To me, this century began on September 11, 2001. It forced me to seriously rethink focusing on incremental changes in chemical education versus the big picture and the big changes that relate to a global workplace. The traditional divisions in chemistry are in large part historical artifacts. If we were to begin all over today, such divisions within chemistry (and chemical engineering) would probably look different. Since that will probably not happen soon—processes of change are usually evolutionary—we should consider some possible directions.

The best way to bring about more rapid change in chemical education is to look at our graduate programs, which perhaps are more amenable to curriculum flexibility than undergraduate programs at the current time. Changes in the graduate curriculum would hopefully spill over into the undergraduate curriculum as graduate students become new faculty members teaching at undergraduate institutions and bring the new vision with them. Changes in the thinking of existing faculty would serve to increase the rate of change. Global competitiveness and built-in lifetime career flexibility must also be considered as major driving forces.

Chemistry is a central and an enabling science. As such, chemistry is required for much interdisciplinary scientific research and is a necessity for leading the development of many new technologies. A characteristic of this century is that multidisciplinary approaches will be necessary for solving many of our most significant research challenges. This characteristic notwithstanding, many graduate chemistry programs and their course contents still follow the traditional divisions of chemistry—analytical, inorganic, organic, and physical—creating “potential energy” barriers within chemistry that need not exist.

There is much crossover in these divisions; connections and “internal integration” can and should be made. For example, a course in “chemical synthesis” could easily bring all of these divisions together as they exist in the real world. Developing and teaching an integrated curriculum is a challenge and requires a substantial amount of faculty time to do well. Such programs may well exist, but they are probably still in their infancy.

The multidisciplinary challenges posed by the demands of this century require this internal integration. The problems to be solved, advances to be made, and resources to be conserved need the attention of all disciplines. In appropriately working with other disciplines, chemistry will need a well-prepared interface that allows for surface interaction and penetration.

Successful new graduate programs are indeed becoming more multidisciplinary, with research leading the way. In developing more multidisciplinary course support for this research, adapting to the educational experience of students with divergent undergraduate backgrounds is a real challenge. Interestingly, increased government support in certain multidisciplinary areas (biotechnology, nanotechnology)
T he decision to go to graduate school takes courage and is seldom made lightly. The challenges are considerable and demanding. Yet those who go through the experience usually do not regret their decision. The rewards are a lifetime of exciting science, intellectual stimulation, and considerable opportunity—for the chemistry profession has a healthy diversity of career choices within industry, government, and academe, and has weathered fickle economies better than most. Consider for a moment that the number of graduate degrees (master’s and doctoral) conferred annually over the past 50 years has more than doubled (1000 Ph.D.s in 1950 to over 2000 by the turn of the century)—yet the demand for creativity and expertise continues to grow, keeping employment levels high and likely to remain so.

Granted, there are problems—and serious ones if you believe the many reports and surveys that have appeared in recent years that are critical of graduate education, particularly at the doctoral level. In some ways this is surprising, because it is widely acknowledged that doctoral programs and the stature of the universities that offer them are among the great successes of U.S. higher education. However, few of the surveys are discipline-specific, and their relevance to chemistry may be questioned. The exception is the survey by the ACS Committee on Professional Training, which canvasses how academic departments, on the one hand, and graduates, on the other, view their graduate programs in chemistry. While the verdict is favorable overall, these and other reports reveal shortcomings, particularly in realizing diversity in the workforce and in effective career guidance, whether in academe or industry.

How can a professional society like A CS influence the quality and effectiveness of graduate education? Nothing could be more important to the profession and the nation than the preparation of its future scientists. A CS always had a clear focus on undergraduate education, but at the graduate level the efforts are much less visible. However, this is changing as a result of the decision to strengthen the Society’s infrastructure in graduate affairs.

We now have an ACS Graduate Education Advisory Board and an associated Office of Graduate Education that seek to improve communication both within the Society and in the field at large concerning graduate (M.S. and Ph.D.) and postdoctoral education. The newsletter you are reading is part of that effort. We hope that this publication will give a needed face to graduate studies and a voice to those who participate in the experience. The numbers are impressive. Data for 1999 record 18,414 graduate students (some 14,000 of whom are ACS members), 2134 Ph.D.s conferred, and 3774 postdoctoral appointees. It is a privilege to have in this first issue some thought-provoking articles relevant to graduate studies, including feature articles by A CS President Eli Pearce on “Reinventing Chemistry—The 21st Century” and John D. Roberts on the question of time-to-degree.

We hope that the newsletter will appear twice yearly, in the spring and fall, but we need to hear from you about its content and what you would find of greatest interest. Also, please visit the graduate education website at http://chemistry.org/education/student/gradeducation.html to view the CPT special survey reports referred to above and links to other studies.

Carnegie Initiative on the Doctorate

T he Carnegie Foundation for the Advancement of Teaching has undertaken a new project called the Carnegie Initiative on the Doctorate. Chemistry is one of the six focus disciplines chosen by the foundation. Clearly, faculty and disciplinary leadership are indispensable for the success of the initiative.

Why undertake the initiative?

At the start of the 21st century, we take great pride that the world sends students to the United States for doctoral training. There is strong evidence that American-trained chemists are excellent researchers and can look forward to rewarding careers. Nevertheless, we should not be complacent. It is surely opportune to ask in what ways traditional research training works well and in what ways it can be done better.

What is it?

The Carnegie Initiative on the Doctorate is a multiyear research program intended to enrich and invigorate the education of doctoral students. The initiative includes three strands.

Conceptual. The core premise of the initiative is that we need to return to first principles and start with the question, “What is the fundamental purpose of doctoral education?” The foundation’s answer is that doctoral education should prepare “stewards of the disciplines.” The degree should signal a high level of accomplishment in three facets of the discipline: generation, conservation, and transformation.

Experiments. We will identify four to six chemistry departments to conduct multiyear “design experiments” in doctoral education. Selected departments will commit to designing and implementing doctoral programs that foster stewardship of the discipline.

Research. Training a scholarly eye on the experiments, we want to facilitate the broad adoption of successful models.

The project is led by George Walker, Senior Scholar, Carnegie Foundation, and Vice President for Research, Indiana University; and Chris Golde, Senior Scholar. For more information, see www.carnegiefoundation.org/CID, call 650-566-5513, or e-mail golde@carnegiefoundation.org.
How Long Should It Take a Graduate Student to Get a Ph.D. in Chemistry?

John D. Roberts
Gates and Crellin Laboratories, California Institute of Technology

A s a former participant and current observer of graduate study in chemistry, I believe that the average residence time for graduate work has grown substantially, if not doubled, over the last 50 years. Of course, much depends on the talent, dedication, perseverance, and goals of the individual. With respect to the latter, the Ph.D. should not be regarded as just a standard “yard” long. If one’s goal is a professorship at a top-ranked research university, it is not unreasonable to expect outstanding performance. But the amount of time in residence is not necessarily related to quality. So, perhaps using golf as a model, we could define “par” (first-rate), “below par” (sensational), or various degrees of “greater than par” (more or less the average player) for a combination of time and quality. Some would suggest a direct relationship between the two, but I am not at all convinced. A s one example, 35 years ago, I had a superb Ph.D. graduate who finished at Caltech in two years and nine months, with an outcome of 16 published papers. The par-time in those days was perhaps 3 years, while the average student may have taken 3.5 to 4 years. Today, it would seem that par is at least 4 years, and the average is more like 5.5 to 6 years.

It seems reasonable to ask whether this increase is desirable; but, in making that assessment, it is also reasonable to ask what are the important factors that have contributed to it. Perhaps A C S should convene a group to determine what those factors are and see whether some form of suasion could be used to effect a change.

But there is also the question of whether shortening the time of residence is desirable. Presumably, graduate students undertake graduate work to learn how to do research. This will normally involve a steep learning curve that will tend to flatten out or even tail off after some time period. Over the same period, the same student’s productivity curve will rise more slowly and eventually more or less flatten out. It would be helpful to know whether these curves have the same shape as in the distant past and whether the productivity curve has become unduly extended or the learning curve just rises more slowly.

Possible questions to consider include the following:

- A popular and cynical notion is that graduate research directors are endeavoring to extract more and more research output from their students in order to impress granting agencies and to enhance their own personal prestige as scientists. How much of a factor is this?
- A re the current par and average time spent at the level that should be expected for present-day Ph.D. students, because there is now so much more to learn to become an effective researcher? If that is so, has the need changed to learn broader, or has it become to learn deeper, or both?
- A re beginning graduate students now and Ph.D. levels should take seriously the responsibility to prepare students for career success during a professional lifetime, whether it be in academe, industry, or government. That means that we should also sharpen their communication skills, expose them to applied science and technology, and introduce them to concepts related to market forces, economics, and management as drivers for research, development, and technology. A s chemical educators we are enable.

A nd finally, we all are aware of problems in attracting qualified students to our graduate programs, leading to a larger dependency on overseas students. Research programs that challenge potential students to make meaningful contributions for the societal good are attractive. Relevancy is extremely important for attracting currently underrepresented minorities and women to our science, which is not only central but is enabling. This is most important in a society in which, in this century, the minority will become the majority.
Preparing Future Chemistry Faculty
Les Sims

Research has always been the core of doctoral education, and chemistry has a long and successful record of preparing students for a productive career in research—be that within an academic institution, an industry or business, or a government laboratory. But a commonly expressed concern is that doctoral students are not as well prepared in other areas—communication, working in teams, interpersonal skills, etc.—that are common requirements in all areas of employment. And students preparing for an academic career often have insufficient preparation for their expected roles in teaching, service, and outreach.

ACS is one of several science and math societies that have participated in a project funded by the National Science Foundation entitled “Shaping the Preparation of Future Science and Mathematics Faculty.” This is one of a number of ongoing “Preparing Future Faculty,” or PFF, initiatives coordinated by the Council of Graduate Schools in collaboration with graduate deans at doctoral institutions. PFF is designed to better inform graduate students of options and expectations for faculty careers in a variety of academic institutions and to develop teaching, communication, and interpersonal skills that will better prepare them for whatever type of academic career they decide upon.

PFF programs are centered at a research university where future faculty are being trained and that involve a number of “cluster” institutions—liberal arts colleges, regional universities, community colleges, etc. A common feature of PFF programs is the opportunity to visit and/or undertake a teaching internship at one or more of the cluster institutions. Students thus have an opportunity to experience faculty life at a type of institution that they might want to consider as a career option. A nd faculty at the PFF partner institution often become mentors on non-research issues and careers.

The long-term goal of PFF is to enhance graduate education so that students who aspire to be faculty members will be well-prepared to make an informed career option and to fulfill the roles expected of them at whatever type of academic institution they choose.

Chemistry graduate students involved in the ACS-sponsored PFF projects at several chemistry departments have been very positive about the opportunities from their participation in a PFF cluster program. Several students have written articles for ACS publications or have made presentations at ACS meetings. Not only have these articles and presentations been highly professional, they also represent a unique professional development opportunity for the students. The ACS Education and International Activities Division has produced a wonderful brochure on the Chemistry PFF program. The brochure and other information from the Division are available to any student, faculty member, or chemistry department that would like to learn more about this exciting new aspect of graduate education in chemistry. For more information, check the ACS website at http://www.acs.org/education/student/pffweb.html.

Les Sims is Director of External Grants Programs, Council of Graduate Schools. He is intimately involved in the PFF programs across several disciplines.

A Message from ACS Membership

What’s the one thing you can count on with absolute certainty while you pursue your graduate degree? VIP treatment from the ACS Membership Division! As a graduate student, you are eligible for many special membership advantages. You also benefit from 126 years’ experience in helping the chemistry and chemical engineering communities.

At the top of the list of benefits for graduate students is the special dues category that entitles full-time students to a 50% discount off membership dues.

“That’s a terrific deal! It’s less than the cost of a good pair of running shoes,” notes ACS recruitment manager Hilary Baar. Full membership offers graduate students a discount of up to $180 on registration fees for national meetings and free one-on-one consultations with career experts on preparing an attractive résumé and developing successful interviewing skills. According to Debora Fillinich, ACS retention manager, “Our members find these kinds of benefits and services extremely valuable—not only at the beginning of their careers, but as they manage and navigate their careers through promotions, changes in career fields, transitions from academia to industry, and company mergers.”

Recent developments in membership services include the launch of a new online career and employment service called JobSpectrum, which is dedicated to connecting job seekers and employers in the chemical sciences quickly, effectively, and with complete confidentiality (see article on p. 5). The ACS website, chemistry.org, has been redesigned and improved to provide better access to more information than ever before.

In addition, graduates can jump-start their careers with a host of practical membership benefits such as discounts on auto rental and moving vans and a no-fee, low interest-rate major credit card that displays the periodic table!

As Baar puts it, “If you are pursuing a degree in chemistry, joining the Society is a no-brainer. The phrase that comes to mind is ‘just do it!’”

If you are interested in becoming an ACS member, please call our Member Services Department at 800-ACS-5558 or visit http://chemistry.org/acspersonal.html.
The Chemistry of Your Success: JobSpectrum and You

What's free and will help you get the job you've always wanted? The answer is ACS's new website, JobSpectrum.org. JobSpectrum makes it easier to match your skills to opportunities that are right for you. JobSpectrum is a dedicated one-stop career resource for the chemical sciences. What sets JobSpectrum apart from Monster.com and the thousands of other "e-recruitment" sites is its emphasis on the individual, whether that person is a job seeker or a hiring manager. We know first hand that scientists have very specialized career needs, and as an ACS service, JobSpectrum is best positioned to meet your needs. The entire site—job ads, résumés, and content—is dedicated to reflecting the diversity and interests of the scientist and employer.

At the Orlando national meeting, JobSpectrum will introduce its newest element: Campus C center, a comprehensive career service for students, their faculty, and campus recruiters. Our goal is to help students with their career planning to make an effective transition to the workplace, help departments showcase their students and academic programs, and help recruiters looking for entry-level talent. While you're still a student you can post your résumé on Campus C center for all the top companies and chemistry departments to see. You can even link your résumé directly to your department's Campus C center profile so employers who search by school can find you. Plus, you'll be able to see all current job openings and apply online.

JobSpectrum.org
CHEMISTRY. CAREERS. CONNECTIONS.

Campus C center can help you keep an eye out for the right opportunity to make your next career move. You can set up new job alerts that match your objectives, experience, and career goals so you can make the move that's right for you. And you can set up as many alerts as you want.

When you set up your account and store your résumé, applying for a job is a snap. Your Personal Account keeps track of all job applications submitted and whether the jobs are still active.

Even if you're not actively looking for a new opportunity, JobSpectrum offers valuable content to help you manage your career, find the latest on salary and industry trends, and obtain other important career information.

Best of all, services to job seekers are free. So visit www.JobSpectrum.org today to see how fast and convenient JobSpectrum's career and employment tools can help you find a winning formula.

A Registry of Master's Degree Programs

The master's degree in the chemical sciences takes on many different forms. Besides the generic M.S. in any one of the four traditional divisions of chemistry (analytical, inorganic, organic, and physical), there are increasing numbers of M.S. programs in other divisions. These include biochemistry, computational chemistry, materials chemistry, and theoretical chemistry. There are also interdisciplinary and applied areas, such as agricultural, environmental, forensic, and pharmaceutics, as well as educational and professional programs.

Surprisingly little organized information is available on the nature of these programs. The ACS Directory of Graduate Research lists the universities that award master's degrees and the number awarded, but there is no program description. More useful information can be found at www.ScienceMasters.com, but the focus is limited to professional master's programs.

In view of the growing employment opportunities for master's graduates, there is a need to make information on master's programs more readily available. The ACS Office of Graduate Education has created a Web-based registry of master's programs that can be accessed readily through the ACS graduate education website. The information requested of schools regarding their programs has been slow in coming, but a version of the registry will be available by late spring 2002.

We hope that the registry will become a valuable resource for the chemistry community.
To our Readers

As you will see from this newsletter, the American Chemical Society is strengthening its focus on graduate education in recognition of the importance of post-baccalaureate studies to the discipline and the profession. For individuals, learning is a lifelong continuum, but society has organized (quantized) education into levels, one dependent on another. All are important, but the graduate level is especially so because it is the gateway to progress in the chemical sciences.—Editor

Write to Us

Your letters and comments are welcome, and, space permitting, we hope to include them in future issues. Please contact us at the Office of Graduate Education, American Chemical Society, 1155 Sixteenth St., NW, Washington, DC 20036; 202-872-4588; fax, 202-872-8068; GradEd@acs.org.

We’re on the Web!

www.chemistry.org/education/student/gradeducation.html