What You Need for the First Job, Besides the Ph.D. in Chemistry
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Foreword

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Before agreeing to publish a book, the proposed table of contents is reviewed for appropriate and comprehensive coverage and for interest to the audience. Some papers may be excluded to better focus the book; others may be added to provide comprehensiveness. When appropriate, overview or introductory chapters are added. Drafts of chapters are peer-reviewed prior to final acceptance or rejection, and manuscripts are prepared in camera-ready format.

As a rule, only original research papers and original review papers are included in the volumes. Verbatim reproductions of previous published papers are not accepted.

ACS Books Department
Editor’s Biography

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Mark Benvenuto is a Professor of Chemistry at the University of Detroit Mercy, in the Department of Chemistry & Biochemistry. His research thrusts span a wide array of subjects, but include the use of energy dispersive X-ray fluorescence spectroscopy to determine trace elemental compositions of aquatic and land-based plant matter, food and dietary supplements, and medieval and ancient artifacts.

Benvenuto received a B.S. in chemistry from the Virginia Military Institute, and after several years in the Army, a Ph.D. in inorganic chemistry from the University of Virginia. After a post-doctoral fellowship at The Pennsylvania State University, he joined the faculty at the University of Detroit Mercy in 1993.
Preface

“I never let my schooling interfere with my education.”

- Mark Twain

It is fair to say that most chemists and chemical engineers who earn a Ph.D. in their field take their schooling much more seriously than Mark Twain, aka Mr. Samuel Clemens, apparently did. However, his aphorism does make the poignant observation that schooling and education is not always the same thing. This volume is an attempt to educate, to provide a source of information, knowledge, and wisdom to the person who has spent so long, and worked so hard, on his or her schooling.

The Council for Chemical Research and the American Chemical Society have both spent considerable effort over the past decades focusing on how to ensure that graduate education in the chemical sciences remains at the absolute highest caliber, and produces the best possible professionals. The ACS is justifiably proud of its publications on education, including the downloadable document, “Graduate School Reality Check,” and the recent presidential commission report, “Advancing Graduate Education in the Chemical Sciences.” Additionally, it has spearheaded active graduate education efforts within the Division of Chemical Education and elsewhere for decades. The Council for Chemical Research has maintained an active Graduate Education Action Network for nearly thirty years. Yet in that time, neither organization has specifically asked what a person needs to be successful once they have both the Ph.D. and the first job in hand.

Put succinctly, there is much more to being successful in a career in chemistry than just the hard-earned Ph.D. degree.

This volume is based on the symposium “What You Need for the First Job, Besides the Ph.D. in Chemistry,” held at the 246th National Meeting of the American Chemical Society, which took place in Indianapolis, Indiana in September, 2013. But the book and symposium are also the result of several
chapters authored by leading scientists who were not able to attend and present at the symposium, but who were kind enough to contribute chapters based on their years and/or decades of experience in corporations, government labs, and academia. This book is the result of seeds that were planted during numerous informal conversations at the annual meetings of the CCR, as well as during such discussions at national and regional meetings of the ACS, and at the ACS employment clearing houses. It was felt that the same intense focus a person needs to earn a Ph.D. might actually work against the attention to other details needed in order to be successful once he or she has obtained a position.

Leaders want to ensure that new hires are working effectively toward tenure, are quickly becoming productive members of their corporate team, or are well integrated into their government laboratory research group. While it is easy to lump factors other than technical competence in one’s job under the term “soft skills,” this is an oversimplification. This book represents an attempt to have voices from all three pillars of the chemical enterprise — academia, industry, and government laboratories — heard in terms of telling us what is important for their newly hired Ph.D.-holders. Drs. Truitt, Selcuk, Ranbom, and Plaumann do this from perspectives within the corporate world, while Drs. Sullivan, Snyder, and Bohn do so from points of view in government laboratories. Successful academic leadership is discussed by Prof. Donohue and Kilburg, while several other viewpoints from within the academic sphere are provided by Profs. Bodner, Mio, Otto, Marinecan, Kolopajlo, Howell, and Ray. Thank you to all of the authors, as well as to the numerous reviewers who have checked these chapters. A special “thank you” goes to Ms. Megan Klein of Ash Stevens, who willingly took on the task of performing numerous chapter reviews, and who made several valuable suggestions.

Perhaps obviously, no such book can present perfectly all the additional factors and requirements that enter into every possible equation which equals success in a chemical career. We hope though that we have made a very good attempt at it. We also hope that even though this book is not quite as witty and succinct as Mark Twain’s one-line comment made over a century ago, it will be a valuable resource for as many years.

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A chemist’s first industrial job after leaving school or a post-doctoral appointment involves a transition to a work environment oriented around commercial imperatives along with the scientific or engineering principles from the recently ended educational experience. Four attributes of industrial chemist job success are described. They are business awareness, team skills, time management, and communication skills.

All chemistry students leaving graduate school or academic post-doctoral appointments expect new experiences in their first job as an industrial scientist. You are entering a new environment and an interesting learning experience. Not so apparent is that you will go through a transition period involving changes that are sometimes stressful, especially if they are not expected. At the start of the author’s own first job experience, it was quickly apparent that my technical education and personal development would be continuing with some intensity, not downshifting after graduate school. Showing up with technical expertise and a sincere welcome from my new boss and colleagues was the beginning of another education, and I had a lot to learn quickly.

Having coached or supervised many people in their first industrial scientist jobs, a few general comments are possible about culture, skills, and behaviors that really matter. With this essay, I offer insight and advice that I believe will minimize the length and stresses of that transition. To help those still choosing their work-life direction, I provide some perspective on how an industrial chemist career often begins.
Before the advice, here is context for the recommendations to come. First and foremost, keep in mind the mission: You were hired to assist a commercial enterprise. Even if your job is a technical function in early stage research, you are ultimately expected to contribute to business success. Though that may seem obvious, I find this perspective is not given enough emphasis, is sometimes a surprise, or is ignored. So, as well as social and organizational orientation in your new job, pay attention to the company’s business and your role in it. You will find company commercial needs have an overarching influence on your job. Business imperatives influence technology directions, organizational culture, and career paths.

With that context, I selected four success factors that should assist with the transition period from student to effective industrial scientist. These factors are found in diverse business environments and have paid the greatest benefit when addressed, in my experience. Out of many possible topics, the four are business awareness, team skills, time management, and communication skills. Obviously there are other important issues, including some that will have great relevance to your particular situation beyond the four I selected. To capture topics crucial to your new job, I suggest that you ask about job success factors as you begin working with your supervisor and new colleagues. You can properly emphasize the four I chose after those conversations.

**Business Awareness**

We start here because I find it is the perspective most commonly overlooked by new employees. Start early knowing the value of what you do and who cares. With every new assignment, you should know how you fit into the big picture. Clarity about your work’s value leads to good decisions about where to put your efforts and making appropriate commitments (time management is discussed later), but also where to contribute beyond basic obligations. Learn the priorities and imperatives. Understand what is important to your employer’s business, and what is urgent. Understand what makes your department, your division, and your boss achieve their objectives. Ensure your efforts are related to goals that matter and are in proportion to their priority.

Joining any new organization will require technical acclimation and socialization time, but as early as possible, identify and begin to participate in high priority programs, projects, and goals. Performance appraisals and salary increases are affected by the impact of your work. In the long view, career progress, which usually results from increased responsibility, is a function of your cumulative accomplishments and their business/division impact. Access to job opportunities and greater independence to define your role can also come from a record of consistently helping where it matters most.

It should be no surprise that all initiatives are not equally urgent and that priorities shift. However, putting emphasis or too much time on lower priority goals is a common performance problem with new employees, arising from being misinformed about priorities, not willing to say no to requests from influential project leaders or colleagues, or from just ignoring a company imperative he or
she finds uninteresting. Exploratory work and pursuing personal ideas beyond objectives are important, but they must be done in addition to, not instead of, addressing critical business needs. Deciding how to accommodate what is urgent without ignoring what is important is a constant tension in a business environment. I will return to this topic in the time management discussion.

Learn key values. Every company culture has preferred behaviors and operating values. There are usually some that matter very much. Actively developing them and ensuring they are followed is everyone’s responsibility. An outstanding example is safety. Safety is a universal value in the chemical industry, where accidents can cause permanent injury or fatalities and sometimes have significant financial consequences. Typically, there is little tolerance for carelessness and none for negligence in following safety rules. Examples of other values cited on company websites include quality (meaning meeting customer expectations), people development, market leadership, innovation, and being entrepreneurial.

How you work is as important as what you do. Cultures vary considerably, but there are always core rules, especially the boldfaced or bright red boundary lines in company values.

Teamwork

In a company, which is literally a group of people, getting significant things accomplished depends on effectively interacting with others. Teams and good teamwork matter in industry. They are more likely to be engines of project success than individual efforts, and there are myriad examples of how poor team effectiveness is deadly to projects. I recommend that you actively seek collaborations and assist wherever you can throughout your career.

Collaboration is a key success factor because valuable problems tend to be complex and available resources are usually scarce, especially time. Your significant progress in complex assignments or new environments benefits immensely if you have partners with complementary expertise, experience, or knowledge, who share your goals. Intensive collaboration is a disconcerting new activity for some new-to-industry scientists who may have had a solitary or competitive existence prior to the first industrial job, but there is no way around working with others in industry. At a minimum, everyone has a boss, customers, and support providers.

Of course there are individuals who start businesses essentially by themselves, develop new products, or make technical breakthroughs. But by far, especially for moderate to highly complex or innovative projects, teams are responsible for results that matter. Even in smaller companies where individuals carry many roles and proportionally carry more of the responsibility for results, it is often pairs and trios of collaborators that pull everything together. Hard problems, when solutions need to be exactly right, multicomponent projects needing breadth of expertise, or just a critical level of effort for speed, are where teams become progress multipliers.
Another reason you need to become collaborative in industry: job functions are distributed. Except in the smallest industrial lab, you will be handing off parts of your projects or be handed someone else’s, depending on your role and expertise. There is either not enough time to sequentially accomplish tasks or some deep expertise may be needed to get all parts of the program done. A typical industrial project requires specialists to do their unique part and project managers to coordinate all the concurrent efforts toward a goal.

Function specialization extends into the whole enterprise. Companies of a certain size and larger are organized in separate commercial support and development components. Typically these are research, development, production, and sales/marketing. There are also separate infrastructure components that enable those functions, like purchasing, technical services, and human resources specialists. Each has special processes and knowledge, and all these efforts must cooperatively contribute to sales and profitability. A new employee’s transition into this specialization paradigm requires understanding how your role contributes eventually to commerce, and how you fit into the organization of people and processes that must all work together. It also presumes you work effectively with others to get things done. Looking in the reverse direction, poor collaborators are poison to project health. It is a tough career path for those who are notorious for interacting poorly with people, no matter whatever else they bring to the job.

As a new scientist in this kind of environment, quickly embrace collegiality with high levels of information and idea sharing, and sharing credit for success. Effective teamwork is based on trust among the members. A reputation for hiding results, ignoring assigned partners, or not valuing other project members for their contributions is a substantial career impediment.

Time Management

You may join a company that plunges you into the swirl of business priority chaos on your first day. On the positive side, if that happens, you can learn a lot quickly and make life-long friends among your coworkers by coping together. The most common experience, however, is a more gradual integration that ends when the assignments get complicated and having enough time becomes a daily dilemma. When the job responsibilities mount, orientation efforts get much less attention.

Time spent getting oriented and acquiring knowledgeable is a great investment, and the forbearance given to new employees is not likely to return. As much as you can, use the first days and weeks to learn about people and rules, and have them meet you. Don’t abandon this important but unfortunately unsustainable opportunity to meet people, learn the new jargon (and acronyms!), learn the critical technologies, and begin assignments designed to integrate you into the community. Spend as much time as you can reading and learning from experts and veterans. Even though it is a period with a flood of HR new-employee courses, safety training, and one-on-one introductory meetings with your new stakeholders, your management and your key coworkers, don’t stop this learning phase too quickly.
Time management becomes crucial in the next phase of your job when projects and tasks dominate your day. I find that as soon as new employees are perceived as valued technical partners, their orientation period shifts rapidly to being busy with commitments that can be overwhelming in number, size, or speed. Time becomes scarce: time to think, time to meet commitments, time to learn. It is easy to get time taken away. Customers usually do not wait, and coworkers will transfer tasks or responsibilities to you if you accept them.

Actually, being in demand for the right reasons is what you want to happen. You are valued. The problem becomes managing commitments safely and correctly while reserving time for personal growth and learning. Please note: coping by ignoring or missing obligations is not a good way to start your career in a new job. You need to rigorously meet commitments, so do not make them when you cannot deliver results.

There are a great many time management tools, options, and ideas if you do not already use any. While you should find the set that suits your needs and personality, here are a few suggestions for everyone.

- Keep Action Item or To Do lists to track commitments and due dates.
- Keep an appointment calendar that only you or your assistant can change.
- Reserve times of the day for email or catching up on writing. Don’t fall behind.

I recommend a written set of personal objectives you and your supervisor agree are important to accomplish each year, to keep the big-picture goals in sight, and define which are of the highest importance. Best of all, be careful not to overcommit in the first place, and let your customer or colleague know immediately when any commitment will not be met as circumstances change. Learn to diplomatically say “no” or its equivalent, “I can’t right now,” when requests for your contributions are really not possible or are not appropriate uses of time.

Meetings are a common time-sink. Obviously, don’t commit to meetings that have questionable value. For all the rest, I recommend scheduling regular meetings for critical projects but cancel or truncate those where you find there are not enough compelling reasons to meet. On the other hand, do not go too far in the direction of avoiding meetings.

Finally, being busy is not a virtue and it is certainly not an accomplishment. Some people see working hard and long as a measure of their work’s value. We appreciate those who put in enormous effort and extra effort is necessary for achieving results in some cases, but in fact you will be rewarded more for delivering results than the effort. Better to deliver on a few substantial assignments than not having much to show for 60-hour weeks and lots of meetings. As a supervisor, I am not convinced that long weeks and impossible workloads ensure folks are contributing as needed. I respond best to results, especially those derived from proper priorities and from distilling assignments to critical tasks that target goals. Find ways to meet or exceed your objectives without wearing out.
Effective Communication

Despite a lot written about communication in the workplace, this skill remains underdeveloped in new industrial staff and I find it is underappreciated among new employees. I also find “better communication” implies more is needed, when effective and trusted communicating is the real need. Being effective is getting and receiving information correctly to and from the appropriate people, when it is needed and at the right level of detail. When more communication is actually needed, use multiple media or communicate more often as opposed to adding complexity or length. Simple and concise is always better.

Communicating effectively saves time, avoids misunderstandings, and ensures your contributions are used and valued. Doing it well matters because job-essential functions like receiving assignments and information, collaboration with coworkers, and relaying results are all done by speaking or writing. An important subset of communicating is the use of email, texting, and voice messages, since they are the most used communication tools in business. They are speedy and direct communication but they are prone to imprecise, incomplete or unintended messages.

Being an effective communicator means being read (or heard) and understood. These happen when you are concise and clear. Develop a habit of editing or reviewing what you write for clarity and brevity before it is sent. A great deal has been published on this topic and many training courses are available to assist. Here are some useful pointers from journalists:

- Shorter is more likely to be read than longer.
- Simple is more likely to be understood than complex.
- Make your key point or request at the very beginning. Background, data, commentary, etc. should follow for anyone interested in details.
- Use an editor whenever you can. Fresh eyes are much more likely to spot mistakes and weaknesses. At least review what you wrote before sending it.

I recommend a technical writing course if you have not had this training, emphasizing clear and concise messaging through editing. Skills for effective presentations, reports, and email are very valuable, and your coworkers will be grateful for concise, to-the-point messages.

Your industrial career is starting. You are learning the science and technology of your employer. You are also going to learn more about yourself, what motivates you, and how organizations really work. You will learn when your preferred work style is appropriate or inappropriate for the tasks at hand. You are going to meet people who will teach you a great deal, and some who will be dependent on you. The next phase in your education is just starting. I wish you much success and satisfaction in your new job!
What Do You Need To Know To Work in Industry Besides a Ph.D.?

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Graduate students preparing for positions in industrial research focus on the scientific knowledge gained from research and course work. While this is critical to success in industrial research, other skills and expertise are also important. These topics may not be stressed in graduate school, and the approach is not always aligned with the approach taken in industrial research organizations. A new researcher can be more effective in his position by having an understanding of these issues and skills. These topics include working safely; the fundamental principle within industry is that laboratory work will be done safely. Research is becoming more collaborative, and the ability to communicate and to network internally and externally is extremely important to industrial research organizations. Researchers should have an understanding of intellectual property. They should have a general understanding of the principles of toxicology and toxicity testing and an appreciation for product safety and regulatory affairs issues that arise in the course of research. Finally, researchers must recognize that R&D is one part of a business. Researchers must appreciate that the objective is to develop technology that will bring value to the company, and they should understand how company leadership makes decisions related to investments in R&D.
Introduction

Welcome to the world of industrial research. You are completing an advanced degree in science or engineering, and you are preparing to enter the field of industrial research in the chemical sciences. You can expect to find this to be scientifically challenging and personally rewarding.

Industrial organizations invest in innovation and in research and development with an expectation of a future return. Ultimately, the return is a profit that is derived from the sale of a new or improved product or technology, or the savings obtained from a new or improved manufacturing process. Incremental, short term improvements in a product or process will provide a modest return, while much larger returns can come from longer term research that leads to breakthrough innovation.

Successful innovation starts with a specific need or problem to solve. The need or problem must be connected to some one who will pay for a solution. If no one will pay, there is no return and no reason to do the research. Usually, this need is described in very general terms. It can be for a material that has some new or improved properties, a drug with increased effectiveness toward a specific disease, or a new process that produces less waste and is more energy efficient. The first step for the researcher is to convert this need into a scientific challenge. Researchers then seek to find new and better solutions to the problem, and the solutions will deliver value to the company. Ideally, this solution will be based on an invention that will lead to one or more patents. Patents are one of the best ways that researchers can provide differentiation from the competition and a sustained competitive advantage.

Companies do not just invest in new product development; research portfolios will also have exploratory research projects. While new product development is expected to deliver a financial return, the return from exploratory research is increased knowledge in a specific area. Ultimately, this knowledge serves as the foundation for future new product development efforts. This mix of development and exploratory research creates a virtuous cycle in which profits derived from new product development are invested into exploratory research which then leads to future new product development.

Industrial research can be both rewarding and positively affect our future. One of the current trends in industrial research is to direct research toward solutions to major societal challenges such as energy, water, health and food supply. Industrial researchers are increasingly bringing life cycle considerations into their work. This requires them to complete an assessment of the full range of environmental impacts of a new product or process. Working in these areas will provide industrial researchers with the opportunity to have a real influence on quality of life issues and the challenges facing a big part of the world’s population.
Safety

Every research organization has an obligation and duty to provide its employees the safest environment possible. This is a fundamental principle in the operation of chemical research laboratories in industry and at government laboratories. Research can involve the use of highly reactive or toxic chemicals, high energy sources, extremes of temperature, and high pressures. The potential for accidents and exposures is always present, and the consequences can range from relatively minor (a first aid case) to severe (a loss of life). The fundamental principle in industry is that laboratory work must be done safely; if it cannot be done safely, it will not be done.

An important element in the safety efforts in industrial laboratories is the creation of a “Safety Culture.” These are common beliefs that are embraced by everyone associated with the lab. The Safety Culture leads to an environment in which researchers are engaged and commit to working safely and to watching out for their colleagues. The Safety Culture also demands a commitment from R&D leadership to provide a safe environment, ensure that researchers are properly trained and equipped, and that everyone puts safety first.

It is important for researchers to be active and engaged in the safety effort in all of their work. This is a major component of the annual performance review. Researchers are held accountable for their own safety and for the safety of those they supervise. Everyone is expected to be watching out for the safety of others. The ability to recognize and anticipate potential hazards is a skill that industrial researchers must master. In addition, researchers must always be focused on identifying ways to reduce these hazards.

Industrial chemical research laboratories make every effort to reduce the hazards of laboratory work to acceptable levels. Hazard controls are used to lessen workplace hazards that pose a threat to the safety of researchers. The “hierarchy of control” provides a framework for the types of hazard controls and the risk reduction that is expected. At the top of the hierarchy are elimination and substitution: either remove the hazard entirely or replace it with a safer alternative. The next levels, used when elimination and substitution cannot be applied, are engineering controls and administrative controls. This leads to the design of a safer environment (using things like fume hoods and pressure cells) and to the establishment of rules and policies. Personal Protective Equipment (PPE) ranks last on the hierarchy of controls and is used to reduce researcher exposure to hazards when engineering and administrative controls are not feasible or effective.

Personal Protective Equipment is equipment designed to protect the researcher’s body from injury. PPE includes safety glasses, gloves, lab coats and shoes. Industrial chemical laboratories require that appropriate PPE be worn at all times in the laboratory. PPE is selected based on the hazards expected in specific laboratory operations. Safety glasses are a minimum requirement for entry into a lab, but specific tasks may require more substantial protection that would be provided by goggles or a full face shield. Researchers wear a variety of gloves in the lab. There are different gloves to protect against exposure to different chemicals, and there are specific gloves to protect against exposure to
high and low temperatures and against potential cuts and bruises from working with glassware or with tools. All researchers wear a lab coat that is appropriate for the specific hazards.

Industrial laboratories emphasize good housekeeping. This is considered to be a prerequisite for safe lab operations. It is difficult to work safely and efficiently in a lab that is cramped, cluttered, and dirty, and where it is difficult to find equipment or glassware. Industrial researchers are expected to maintain clean bench tops and hoods, to organize storage areas (drawers and shelves), to dispose of unnecessary equipment and chemicals and to maintain this on a daily basis.

An important element of any Safety Culture is that all researchers are properly trained to do the specific experimental work they are assigned. Achieving this has led to the development of written procedures that serve as the basis for training. Simple, everyday lab work can be described as common practice or prudent laboratory practice. More significant and potentially hazardous lab work uses Safe Operating Procedures (SOPs) to describe how the work is to be performed. The SOP provides detailed instructions for safely performing the task; the operational boundaries including items such as scale, temperature and pressure; emergency shut-down procedures; and PPE requirements. An SOP is reviewed by other scientists to ensure that it is correct and complete. The collection of common or prudent laboratory practices and SOPs defines how normal laboratory work is to be conducted.

Experience has shown that many safety incidents occur when researchers go beyond the scope of these written instructions. To deal with this, industrial laboratories have adopted the Management of Change process. When starting laboratory work, researchers ask themselves if what they are about to do is specifically covered under existing procedures. This can include the nature of the chemicals being used, the scale or reaction conditions, and the laboratory equipment. If the answer is that it is something new, the normal procedure is to stop and complete a detailed hazard review for the proposed experimental work.

These procedures are not intended to stifle creativity. They are intended to slow down the rush to run poorly conceived or ill considered experiments that may jeopardize the safety of researchers. Remember that the fundamental principle is that if work cannot be done safely then it will not be done.

Industrial laboratories operate under very stringent standards for disposal of laboratory wastes. This includes chemicals that are no longer needed. All of these materials to be disposed of must be properly labeled and packaged for disposal through an outside vendor. Nothing is ever poured down the drains.

**Communication and Presentation Skills**

Excellent communication skills are valued highly in industry. Industrial researchers must be able to skillfully articulate key information, both verbally and in writing. They must be able to present their ideas clearly and concisely. The ability to share ideas and information on projects, science and technology with colleagues is at the heart of the collaborative process. Communication skills also include the ability to listen carefully and to understand various viewpoints.
Strong communication skills can mean the difference between an outstanding industrial career and a good industrial career.

Writing and presentations are equally important to an industrial researcher. Written reports provide regular updates of progress on projects and document advances in technology. They also serve as the basis for drafting patent applications. Internal presentations provide many of the same benefits, but they also provide opportunities for researchers to demonstrate their abilities. A good presentation provides a researcher with the opportunity to demonstrate mastery of a topic and the ability to think on her feet. She can show the ability to organize information, to be concise and focused and to understand and answer questions.

Graduate students likely have experience in writing update reports, papers for peer review and grant applications. They have made presentations within a research group or department, and perhaps at scientific conferences. In these instances, the students are writing for or presenting to an audience that can easily understand the topic. In the industrial world, researchers will present to a much less homogeneous group. Researchers will often be asked to explain technology to people who do not have a comparable technical background. They may be business colleagues, executives who make decisions on the future direction of the company, patent attorneys, manufacturing staff and/or customers. Researchers should be able to present information in a way that anyone can understand, regardless of their educational background.

Another important communication skill is the ability to deliver an “elevator speech.” Imagine a researcher on a two minute elevator ride with the company president. The challenge is to explain clearly and concisely what she is working on and why it is important to the company. Similarly, a researcher may be asked to make a brief presentation to a venture capitalist seeking his support for a great idea.

Networking and Collaboration

Innovation often occurs at the intersection of diverse fields, industries, disciplines and cultures. As a result, research everywhere is becoming more collaborative. Researchers who will be successful in collaborations will have strong networking skills and the ability to successfully manage relationships internally and with customers and partners. Opportunities to collaborate start with internal research projects which almost always involve multi-functional teams. Successful industrial researchers must be able to work with a variety of people and disciplines. New researchers will join a project that can include experts in synthesis, applications, characterization and analytical chemistry, and process research. Other functions also contribute to projects; these include engineers from process technology, patent attorneys and safety and environmental experts. New researchers should seek to participate in internal networks and to create their own networks. Developing an informal, internal network consisting of both peer scientists and experienced, scientific experts can lead to success in many areas. Who you know can be as useful as what you know in solving technical problems,
so researchers should find the experts in their company, get to know them, and utilize their skills.

Collaboration and networking within a company’s global organization is also important. The chemistry related industries are global in scope, and this has extended to the research efforts. As companies globalize their research efforts, projects utilizing global research teams for global opportunities are becoming common place. It is unrealistic to believe that the smart people only work in laboratories in the U.S. Researchers must be able to function as part of a global scientific community. They must be able to network with the company’s scientists around the world, and be able to communicate with many different cultures. This is essential to achieving innovation breakthroughs.

Working with customers is another aspect of collaboration and networking. Really successful innovation requires a deep understanding of customers’ needs and problems, and the best source of this understanding is to work directly with the technical staff at a customer. Researchers often work with customers to introduce new technology. A Joint Development Agreement (JDA) with a customer is an excellent way to collaborate with a customer already committed to using the new technology that they are helping to develop. Leading companies are increasingly using JDAs to increase their probability of success in innovation.

The need for innovation has led many companies to embrace the concepts of “Open Innovation.” Companies are seeking external ideas and capabilities to complement the ideas and capabilities within their own laboratories. Companies seek ideas through partnerships with customers, suppliers, universities, government laboratories, and start-ups. Networking and collaboration skills become really important when looking for innovation outside the company.

**Toxicity and Regulatory Affairs**

Research in the chemical sciences supports some of the most regulated industries in the world. The concerns over the safety of products from these industries continue to grow, and have become global concerns. These product safety questions can have a major impact on the success of a product in the marketplace. A fundamental objective for industrial research is to create something new: a new pharmaceutical, a new chemical, a new polymer, and these new materials must be evaluated for their safety. The testing to ensure compliance with safety and toxicity regulations can be expensive and is increasingly global in scope. Ultimately, the regulatory requirements can be a significant roadblock in the development of a new product.

All researchers should have a general understanding of the principles of toxicology and toxicity testing. This would include an understanding of the issues associated with making and using toxic materials, an awareness of new tools being developed for predictive toxicology and the knowledge of when to involve product safety experts. This understanding can bring a number of benefits to the researcher and to the company. Identifying the critical toxicity issues early will help researchers to focus on reducing hazards as much as possible. This