THE VALUE OF DIVERSITY TO THE CHEMICAL SCIENCES

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Chemistry is an intensely human activity wherein we attempt to explain the world from a molecular perspective. As chemists we seek to gain through experimentation a molecular understanding of reality, and with that, the ability to describe, manipulate and create. Undoubtedly the most interesting chemical questions of the twenty-first century have not even been asked, nor, perhaps, a vocabulary yet formulated to pose them. What is clear is that there is a lot of hard and joyous work ahead as scientific disciplines make giant strides or tentatively inch forward towards a better, if provisional, level of understanding. The talents of very creative and intelligent individuals must be developed and recruited to participate in the chemistry research enterprise.

The most valuable commodity in chemistry research has always been the creativity, inventiveness and the intellectual capital of the practitioners of molecular science. But then, who will do chemistry? Who will make up the molecular science labor force in this rising century? Who gets to ask and answer research questions? The premise here is that it is in the best interest of chemistry and of society that the intellectual workforce be comprised of the "best and the brightest" from diverse backgrounds.

INTELLECTUAL DIVERSITY AND THE DEVELOPMENT OF CHEMISTRY

What is the effect of the chemist on the development of chemistry? Is it better, is it different, depending on who the chemist is? Does it matter that the chemist is male or female? Black, White, American Indian, Asian or Latino/Hispanic? Is not chemistry just chemistry? Does the chemistry depend on the chemist? If chemistry is just another human activity, is there not American Indian chemistry, Latino Chemistry, Black chemistry, or female chemistry? Well, not any more than male, White chemistry. But not any less.

Chemistry progresses in proportion to the quality and novelty of the research questions posed by its practitioners, and the creative effort expended in answering these. Yet our worldview, including the research questions we allow ourselves to ask, are influenced by our life histories and circumstances, including culture, gender, ethnicity and social class. Individual human uniqueness allows each one of us to frame research questions --and the answers to these-- from different perspectives. This is the value of intellectual diversity to chemistry: that we can gain a better understanding of molecular phenomena by having many chemists form and answer chemical questions from various perspectives; and to subject these to experimental verification and reproduction.

The American chemistry enterprise has been well served by the intellectual diversity of its practitioners. Notable to this diversity is the entry into the chemical sciences by individuals from a variety of social and economic circumstances as a consequence of the GI Bill. After World War Two and the Korean War, educational opportunities were made available to millions of Americans through this bill. For the first time in our history, significant numbers of urban and rural poor and of modest means were able to obtain a college education. A disproportionate number went into science and engineering, and most were white and most were men. A contractor's son from Los Angeles became a biochemist; the son of immigrants became a chemical engineer; a talented Vermont farm boy became a university professor. This influx of talent into all levels of the American chemistry enterprise had a very positive effect. The work of these technicians, researchers, professors and leaders of industry, who brought to American chemistry quite different life perspectives than previous generations, contributed greatly to the success of this world-class enterprise.

It is arguable that chemistry is made richer and better by differences-- gender, race, ethnicity, culture-- among chemists, since we all look at the world in slightly different ways; that we can contribute to a better understanding of chemical reality by bringing to bear on chemical problems the

talents of a broader range of individuals. There are groups in American society, notably African Americans, American Indians and Hispanics, whose participation in the chemical sciences is disproportionately low. These populations are sources of talent which can bring additional intellectual diversity into the enterprise, but that have not participated in chemistry in significant numbers.

Different cultures, and subcultures employ different metaphors. Is science not enriched by incorporation of different metaphors? In *Chemistry Imagined: Reflections On Science,* Roald Hoffman reiterates the value of metaphorical thinking to chemistry[1]. Echoing Heisenberg's notion that the observer has an uncontrollable and non-removable effect on what is observed, Roger S. Jones, professor of physics at the University of Minnesota reminds us that "... science and the physical world [are] products of human imagining—that we are not the cool observers of the world, but its passionate creators. We are all poets and the world is our metaphor".[2]

There are experimental data on the value of diversity to the research enterprise. Kevin Dunbar while at McGill University (now at Dartmouth) reported that the social composition of the research group may influence conceptual change.[3] Two laboratories, one with a group made up of people from different backgrounds; the second with all members from the same background, faced the same type of research problem. The lab with members from the same background solved the problem using brute force experimentation; the lab with people from more diverse backgrounds solved the problem using analogy. Apparently, the lab with the diverse background used more different sources of analogies than the more homogeneous lab

Demographic changes demand greater attention to minority participation in all aspects of American life, but especially in the sciences, where participation remains exceptionally low. Trends in California, the most populous state, are illustrative and point to a national reality in the coming century. The 2000 Census confirmed what we already knew: that California joined New Mexico and Hawaii officially as "minority majority" states, and have a combined minority population in excess of 50%. Texas will soon follow. Federal agencies whose mission includes development of a scientific workforce, primarily the National Institutes of Health and the National Science Foundation, have established programs to create a diverse workforce in industrial and academic science, and these have seen real, if limited, success. Though significant, these efforts have been small parts of agency activities (for example NIH programs targeting minority participation have generally been less than 1-2% of overall NIH budgets over the past 30 years. Yet their contributions have been invaluable).

The American Chemical Society has increasingly paid attention to the low participation by minority group members in the sciences, and questions who its members will be in 2050. Genuine altruism and enlightened self-interest guided the ACS to become a major player in encouraging the participation of minority group members in chemical sciences careers through its educational programs, and through its ACS Minority Scholars Program, a commitment of several million dollars in scholarships for undergraduates. This is consistent with the fifth strategic thrust of the ACS Strategic Plan for 2001-2003, which includes:

- "Provide programs and activities to encourage the participation and leadership in all aspects of the chemical sciences by women, underrepresented minorities, and persons with disabilities."
- "Workforce diversity is increasing. …there is a world-wide trend toward a more heterogeneous workforce, which increasingly requires individuals from different backgrounds to work together effectively. Currently, women, some ethnic minorities and persons with disabilities are underrepresented in the chemical sciences. Increasingly, efforts are being made to increase their participation and leadership opportunities. Expanding opportunities for chemical practitioners in these categories will boost the potential creativity and effectiveness of the chemical enterprise."

INTELLECTUAL LABOR FORCE STABILITY AND SECURITY CONCERNS

Shirley Ann Jackson, President of Rensselaer Polytechnic Institute, reiterated the concern of labor economists and educators that we have a looming personnel crisis in American science and technology.[4] Our educational system is not producing sufficient scientists and engineers to meet current or projected demand. A quarter of the current science and engineering work force is over 50 and will retire within the decade. This is the population whose research and innovation fueled the 1990s economic boom.

We have had for many decades a shortfall in the number of technically trained individuals our economy needs, and the number our educational system produces. Our nation has been able to attract

talented foreign workers from around the globe, but factors mitigate against this being a sound future strategy. First, is the improving economies of several parts of the world and growth of centers of innovation (notably Scandinavia, Singapore, South Korea, Ireland, Israel, China, India and Malaysia), and the increased ability of these countries to retain their own talent, and themselves become foci to attract regional scientific talent. Second, globalization has opened greater opportunities abroad for careers in science. Third is the increased security consciousness of the United States post-September 11, 2001, and the greater difficulty foreign students and postdoctoral scholars have in entering this country. We can no longer take the ready availability of foreign talent for granted.

Dr. Jackson notes that the two-thirds of the US population is composed of women, African Americans, Hispanics, and American Indians, the "underrepresented majority", and represent an intellectual talent pool that if "identified, nurtured, and encouraged, the projected gap of scientists and engineers would be filled. The underrepresentation in science and technology is no longer a merely social problem nor even a moral question. It is now an economic and security requirement – and has become a national imperative".

Training and education are requisite, but do not necessarily translate into participation.[5] Women have comprised about one-third of chemistry graduate students for almost two more decades, yet these gains have not been reflected in commensurate participation of women in faculty positions in chemistry faculties in institutions ranging from major research universities to liberal arts colleges, or in top positions in chemical industry. Yet, chemistry will be somewhat different, and richer when a greater number of women chemists are in leadership positions in academia and industry.

WHAT MUST BE DONE

Significant numbers of talented minority group members must be encouraged to pursue careers in the molecular sciences, and, as in any human endeavor, some will succeed and others will fail. Individuals from minority group backgrounds must be freed from extreme expectations—the lowered expectations which dampen drive and achievement; or the opposite, such exalted expectations placed on those few who earn advanced degrees that their professional success or failure is viewed not as individual accomplishment, but as group characteristics or limitations.

The labor market challenge to all of us is the creation of an environment within the molecular science enterprise -- in academia and in industry --in which the intellectual talents of Americans from all ethnic and racial groups can be developed and brought to bear on the solution of current and future problems. There are no simple solutions, no clever insights, and no easy ways to do this, just hard and thoughtful and committed work and support. We must improve our colleges' and universities' abilities to attract talented minority scientists into our chemistry faculties, not to fill any quotas, but to improve our institutions. We must recruit talented minority students and engage them, as we should all talented students, as the future leaders of the chemistry enterprise. We must strengthen their commitment to excellence by incorporating them as full members into excellent academic programs. And pertinent to the present workshop, we must stimulate their interest in chemistry by using undergraduate research as a beginning to their careers in chemistry.

Is chemistry changed by changing the mix of chemists? Of course. It must be. It is important that talented men and women from all American populations be able to contribute to the development of chemistry in this country. We short-change chemistry to do otherwise.

References

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