above that needed to balance experienced hires, was assumed to be 2.5% in all age groups, and everyone was assumed to retire at age 60. It is necessary to hire 85 new staff, 25 year olds, each year to keep the Hypothetical Corporation in steady state. The availability was assumed to be the PhD graduation rate for women in the physical sciences and engineering weighted in the ratio of one third to two thirds, respectively. The availability, thus calculated and projected to the year 2000, is shown as the upper curve in Figure 3. The lower curve shows the resulting utilization of women in the Hypothetical Corporation. Clearly, even in the absence of any bias, utilization cannot match availability for cases where the availability is changing rapidly. In order for the utilization to match the availability, in this example, women would have to be hired at twice their availability rate.

Figure 3. The Hypothetical Corporation

Summary

The field of human resources presents many challenges to corporate management. Studies in the field can be misinterpreted, leading to errant policy decisions. Careful analysis is called for in interpreting the data and formulating personnel policy. In particular, care is needed in cases where the population demographics are rapidly changing. If a targeted group is increasing in availability in the hiring pool, but there is low turnover, it is almost certain that the on-roll utilization of that group will show a shortfall. It needs to be recognized that this is a result of system dynamics, not bias in hiring or promotion.
Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, 175 Oak Ridge Turnpike, Oak Ridge, TN 37831; prices available at (615) 576-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161; phone orders accepted at (703) 487-4650.