The question of whether or how to reform doctoral education has energized the higher education establishment worldwide during the last decade. Serious adjustments are being made in Germany with the elimination of the habilitation, in the United Kingdom with the introduction of the New Route Ph.D., and in the European Union more generally with the Bologna Process. Similar discussions are under way as well in China, Japan, Korea, and Taiwan, for example. In the United States the most recent effort is reflected in the Carnegie Initiative on the Doctorate. Why this sudden spurt of activity in revisiting doctoral education? Among a number of factors a few can be readily identified as likely drivers.

- The emergence of the knowledge-based economy has made it increasingly clear to policy makers that advanced education and the concomitant discovery processes are essential if a nation hopes to be competitive in the new economy.
- Likewise, the growing interdependence of knowledge and the increasing complexity of the world’s problems demand broader collaboration and new strategies.
- The long period of reductionist science, with its spectacular successes, provides both the foundation and the imperative for greater efforts in integration and an increased interdisciplinary emphasis.
- The relentless pressure on our industries creates a demand for employees who can contribute more quickly and more effectively to corporate goals.

These and other factors represent a sometimes subtle but profound change in the fundamental character of our higher education enterprise. The chemistry community needs to give thoughtful attention to these global trends. Their specific manifestations would include the following considerations.

1. The changing nature of our discipline. Many of the fundamental questions in chemistry have been addressed and understood in broad outline so successfully that the molecular paradigm has become foundational for virtually all...
2. The changing nature of the United States economy in general and the chemical industry in particular. The chemical industry in the U.S. is undergoing profound and probably permanent structural change (steady decline in corporate research emphasis, steady shift offshore in commodity chemical production, outsourcing R&D to international venues, etc.). In 2002 the trade balance in chemicals essentially dropped below zero after decades of roughly $10 billion per year in positive trade balance. This long-term trend is not likely to be reversed, and this shift will affect employment patterns for U.S. chemistry Ph. D. graduates in the future. Fortunately, for now, the biochemical sector of the chemical industry remains a robust exception to the above trends (and this itself suggests that some thoughtful adjustments in our traditional mix of programs may be in order).

3. The globalization of the economy and the rise of increasingly competitive economic sectors and research institutions in the rest of the world. The nearly century-long dominance of the United States in research may have reached an asymptotic limit and could even go into partial eclipse in the coming decades. This may change the largely unidirectional flow of scientists to the U.S. and may mean that many of our graduates will spend a good portion of their careers in international settings. This development has been given wider visibility recently in a news article by William J. Broad, who states, “Foreign advances in basic science now often rival or even exceed America’s, apparently with little public awareness of the trend or its implications for jobs, industry, national security, or the vigor of the nation’s intellectual and cultural life.” Are those of us charged with ensuring the continued strength of the education and research enterprise in this nation aware of these trends? Are we doing anything to prepare our students for that future?

These are just a few of the long-term trends that are gradually changing the environment for advanced education in chemistry. Within this larger context, much of the discussion about what is missing in graduate education has been of more modest scope. (The focus has largely been on what I have referred to elsewhere (see footnote 5) as “functional enhancements” of our traditional doctoral programs.) Most of the suggestions for change have not yet been systematically evaluated or debated. However, even as we refine our thinking about these suggested changes, it is imperative that we address the larger and rapidly changing reality that is only beginning to register in our collective understanding.

In 1947 the ACS published a survey of changes that were seen as desirable in chemistry doctoral programs. The observations recorded then differ only slightly from those being proposed today. One could say that we haven’t made much progress addressing the perceived “shortcomings.” Alternatively, one could say that this simply reflects the fact that the doctoral program in chemistry isn’t broken—indeed, that it has been remarkably stable and successful. Further, the arguments for including some of the suggested changes or additions to the program are not so compelling that any given department wants to be the first to implement them.

Why have these issues not been addressed and the putative “problem” solved? First, it is difficult to motivate change to well-established systems in the absence of a real or perceived crisis. Second, among most of the active faculty engaged in graduate education, there is a decided lack of conviction that significant change of the sort proposed is needed. Third, many of the changes suggested are modest and on the margins and hence don’t rise to the level of significance that might energize the thought leaders. Fourth, many view any additions to the doctoral program as being an unnecessary distraction from the core research activities and therefore in competition with their highest priorities. Fifth, the suggested enhancements are generally not well defined, can’t be cribbed from existing textbooks or syllabi, and aren’t an explicit part of the repertoire of pedagogic tools of the faculty. They may have little to draw on from their own experience to address these topics. Sixth, some may feel that this is something that bright students can pick up on the job, or that it should be left to industry as part of “on-the-job training.” Seventh, some faculty members do not take their pedagogic responsibility of graduate education as seriously as might be appropriate, and instead often focus their considerable talents and energies entirely on the execution of the research process itself.

Thus, although the case for making wholesale “functional” changes may not be compelling, the challenges of even incremental change are non-trivial. However, there are even more serious issues (besides the long-term trends mentioned at the beginning) that deserve serious attention.

I continue to believe that the time to degree remains too long, although some will disagree. Colleagues at the best universities argue that “their” students graduate in about five years and that this is about right. The median time across all institutions is of course more than a year longer, and if one adds postdoctoral years, we are often looking at a start-of-career age approaching 30. This makes a career in chemistry (via the doctoral path) less attractive to bright students who may opt for other career choices. The three-year Ph. D. programs possible in U.K. institutions stand in sharp contrast to our model.

However, as I argue in the Carnegie
Foundation paper, the greatest indictment of the academy (higher education generally, not just chemistry) is our failure to adequately mentor the next generation of the professoriate. This is not necessarily a failure in our doctoral programs per se, but in our system. We pay far too little attention to this critical issue which has many subtle and far-reaching ramifications. Some steps to address this issue have been taken by the Preparing Future Faculty program, but a much more comprehensive program is needed, as outlined in the referenced paper (5).

Should we reform the doctoral programs in chemistry? Should we address “functional enhancements,” time to degree, preparing future faculty? Should we be focusing on the changing nature of our discipline or the global trends that were addressed at the outset? The answer depends on how we perceive the challenges that lie ahead. What is important, and what the ACS Graduate Education Office, the Carnegie Foundation, and others are trying to do, is to raise the visibility of some of these questions so that faculty and students will engage in serious conversation and reflection about these issues. Only they can make the changes that will shape the long-term success of our discipline, our educational enterprise, and our national economic future. This offering is just another small salvo in that consciousness-raising effort.

References
(1) An extensive bibliography is provided by the program on “Re-envisioning the Ph. D.” at the University of Washington and funded by the Pew Charitable Trusts. See http://depts.washington.edu/envision.

(2) The federal government in Germany has ended the centuries-long habilitation pathway and replaced it with junior faculty positions similar to those common in the United States (with important differences). See, for example, Q. Schiermeier Breaking the Habilitation habit. Nature, 2002, 415, 257–258. For a full discussion in German see Dienstrecht-tsreform an den Hochschulen at www.bmbf.de/de/757.php.

(3) The New Route Ph. D. is being introduced in many disciplines across many institutions in the United Kingdom. The goal is to provide “functional enhancements” (see below) that go beyond the dissertation research in order to better prepare students for their careers. Information can be found at www.newroutephd.ac.uk.


(5) See, for example, the Grand Challenges Initiative of the Gates Foundation. www.abhf.org/BillMelindaFoundation.asp; and also www.grandchallengesgh.org/.


(8) Chemical and Engineering News, 25 (1947) 1934–1936, 2010–2013, 2076-2081; Chemical and Engineering News, 26 (1948) 166-167. Examples include training in patent law, improved communications skills, an early introduction to the nature of a career in industry, learning to work in teams, greater breadth of training, and so on.

(9) John D. Roberts’ article on this topic in the Graduate Education Newsletter, Vol. 1 No. 1 2002 at http://ACSGradEdNewsletter.org/.

(10) A description of the Preparing Future Faculty program can be found at www.preparing-faculty.org/FFWeb.Contents.htm. The PFF programs have been sponsored by the Council of Graduate Schools (CGS) and the Association of American Colleges and Universities (AAC&S) and supported by the National Science Foundation and The Pew Charitable Trusts.

(11) A description of the Preparing Future Faculty program can be found at www.preparing-faculty.org/FFWeb.Contents.htm. The PFF programs have been sponsored by the Council of Graduate Schools (CGS) and the Association of American Colleges and Universities (AAC&S) and supported by the National Science Foundation and The Pew Charitable Trusts.
About two years after I began a new phase of my academic career in Germany, I suddenly became aware that none of my graduate students were working towards Ph.D. degrees. No, this does not mean they were not working, or that they were law students posing in lab coats. Rather, after chemistry students defend their theses in Germany, they receive a "Dr. rer. nat." or "Doctor of Natural Science" degree. This triggered a sinking feeling in my stomach, as it meant I had been naive and politically or culturally incorrect in my professional conduct. In various manuscripts I had written over the years, I often included references such as "Ph.D. Thesis, Dr. J. Doe, University of Heidelberg." From this epiphany onwards, I switched to "Doctoral Thesis" for such citations, an expression that better approximates practices in almost other (but not all) countries.

This brief anecdote illustrates why I believe it is critical for U.S. academicians to have a minimum level of perspective regarding graduate (and undergraduate) education in other countries. Think of the era fifty years ago when the administrative vocabulary in academia was not gender neutral, and how faculty regulations or advertisements for positions from that period can sound so offensive today. In a similar vein, I assert that the present-day vocabulary of academia is dangerously non-internationalized and americanocentric, and can easily be construed as offensive in other countries.

For example, this newsletter refers to a symposium entitled "The Future of Graduate Education" at the fall ACS meeting. This would appear to promise something to someone in Europe or Asia or elsewhere, but the program consists only of speakers from the United States describing domestic issues. I don’t question the content, but I do question the catholic title. Some might counter that since the symposium takes place at an ACS meeting, an americanocentric orientation is a given. However, the scientific programs at ACS meetings are fully internationalized, and seek a global perspective on the best chemistry worldwide. Why the inconsistency?

Granted, it may not be humanly possible to internationalize our professional vocabulary to the same degree that it is now gender-neutral. Nonetheless, those pondering a common headline of the last few years—"why do they hate us?"—would do well to reflect on the analogy.

What other features besides the name of the terminal university degree render graduate education in Germany or Europe unique? A good starting point would be the "Bologna Agreement", which has been signed by the education ministers from 29 European countries. As a result, an open "European Higher Education Area" will be in place by 2010, making Bachelor’s, Master’s, and doctoral degrees fully portable between countries. Thus, all chemistry departments in Germany are busy converting their traditional "Diplom" degrees—a Bachelor’s/thesis-Master’s experience rolled into one—into degrees with names more familiar to Americans.

However, differences remain. The Bachelor’s degree requires only three years...
(six semesters), and for chemistry students consists only of chemistry, math, and physics courses, sometimes with a smattering of biology. One reason for the narrower curriculum is that "high school" (Gymnasium) lasts one year longer in Germany (although moves to trim the length are under way in certain regions). This has historically been considered enough exposure to the liberal arts. In view of the extensive language study throughout the school years, and the rich cultural traditions, I tend to agree.

The Master's degree requires two years, with a 6–9 month period for a thesis project. The older "Diplom" degree typically includes three comprehensive oral exams, featuring cumel-level questions from organic, inorganic, and physical chemistry, before the start of the thesis project. Both have a sense of "advancing to candidacy," such that subsequent doctoral study is essentially a pure research experience, without coursework, research proposals, or the like. However, chemistry departments in Germany often have a "graduate college" (Graduiertenkolleg) sponsored by the German NSF. This is an interdisciplinary area grant that funds stipends for 12–15 doctoral students and supports special seminars, workshops, and courses. Representative themes include electron transfer, nonlinear optics, and heterocyclic chemistry www.dfg.de/forschungsfoerderung/koordinierte_programme/graduiertenkollegs/).

As in the United States, the exact format of the final defense varies from university to university. In Erlangen, doctoral candidates first summarize their dissertation research. After a discussion period, they must answer 30 minutes of general questions in each of two areas: the field of the dissertation (for example, organic chemistry), and a second area, of the candidate's choosing, in which the University grants doctoral degrees. An obvious choice for one of my co-workers would be inorganic chemistry, but the candidate could equally well select areas such as toxicology or medieval church music.

The above paragraphs outline a traditional chemistry curriculum. However, there are a variety of modern, innovative, new "majors" that also attract chemistry students. These are sprouting up everywhere and have names such as "Molecular Science," "Molecular Medicine," or "Nanotechnology." Most are five-year Diplom or Bachelor's/Master's degrees that feature some of the traditional chemistry courses, together with a broad palette of offerings from biochemistry, medicinal chemistry, materials science, computational science, and additional allied fields. Many require an entrance exam, and a few are described as "elite majors." Often there are many elective options. These "majors" are usually prominently displayed on the home pages of the sponsoring chemistry departments www.chemie.de/chemdepts/de/).

For some of these newer "majors", instruction is in English. There is much interest in creating "magnet programs" for outstanding international students. The difficulty that many international students currently have entering the United States is seen as a "window of opportunity" for changing historical educational migration patterns. The long-term goal is to better profit from the brain drain and challenge U.S. economic dominance, particularly in "high-tech" areas.

One notes less reliance on textbooks in Germany. Since chemistry students attend tailor-made lectures separate from premedical students, biologists, and engineers, the market is smaller. Furthermore, there is no counterpart to the GRE exam to promote curricular conformity. Hence, there is a greater freedom to innovate, and more diversity between the lecture notes of professors at various institutions. Many have evolved their own detailed in-house texts. In theory, it would also be easier for an outmoded treatment of a subject to survive without scrutiny, although I have seen no examples of this firsthand.

Teaching experience is usually considered an integral part of graduate education. Most German chemistry departments have roughly the same number of teaching assistant lines as U.S. departments. However, they are often administered differently. It is not unusual to find departments or divisions where all undergraduate teaching is divided equally among all graduate students (and often postdoctorals), irrespective of the funding sources of their salaries. The net result is that all co-workers teach something on the order of one afternoon per week during the semester. With such small and flexible modules, graduate students often gain a wider range of teaching experience over the course of their studies. From the very beginning, chemistry undergraduates are incorporated directly into research laboratories, and clever assistants use this labor pool to further their own projects. What better way is there to get a beginning student excited about research?

Throughout Europe, a premium is placed upon "human mobility." However, the traditions for students as well as professionals differ from those in the United States. Students eagerly look for opportunities to spend a semester at a university in a different country during the Bachelor's/Master's portion of their studies. There are many exchange possibilities within Europe, the most popular of which is the ERASMUS program. Importantly, affordable university-sponsored housing is given. Unfortunately, there are far fewer programs involving North America, and most visits must be organized on an ad hoc basis.

For doctoral work, more than half of

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the students remain where they have done their earlier studies. Although this runs against the U.S. culture, I now see certain advantages. From the faculty side, if one knows that such a high proportion of undergraduates will remain as graduate students, one does a much more conscientious job of teaching and mentoring. Also, since most students do a "thesis-Master’s" degree at their original institution, there is a natural inclination for many to continue the same project.

Under this scenario, there is a general expectation that the doctoral research can be finished in three years or less.

There is also a long-standing tradition in Germany of students carrying out their doctoral work in industry—often a local company. Formally, there is a university co-supervisor, but this person frequently plays only a nominal role. I see several such cases each year at Erlangen, where all dissertations in chemistry are circulated (much to the annoyance of many candidates, who are forbidden to defend until this process is complete, and often have to track down the desk of the vacationing professor or secretary on which their thesis is marooned).

Some of the students who switch affiliations for doctoral studies go to a Max Planck Institute. These are roughly comparable to a U.S. National Laboratory, such as Los Alamos or Brookhaven. Most of the investigators have faculty appointments at nearby universities. However, there is also a trend toward freestanding graduate schools at such places—i.e., that is, a "University of Los Alamos." Other students transfer to universities in other European countries. The United States is not as popular, as few departments or admissions committees are able to recognize that these individuals have already advanced to candidacy.

There are numerous funding sources in Europe that allow a doctoral student to spend a semester or other period at another institution, often where some special research opportunity is offered. The best known are the EU-funded Marie Curie training sites (www.cordis.lu/improving/fellowships/home.htm).

These provide extensive local expertise in fields such as ESR, ionic liquids, molecular chemistry of transition metals, or electrochemistry. Students receive a stipend in addition to that from the home institution, with the idea that two residences must usually be maintained.

There are, furthermore, countless bilateral and multilateral programs—perhaps even too many. European politicians and administrators, like those anywhere, love to throw money at virtually any type of collaboration, irrespective of cost-effectiveness or efficiency. One of the strongest and best-conceived programs involves the German NSF and French NSF. Principal investigators from both countries can jointly apply for support for 2–4 coworkers. Student interaction and exchange are important in the evaluation and funding criteria.

Mobility is also important at the postdoctoral level. Any German student who aspires to a career in academia or as a manager in a leading industrial company must take a postdoctoral position outside of Germany. In the majority of cases, funding is received directly from a German granting agency, resulting in a "cost free" postdoctoral for the lucky sponsor. The United States has traditionally received the lion’s share of such individuals, but in recent years there has been increasing interest in other countries, and particularly Japan.

It is a pity that there are so few formal "study abroad" or exchange programs of the types noted above offered by United States federal agencies. This is not to say that there aren’t any, and those program officers who have worked hard to increase the menu of possibilities over the last decade deserve high praise. For example, the latest NSF webpages list chemistry REU (research experience for undergraduate) sites in France and Thailand. However, the fact that NSF graduate research fellowships can be applied abroad, while laudatory, is a mere poultice. There are only about 40 awards in chemistry each year, and perhaps one fellow will elect this option. The "Distinguished International Postdoctoral Research Fellowships" funds only 20 awardees in all of the physical sciences each year, and the first page of the program announcement carries the disclaimer "good only until cancelled" (www.nsf.gov/pubs/2001/nsf01154/nsf01154.pdf). Thus, the sparse menu of existing possibilities is largely within the framework of "elite programs."

This is sort of like saying that only the top 2% of chemistry graduate students should be fully educated in laboratory safety or partake in a course on research ethics. I would counter that international experiences will likely have the greatest long-term impact and benefit, both for U.S. science and society, if they are made available to a cross-spectrum of undergraduates, graduate students, and postdoctorals. In other words, why not target typical or average students, who will subsequently go out into a variety of types of permanent jobs?

I attribute the paucity of programs and/or their anemic funding levels in part to an entrenched U.S. scientific lobby (which includes, passively or actively, most readers of this newsletter) with the working motto "let’s keep our money at home," preferably in the hands of the professors who "know best." How many times, in the closed-door sessions where these types of policy decisions are made, has a prominent academician banged his or her fist on the table and angrily exclaimed to an agency directorate, "every three postdoctorals you fund to go abroad will mean one less grant awarded to an Assistant Professor, and one more promising career terminated by a negative tenure decision?"

Another way to gauge the current situation is to normalize the opportunities for U.S. citizens described above, and all related programs that can be found on
federal agency webpages, to the U.S. population. The comparison to analogous normalized statistics from Germany is embarrassing. Further tipping the imbalance, top U.S. Ph.D. graduates have excellent chances of receiving postdoctoral fellowships for study in Germany from the Humboldt Foundation (www.avh.de/), which is supported by the German government. The Japan Society for the Promotion of Science (JSPS) funds a similar program, which they let NSF administer. If there was ever an area where U.S. private philanthropy could fill a gap, this would be it!

In the above paragraphs I've tried to provide an overview of the lively academic, scientific, and cultural scene in Germany, as it relates to graduate education. Just as with any other educational/research/funding system, there are problems that need to be addressed. However, there is much to be learned in both directions. Over the last few years, I've mused about how the current U.S. political problems involving foreign policy and international relations might reflect the fact that so many elected officials are such one-track life-long overachievers that they have never lived in a foreign culture, mastered a foreign language, etc. Exactly what percentage of senators and representatives have spent even six months abroad as adults, military bases excluded? How much does the U.S. lose over the long haul if homegrown scientists have a similar level of cultural experience or awareness? How much does United States science suffer by not committing dollars to study abroad at the same level seen in most European countries?

A postcard has the sense of something that is sent home during an extended trip. They tend to be brimming with pell-mell impressions and convey a sense of discovery. After 6+ years in Germany, I continue to gain unique insights that profoundly impact the way I approach graduate (and undergraduate) education. These come from my everyday interactions with students, coworkers, and faculty colleagues, and would be virtually impossible to duplicate in the United States. Admittedly, many of the questions or problems I have framed above do not have easy answers or solutions. However, I will consider this postcard a success if I see them more frequently debated in these pages and other forums offered by the ACS.

**Faculty Recruiting Revealed**

A report of the panel session on recruitment, ACS National Meeting, Anaheim 2004

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The most important criterion for being hired at an academic institution is intellectual merit. However, competition is intense, and there are additional attributes that those seeking faculty careers should be aware of. Candidates for faculty positions are well-served by admirable pedigrees, a record of accomplishment, networking broadly, being visible, and being an effective self-advocate. These and other criteria were candidly expressed by a group of senior and junior faculty during a panel discussion on Recruiting Faculty: How is it Done? Who Gets the Job, and Why? at the 227th ACS National Meeting in Anaheim, CA in March.

This was the first event in the Academic Employment Initiative (AEI), which is a pilot program championed by ACS President Charles Casey and supported by the National Science Foundation to broaden the process by which faculty are hired.

The charge to the panelists was to “tell it like it is,” meaning that the senior faculty summarized what they expect and look for in job applicants, and junior faculty described their experiences going through the application process. Both groups offered advice to aspiring faculty based on their experiences. The panelists represented widely different institutions—from research universities to comprehensive (BS/MS) institutions and primarily undergraduate institutions (PUIs). However, they had one common expectation for new faculty (which in retrospect was not sufficiently advertised in advance) and that was demonstrable strength in teaching and research. Besides teaching ability, all stressed the importance of the ability to establish a viable, externally funded research program suitable for graduate students at Ph. D. and M. S. institutions and for undergraduates at the PUIs.

The topic was clearly of interest judging by the attendance (over 100). The panelists had more to say than time permitted, and their engagement and enthusiasm were stimulating. Responses to the session were offered in the discussion period and by way of written evaluations, letters, and informal exchanges. Some rated the session as informative and helpful and recommended that it be repeated, with more time allotted for general discussion. Others felt that the emphasis on research expectations overwhelmed teaching expectations. Some were offended by the omission of diversity as an issue in the hiring process, and some were critical of the session for its...
frank portrayal of recruitment practices that came across as possibly discouraging to those in the audience contemplating whether a faculty career was right for them.

The comments suggest, to some degree, that what the audience expected or hoped to hear from the panelists was not what they actually heard. This reinforces the suspicion that the academic recruitment process is not sufficiently transparent. The objective behind the Academic Employment Initiative is to make recruitment more transparent; open it up to more individuals, particularly underrepresented faculty, and to encourage departments to broaden their recruitment net and be more inclusive.

A fact not made by the panelists but which is well known is that it is not uncommon for recruitment efforts to fail even though the number of applicants exceeds the number of jobs available. How can this be when the market strongly favors the recruiter? This occurs when departments go after the same set of individuals, creating a microsituation where there are more openings than candidates. The narrow search criteria used by departments, usually at RI schools, tends to bring to the surface a small group of candidates for which the top departments compete. At the final stages of recruitment, the top candidates may receive multiple offers. Departments unsuccessful in securing their top choices often decide to start over another year. This is costly in time, money, and human capital. It is not that the process does not attract excellent faculty—our panelists are living proof of that. The concern is that the narrow structure of the recruitment process might overlook some otherwise excellent candidates and discourage others from applying. As the nature of this process is better understood, possibly through forums such as the AEI panel on recruitment, the more likely it is for improvements to be made.

And now—a more detailed look at key points made by the panelists 4.

SENIOR FACULTY

Frank A. Gomez,
Los Angeles State University

The typical recruitment strategy looks at pedigree, publications (the more the better), letters, innovative and creative proposals, and (hopefully) interest in teaching. However, at my institution, we are rethinking our way of doing things with the goal of having a faculty that values both research and teaching and who resemble the diversity in the general population. There is a cultural change in the way we hire and an education in the benefits of a diverse work force.

George McLendon,
Duke University

We get about 250 applications for every job advertised in C&EN. To make the first cut, the candidate’s pedigree is a significant factor. It is true that institutions are slightly prejudiced toward taking candidates from more prestigious schools. What can you do to improve your case? Postdoctoral experience is advisable. It also helps to have experience in writing grants in support of research. You will want to talk about start-up funds during your interview, but be realistic in your expectations and find out beforehand what is a normal start-up package. Mentoring experience is valuable, usually while a postdoc. Develop your teaching skills, and consider every seminar a job talk. Yet, for chemistry departments to succeed, they need to make sure their faculty reflect the demographics of their students. Half of undergraduates in chemistry are now women, as are a third of the graduate students. Underrepresented minorities are also increasingly part of the student population. Places that don’t pay attention to demographics [in their hiring practices] do so at their own peril.

Michelle Bushey,
Trinity University, San Antonio

My perspective is from a small, private, undergraduate school. We value both good teaching and good scholarship very highly. When we search for that “perfect fit”, we are looking for someone whose personal career goals are well-matched to our expectations—someone who understands this environment (it is markedly different from the larger research institutions with graduate programs); someone who is enthusiastic about science and working with undergraduates; someone whose application file shows that he or she is likely to become an excellent teacher, capable of developing a sustainable, quality undergraduate research program. To the candidate: Target your applications carefully, proofread even more carefully, get all portions of your application submittedContinued from page 7

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on time (including reference letters!), be patient, and network, network, network! Good luck.

Isiah M. Warner,
Louisiana State University

Isiah M. Warner offered advice on preparation of the application packet and emphasized the necessary academic qualifications.

JUNIOR FACULTY

Anna Kathryn Mapp,
University of Michigan

Preparing for the Job Search. Before you apply, see whether the department is a good fit for you. This means meeting some of the current faculty, evaluating the physical and intellectual environment. For instance, what is the balance between teaching and research? Are there core faculty in your area? To meet faculty, take advantage of ACS meetings by giving posters and oral presentations. Attend smaller specialty meetings (Gordon research conferences, Keystone conferences, Regional ACS meetings), and get involved in the seminar program at your institution.

Your application should clearly and convincingly describe your accomplishments, skills, and expertise, and present a coherent future research plan and teaching philosophy. The CV should be clear and concise. In preparing your research plan, first read the job advertisement carefully to meet its requirements. The focus should be in an area that reflects your expertise and in which you are most interested. Try to develop a theme, and provide a clear and concise abstract. Start this process early and get feedback before you submit. In selecting letter writers, choose those who can comment convincingly on your research and teaching capabilities. Give them at least 5–6 weeks lead time, and follow up with a friendly reminder. Provide them with your CV, your proposals, addresses and envelopes, and deadlines. Don’t overlook updating them on interviews and job offers, and send them thank you notes. For those of you with a two-body problem, there are three strategies to think about. Apply separately to all schools, or disclose the dual job search in the applications, or use a combination approach, which may involve dual applications to a single employer, or separate applications to multiple employers in one locale. Be sure to start the process as early as possible, and identify one or more mentors to get advice from about the process.

Eric Hegg,
University of Utah

The interview: There are three basic components to the interview, and each brings with it a different opportunity to “sell yourself” and highlight your different talents. They are:

1. Seminar on your current research. This is an opportunity to highlight your scientific achievements, communication skills, and enthusiasm.
2. Presentation of your proposed research will highlight your creativity, your ability to think deeply and critically, your ability to see the “big picture,” and your ability to communicate the significance of your work to others.
3. One-on-one interviews with faculty will reveal your enthusiasm for the institution and that you are broadly knowledgeable and interested in the field of chemistry, meaning that you are interested in the work that others are doing outside of your specific field.

The take-home-message: Be confident, but remember there is a fine line between confidence and arrogance. Be enthusiastic—about the potential job offer, your own research, and the research of others.

Shelli McAlpine,
San Diego State University

Important factors that helped me attain a faculty position include:
- Research experience prior to graduate school.
- Publications resulting from graduate work.
- Conference presentations.
- Strong postdoctoral experience.
- Developing a strong network.
And to get the job, there are certain qualities that really help: tenacity, communication, charisma, creativity, and writing ability.

Linda H. Doerrer,
Barnard College, New York

The Interview. Of course, your resume documents that you are smart, creative, competent in the lab, have a solid understanding of your field, and are a self-starter. But the interview is when you demonstrate skills in research and teaching that are not so obvious from the resume. In research, show that YOU HAVE A PLAN, perhaps even draft proposals, knowledge of funding sources, and equipment needed. In teaching, show that YOU HAVE A PLAN, perhaps even draft proposals, knowledge of funding sources, and equipment needed. Continued on page 10
You’ve applied for positions and been invited for an interview. Then a challenge presents itself. You are asked to give a teaching presentation—what should you do?

First, ask what topic should be the focus of your presentation. You may have a choice between acid-base equilibria or stoichiometry for general chemistry, electrophilic aromatic substitution or SN2 reactions for organic, or the first law of thermodynamics or kinetics for physical chemistry, depending on the course you would teach if you joined the faculty.

Second, ask what textbook the institution uses, then find it (or one similar to it) and use it as a resource for the particular topic.

Third, ask about the audience. Will it be faculty only, or a mixture of faculty, undergraduates, and graduate students?

Fourth, ask about the time frame—is it a 30-minute lecture, a 50-minute lecture, or a novel format? Finally, ask about the teaching strategies, styles, and philosophy(ies) of the department. What student-centered learning strategies might they expect you to use as you teach? Do other faculty use technology and how do they incorporate it in their teaching?

Now comes the hard work, structuring your presentation. Keep in mind that faculty look for attention to detail as well as the big picture. Be prepared to put your presentation in context with the entire course. For example, you can begin your “class” by saying “Here’s where we’ve been, and here’s where we are going today.” It is expected that you will use appropriate examples to display concepts or problem-solving procedures. Faculty look for pacing—can the audience understand what you are saying, can they keep up with writing notes while listening to you (much as students do)? Can your voice be heard in the back of the room? Is your board work legible, accurate, and well-organized? Using PowerPoint slides will not save you from board work. Eventually, someone will ask a question that will require you to write on the board. You can also expect audience members (faculty and students) to ask you questions even during the lecture. Essentially they want to learn how accurately and smoothly you respond to questions from the entire range of “students” in the audience. Although you are expected to know your topic thoroughly, can you say “that’s a good question, I don’t know the answer?” End your presentation on time even if you don’t cover all of the intended material.

Institutions that value teaching may expect faculty to use student-centered strategies in their teaching and hope that candidates show an awareness of modern pedagogy. Do you engage students by using active learning strategies? Do you ask them questions and wait for them to respond? Do you have the students work examples or use strategies such as think–pair–share, small group activities, or classroom assessment techniques to engage “learners?” Look at the audience—don’t lecture to the blackboard, computer, or overhead projector.

Many faculty use PowerPoint slides and resources from the Internet while teaching. You may be expected to follow that established pattern or you may wish to integrate these elements to show your ability to use technology effectively. However, if the technology fails then faculty will see how you will react in front of students in such an instance (bring overheads as a backup). Also recognize that engagement of students doesn’t happen easily with the lights down.

Finally, there is a well-established literature base surrounding the scholarship of teaching and learning just as there is for organic chemistry, physical chemistry, and so on. The Journal of Chemical Education and the Chemical Educator are excellent resources; in addition there are science education journals such as the Journal of Research in Science Teaching. Many faculty have an awareness of pedagogical techniques such as learning in groups, hands-on learning, inquiry-based labs, problem-based learning, calibrated peer review, and PLTL (peer led team learning). If a position at an institution that values teaching is your ambition, then demonstrating familiarity with student-centered learning approaches via your teaching presentation or indicating how you might incorporate these strategies in your classroom is a good place to start.
A New Resource for the Research Community

Alyson Reed,
Executive Director, National Postdoctoral Association

The time that chemists and engineers invest in postdoctoral training is a crucial element in the nation’s research enterprise. Postdocs make essential contributions to the process of discovery and the development of new ideas in the field of chemistry. But the postdoctoral experience for emerging chemists is sometimes hampered by insufficient training, a lack of resources, and the absence of standard policies governing the treatment of postdocs.

In recent years, a number of national organizations have issued reports and recommendations calling for changes in the postdoctoral experience, to place greater emphasis on mentoring, professional development, and the transition to independence. These organizations include the National Academies, the National Science Foundation, and the American Association for the Advancement of Science (AAAS). While these efforts have been driven by policy leaders, academic officials, and professional societies, the voices of postdoctoral scholars have not been fully represented until now.

With the formation of the National Postdoctoral Association (NPA) early last year, there is now a national membership association providing representation for postdocs and other individuals and institutions concerned with these issues. Organized under the auspices of the AAAS with a grant from the Alfred P. Sloan Foundation, the NPA has partnered with many national organizations and local institutions to advocate for change in postdoctoral policies that affect such issues as training, mentoring, compensation and benefits, the transition to independence, and uniform data collecting and reporting on postdocs.

At the NPA’s second annual meeting in Washington, DC, Jura Viesulas addressed participants regarding the role of the American Chemical Society in addressing postdoctoral issues. The NPA is working to establish dialogue with other professional societies representing a broad spectrum of academic and research disciplines. We understand that the needs of chemistry postdocs may differ significantly from those in the more dominant life sciences fields. We are anxious to involve more individual chemistry postdocs in the national debate on the best ways to enhance the postdoctoral experience.

The NPA’s website, meetings, and publications are a tremendous resource available to those who interact with the postdoctoral community. The association has developed resource materials on visa issues facing international postdocs, including a database of institutional policies governing the training of postdocs at campuses across the United States, and is working to develop tool kits of ways to establish and maintain effective postdoctoral associations and administrative offices to better meet the needs of postdocs and their allies. Membership in the NPA provides access to the full library of NPA resources, discounts on national meetings, and support for our national advocacy programs. We encourage you to visit our website, www.nationalpostdoc.org, or contact us directly (areed@nationalpostdoc.org) for more information about how we can help you address issues affecting chemistry postdocs at your institution. Together, we can make a difference in the training experience of chemistry postdocs to enhance the research enterprise.

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Looking to hire some bright new faculty? Aei

Then you are invited to attend the first Academic Employment Initiative (AEI) SciMix poster event during the ACS National Meeting in Philadelphia where about 130 candidates for faculty positions will present posters on their research or teaching or both!

The AEI is a new ACS presidential program to support the academic hiring process by making it easier for faculty recruiters to meet and interact informally with several candidates during the popular SciMix poster session at national meetings. To receive biographical sketches of the AEI candidates or to find out more about the AEI, please call the ACS Office of Graduate Education at 202-872-4588 or send an e-mail to aei@acs.org.
Experiments in Graduate Education in Chemistry
Carnegie Initiative on the Doctorate

Doctoral education in the United States has been the subject of scrutiny for the past decade, resulting in numerous surveys and reports that call for some degree of reform. Tactical steps toward implementing reform have been slow in coming, but a significant program with this intent is the Carnegie Initiative on the Doctorate or CID. The CID is a multi-year research program aimed at enriching and invigorating the education of doctoral students. Chemistry is one of six disciplines chosen for study. Seven chemistry departments have agreed to partner with the Carnegie Foundation and the chemistry community to begin experiments to transform their doctoral programs. An additional four departments have joined the effort as “allied” departments. After two years of preliminary work, it is opportune to see what has been accomplished and where the project is headed.

For the CID experiment to have an impact, the participating departments need to communicate broadly with each other and with the chemistry community at large. The CID enables the departments to convene periodically to discuss their progress. Also, the CID website is the parent source of information and contains a collection of “must-read” essays commissioned by the Carnegie Foundation on the conceptual foundation and status of doctoral education in each of the six disciplines. But broad publicity about the reform activities of the individual chemistry departments remains limited. This may change as the ACS provides more opportunities for departments to present their findings, particularly at ACS national meetings. The first of several such programs will take place at the 228th ACS National Meeting in Philadelphia as part of the Presidential Symposium on Graduate Education sponsored by ACS President Charles Casey. One session of this symposium is devoted entirely to the Carnegie Initiative on the Doctorate and will cover experiments undertaken by the CID departments on various themes, including the graduate curriculum, professional development, “climate” issues, and assessment issues. This type of discussion with chemistry departments will hopefully be featured regularly at national meetings, or until there is no further need to communicate doctoral reform efforts. We are pleased to be able to present in this newsletter highlights of ongoing experiments in doctoral reform by some of the participating departments. While the descriptions are brief, it is clear that a lot of careful study is involved, and some changes have already been implemented. Thus far, the changes seem to be “on the margin” or “functional enhancements” indicating confidence that their doctoral programs are basically sound. We hope to include more about these evolving reforms in future issues.

Seven chemistry departments have agreed to partner with the Carnegie Foundation and the chemistry community to begin experiments to transform their doctoral programs.

Department of Chemistry and Biochemistry
University of Texas at Austin
CID Leader: Jennifer S. Brodbelt

After more than a year of deliberations and an extensive survey of the graduate students, several aspects of the graduate program in chemistry and biochemistry at the University of Texas at Austin are undergoing evolution. Two general concepts used to assess various facets of the graduate program were “the value of uniformity” and “hurdle versus instructional.” Key issues of the graduate degree, such as coursework requirements and the candidacy exam system, were dissected with respect to the value of uniformity across divisions or disciplines. The concept of “hurdle versus instructive” was aimed at critically evaluating the graduate program in terms of whether the coursework, candidacy exams, student seminar program, requirement for teaching service, etc., were structured in such a way as to be viewed as a hurdle or as an instructive component of graduate education. Following the comprehensive survey of the graduate students, additional direct feedback is obtained via weekly deliberations by a graduate student committee so that the faculty perspectives can be compared to those of the students.

Department of Chemistry
Virginia Polytechnic Institute and State University
CID Leader: James M. Tando

Throughout our deliberations, we held close to the philosophy that the Ph.D. degree is a research degree, and students must be trained to formulate a hypothesis and devise experiments or theories to address the research problem. In addition to technical competence, they must be able to present and defend (orally and in writing) their ideas and work. Accordingly, degree requirements that achieve these educational goals were retained or developed; those which did not were eliminated. Consistent with this philosophy, the major changes in our Ph.D. program in chemistry are noted below:

- Formal course requirements were dramatically reduced (from 30 credit hours to 12).
- Cumes/prelims were replaced by a requirement that students prepare a detailed literature review (pertaining to their thesis research), which is evaluated by the Ph.D. advisory committee as a prerequisite to the preliminary oral examination.
- In the third year, students prepare (and defend orally) an original research proposal. An important point is that the student’s Ph.D. committee is indeed advisory and provides guidance and feedback rather than simply evaluating performance.

Department of Chemistry
Duke University
CID Leader: Michael Pirrung

Activities so far have mostly involved studying what we are doing in our program and how our students learn in our system. One important component is the status of women in the department. We have three female professors current-
ly (of 20 total tenure-line faculty), and our graduate student population is ~40% women. We explored what has made Duke a fairly hospitable chemistry department for women and the consequences this has for our scientific culture and our graduates’ future careers. In another study, we attempted to correlate subjective evaluations of recent graduates with admission criteria, particularly objective criteria like GPA and GRE. We found very poor correlations, which suggests that other aspects of graduate applications, such as letters of recommendation and research experience, may be more important. We have also done some brainstorming about how we could enhance graduate student experiences. One change we made was to establish our Phi Lambda Upsilon chapter as a representative graduate student body by funding memberships for all graduate students. This was an issue because international students had not been participating in PLU because of the cost of dues. We also made curricular changes in our first-year progress report, qualifying and propositional exams, and our seminar requirement (which can now be met through any formal oral presentation). A new event just conducted was a Career Day that brought several doctoral alumni back to the department. One alumnus was asked to present a special honorary scientific lecture, and all shared their work experiences in the area of start-up companies. Our plan is to rotate the sub-field that forms the theme for the Career Day each year so that students are exposed to the full range of chemistry careers. This plan also avoids repetition that would make the day a rote exercise.

**Department of Chemistry**
The Ohio State University
**CID Leader:** Claudia Turro

To date, the CID team at The Ohio State University, composed of five faculty and five graduate students, has focused on collecting data on our program through surveys of our current graduate students, alumni, and faculty. The results of the surveys are currently being interpreted by focus groups composed of an equal number of faculty and graduate students. In addition, issues concerning various facets of our Ph.D. program will be discussed at a faculty retreat this summer, including the purpose of each requirement, current curriculum, and possible changes. A program that we have already started aims at the formal training of our graduate students on issues pertaining to future careers, both in industry and academia. We have begun informal discussions between our graduate students and alumni employed in various sectors, as well as with OSU chemistry faculty. The Career Experiences series will in the future be complemented by formal courses with specific training goals.

**Department of Chemistry**
SUNY Stony Brook
**CID Leader:** Kathlyn Parker

At Stony Brook, all aspects of the graduate experience are under examination: curriculum, degree requirements, career preparation, mentoring mechanisms, and department environment. The first stage of the project has been the establishment of meaningful communication between the graduate students and the faculty. We have learned that getting the graduate students involved is essential. Some of the things bothersome to students were trivial to fix, but others were not at all obvious. The process continues but we have already made notable improvements in our program just by asking for information.

1. See www.carnegiefoundation.org/cid.
2. See also a description of CID in the Graduate Education Newsletter Vol 1, no. 1, 2002 at http://ACSGradEdNewsletter.org.
5. The chemistry essayists are: Ronald Breslow (Columbia), Alvin Kwiram (U. of Washington), and Angelica Stacey (U.C. Berkeley).
6. See Alvin Kwiram’s article in this Newsletter and his CID essay in reference (1).
Win a FREE Subscription to DGRweb 2003!

The Committee on Professional Training has published the ACS Directory of Graduate Research biennially since 1953 as part of its mission to promote and enhance the education of chemists. The primary motivation for producing the Directory is to provide students considering graduate study in chemistry (and closely related areas) with a convenient and authoritative source of information about the graduate programs they might consider. For many years the Directory has also served graduate students, postdoctorals, faculty, and practicing chemists as a convenient source of information about academic research programs and departments. The Directory contains a listing of programs with contact information, the degrees offered, and information about each faculty member. These individual faculty listings give birth year, academic history, research interests, publications in refereed journals, and the dissertations directed by the faculty member during the previous two years. The Directory turned 50 in 2003, and as with all venerable endeavors, it is time to consider its future.

The Internet has become the first choice for chemists who want to obtain information rapidly. Virtually every department has a Website describing its offerings, and most provide a convenient path to the research interests of individual faculty. In addition, powerful literature searching tools such as SciFinder Scholar, PubMed, and the Web of Science give rapid access to the most current listings of publications. Although some of these products come with a fee and are not freely available, they are part of life for more and more students, even those at primarily undergraduate institutions. These developments raise fundamental questions about the future of the Directory. It is a useful tool for obtaining a summary of the scholarship in a Department and, because of its format, one can conveniently make direct comparisons among programs. The Directory is also one of the few places that lists the doctoral dissertations from a particular laboratory along with other statistical information about the faculty member. At the same time, the publication lists in the Directory are at least a year old at the time each volume is published because of the time required to assemble, verify, and produce the material.

CPT needs your help in shaping the Directory for the future. Please take a few moments to complete our short online survey at http://fs12.formsite.com/acs_cpt/dgr_gs/index.html. Five lucky graduate student survey participants will be selected to receive a free subscription to DGRweb 2003!
Responses to Changing Needs in Doctoral Education
Cosponsored with CHED, HIST, PROF, CMA, COMSCI, CPT, SOCED, WCC, and YCC

Monday, August 23, 2004
Doctoral Education—How Did We Get Here? Where Are We Going?
M. C. Caserio and M. A. Cavanaugh, Organizers, Presiding

9:00 am  Introductory Remarks. M. A. Cavanaugh.
9:05 am  Desired outcomes from graduate education in chemistry. C. P. Casey.
10:00 am Knowledge, structures and transformations: The shaping of graduate education. R. L. Geiger.
noon  Panel Discussion.

Driving Forces in Doctoral Education: People, Discovery, Economics, Funding, Assessment.
J. I. Seeman and R. Lichter, Organizers, Presiding

2:00 pm  Introductory Remarks.
2:20 pm  National and institutional perspectives on graduate study: Continuity and change. C. Mitchell-Kerman.
3:00 pm  Training grants as agents of change. M. E. Rogers.
3:30 pm  Graduate student survival in the entrepreneurial university. R. K. Koehn.
4:10 pm  The NRC assessment of doctoral programs: A knowledge base for improvement. C. Kuh.
4:50 pm  Panel Discussion.

Tuesday, August 24, 2004
Experiments in Transforming Graduate Education—The Carnegie Initiative on the Doctorate
B. P. Coppola and R. Lichter, Organizers, Presiding

10:30 am  Intermission.
12 Noon  Panel Discussion.

Creating Complete Scientists: Graduate Student Visions of Doctoral Reform
K. M. Metz and A. Mangham, Organizers
M. F. Phillips, Presiding

1:30 pm  Introductory Remarks.
1:35 pm  Importance of communication and leadership skills to graduating doctoral students. S. D. Hanton.
2:00 pm  Chemistry graduate education from the students’ perspective: Data from the Survey of Doctoral Education and Career Preparation. T. M. Dore, C. M. Golde.
2:25 pm  Graduate study in chemistry at Cornell University: Do reduced requirements affect graduate quality? C. A. Bradley.
2:50 pm  Organic basic training: Concurrent undergraduate and graduate education. M. D. Bowman, G. H. Hanson.
3:15 pm  Intermission.
3:30 pm  International students and U.S. graduate school. E. Kieken.
3:50 pm  Facilitating a culture of mentoring among graduate students. D. L. Casher, M. G. Trainer.
4:35 pm  Examining student–advisor relationships. C. J. Ciolli.