Fear of All Snakes, Spiders, . . . and Chemicals

by David A. Evans

I admit to being terrified of snakes, even when I recognize a nonpoisonous species. My daughter will not enter a room if she suspects the presence of a spider—even though she knows that there are no harmful spiders in the UK where we live. We are both scientists, but to be provided with any amount of profound and convincing evidence that these species are benign does not remove our fear. It is not a matter of trust, it is simply an irrational response. But knowledge does help—we do not kill these species and we recognize their beneficial role in their environment.

Similarly, a section of the population has a fear of, or a dislike for, "chemicals." Whereas such a phobia is often based upon lack of knowledge or familiarity, the same irrationality governs the responses. Again, informative statements based upon faultless logic almost always fail to convince. For others, the root of chemophobia is in a dislike of meddling with nature—and this group is often unaware that natural products consist 100 percent of chemicals. Thus, my niece seeks to consume only "pure butter, free of chemicals of all sorts"—we also note that she has a problem with the concept of purity, but purity is very often taken to mean the absence of manufactured chemical additives!

I know that many colleagues share these experiences, but what can we do to gain a better appreciation of our work? Perhaps the most obvious, yet frequently ignored, aspect is absolutely never to rebut an irrational or emotive argument by bombardment with scientific data and explanations. "Don't you realize that these chemicals are safer than toothpaste" just doesn't convince the sceptics—and it besmirches the qualities of toothpaste! Similarly, we should try to resist stating that many natural products are much more poisonous than synthetic chemicals. For many of the public, this is akin to trying to compare apples with pears—they are not parts of the same argument.

We should also acknowledge that people are not always unjustified in their fear of chemicals and history teaches that some dangerous chemicals have slipped through the net. In the past, we have sometimes been less than straightforward with the public, with appalling consequences for our credibility. We should understand that to many people, including highly educated citizens, the term "chemical" is now exclusively synonymous with manufactured materials, presumed to be toxic or carcinogenic. These find their way either on purpose or accidentally into the products they buy, the food they eat, or into the air, water and soil—and questions should be asked and answers given.

In practice, I know of no all-encompassing answer to this problem, but one of the best ways to make progress in my experience is to describe the benefits of a chemical product or process, together with straightforward comments about costs and risks. Most people are best persuaded by a benefit that they themselves experience. Thus, healthcare products provide an easy win, but to state that pesticides help farmers' profitability is hardly a selling point!

Segmenting the Audience

Our positive messages need to be tailored to our audiences—the public is very heterogeneous. A win for one group might be an anathema for another. Let's consider some of the active groupings:

The Media

The prime objective of all media, with the possible exception of some public service broadcasting, is to sell advertising space—in which audience ratings and circulation figures dominate. In the UK, some of the newspapers have devoted themselves to tirades against chemical usage. They are aware that sensation sells and never fail to print alarmist reports of the slightest chemical incident with exaggeration and distortion adding to the mix. Conversely, erudite reports of progress in science attract only a few and thus command very few column inches. Nevertheless, a fascinating story about a new development will get printed in the quality newspapers. A win here demands persistence in which development of relationships between science reporters and, for example, the press officers of learned societies, is required. Good relationships also facilitate the rebuttal of the nonscientific scaremongering that is often peddled to the public. Some learned societies have taken the initiative by assembling a rapid-response panel to deal with urgent press inquiries.

But scientists have an important part to play, too.

When addressing the media, we are prone to raise unrealistic expectations and to exaggerate. We sometimes are guilty of providing support for our pet project by unjustly denigrating an alternative—and the result is the debasing of all science. Whereas critique and debate are a part of the scientific method, public rancor amongst members of our profession is very damaging.

Government

The prime aim of a ruling political party is to stay in power, for example by re-election in a democracy. It is naïve to hope that politicians will rally to a cause that is unpopular with the public electorate, although there are notable exceptions to this. The paradox is that the actions of governments affect generations, but elections occur every few years. Small wonder therefore that political decisions are often short-term expedients. So what can long-termist scientists do about this? In my experience, the fostering of regular liaisons between the political office of a learned society and the appropriate government body can be mutually beneficial. The provision of authoritative and consistent information, independent of vested interests, is highly appreciated by politicians. This brings into focus the potential for IUPAC to act as an NGO. As an organization that is dedicated to accuracy, standards, and the principles of scientific method, IUPAC is well placed to provide leadership in this arena. Its freedom from bias, coupled with the formidable breadth, expertise, and authority of its membership, means that IUPAC is splendidly placed to act as an independent NGO, in contradistinction to many of the single-issue pressure groups that currently masquerade under this banner. It must also be mentioned that trade associations, however well intentioned, will not be regarded as neutral by governments, again underscoring a role for IUPAC.

The Education Sector

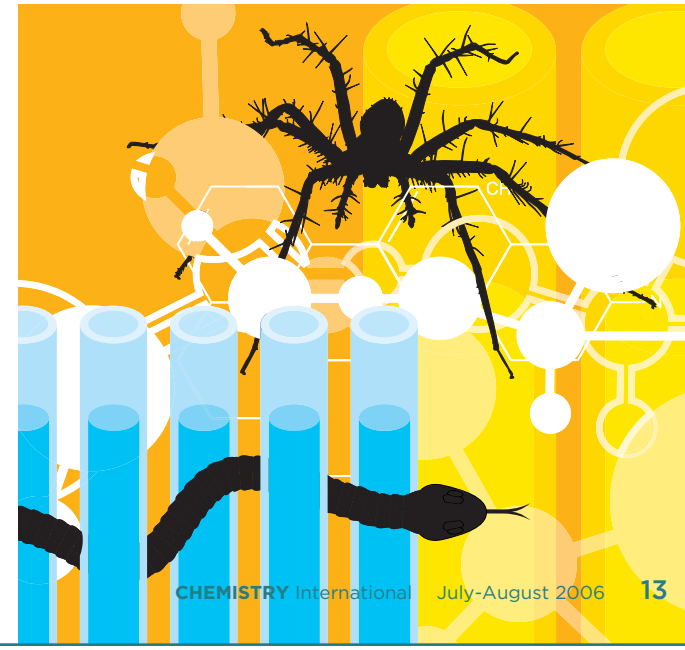
Here we meet our biggest opportunity for influence—and also a major challenge. Perhaps the best returns are to be gained from involvement in teacher training and by supporting teachers with learning aids and materials. The IUPAC Committee on Chemistry Education (CCE) has spawned or supervised many powerful initiatives in chemical education, many of which have already been described in *Chemistry International*. The National Adhering Organizations (NAOs) that support IUPAC often carry out major initiatives in this sphere and there is no shortage of commitment to continuing this work. This is clearly a major area for contributions from IUPAC in the future.

Scientists

It must be recognized that we scientists are ultimately collectively responsible for the esteem in which our profession is held by the public. In addition to the comments above, mention must be made of our past failures in engaging the public adequately. We have often insufficiently explained our purpose and our work. Our public attitude to risk has often been to deny its existence. Our openness when faced with emergencies and accidents has been at fault. In short, science communication has been suboptimal and IUPAC is poised to play a major role here.

IUPAC's Key Role

Whereas IUPAC's scope for involvement in the public understanding of chemistry is broad, it needs to clearly establish its niche alongside the numerous bodies with interest in this topic. At the 2005 General Assembly in Beijing, Peter Mahaffy, now Chair of CCE, prepared and presented a seminal report entitled *Chemists and "The Public": IUPAC's Role in Achieving Mutual Understanding*. This paper sets the direction for IUPAC's efforts to enhance public understanding based upon an analysis of best practices for science communication (see p. 14). The intention is to help scientists identify and understand their publics, to support science education systems, and to influence international organizations. To quote the report:



> "IUPAC is just one of many actors in public understanding of science, and will frequently need to work collaboratively with the other scientific unions and other bodies. IUPAC cannot cover the full range of possible activities and address all audiences, not least because it is remote from the general public. IUPAC's primary targeted public should be IUPAC chemists and educators, and IUPAC's most important role is to help them understand and work with a variety of other publics."

Furthermore, we need to be aware that our notion of public understanding often overlaps with public awareness of, and public appreciation for chemistry. These are rather separate topics encompassing different processes—the report clarifies the distinction.

The public understanding arena is characterized by numerous well-informed and substantive contributions, but there is an evident lack of coordination leading to much duplication of work. Within IUPAC, it is vital to have a focus for our work and I believe that CCE should be that focus. Whereas the Committee on Chemistry and Industry (COCI) has a program in this area, it is agreed that COCI should concentrate on the industrial perspectives with a greater focus upon public appreciation. Many NAOs will pursue their own national programs, and indeed several have pointed

Did You Say PUC or *PAC*?

Chemists derive great benefit from precision in the use of terminology in their scientific work and IUPAC uses a variety of terms for science communication as do other organizations. The practical definitions proposed for the purpose of science communication are:

Public understanding of chemistry: Understanding of chemistry matter by non-chemists, including chemistry content, the nature and methods of chemistry (as a social enterprise), and the roles and uses of chemistry in society.

Public awareness of chemistry: General knowledge of chemistry content, processes and societal roles, without detailed and precise understanding.

Public appreciation of chemistry: A positive attitude to chemistry, including respect and/or admiration for its methods and its contributions (and potential contributions) to society.

This is an extract from Mahaffy's draft report.

Chemists' Understanding of the Public

by Peter Mahaffy

Perhaps you read the title above as a test for dyslexia, as the chemistry profession usually inverts the order of those words to highlight the challenges associated with winning increased public understanding of and appreciation for chemistry. And, as outlined in the accompanying article (p. 12), those challenges are profound.

A task group of the Committee on Chemistry Education (CCE) is completing a project aimed at clarifying IUPAC's niche in meeting the global challenges of increasing public understanding of chemistry. One significant recommendation is that we turn the phrase "public understanding of chemistry" around, and focus considerable attention on helping IUPAC chemists identify and understand their diverse publics, so focused and effective strategies for science communication can be developed.

An overarching goal for the project is to provide a framework that will bring the same level of intellectual rigor to IUPAC's science communication activities as to IUPAC's scientific activities. Thus, work began with a careful review of the extensive literature on the public understanding of science and paid careful attention to the nomenclature used to describe these activities. The report recommends that IUPAC clearly define its most appropriate target audiences, clearly articulate goals and motives for IUPAC public understanding of chemistry (PUC) initiatives, and design PUC projects with a plan for rigorous evaluation of outcomes.

The project task group included CCE members Peter Mahaffy (chair), Tony Ashmore, Bob Bucat, Choon Do, and King's University College undergraduate student Megan Rosborough, who carried out an extensive literature review and assisted in the development of the project report. The report was presented in a well-attended joint workshop at the 2005 General Assembly in Beijing, and will be finalized following the 19th International Conference on

out the diversity of perceptions across the world. Here, the imperative is to share best practices and learn from past successes and mistakes.

From an industry-based COCI perspective, we feel that we need to help improve public image by directly and honestly confronting the issues of safe and responsible manufacturing, handling, and use of chemicals. Hence, we are engaged in initiatives such as the Safety Training Program and Responsible Care. We need to better inform the public about what we are doing to make improvements and to acknowledge what has gone wrong—and to engage the public to collaborate on good ideas to improve even further.

One thing is for sure, in IUPAC we have the skills and the determination to tackle this problem. It is now a matter of getting ourselves organized to play a pivotal global role in advancing our cause—and to begin to rationalize the irrational!

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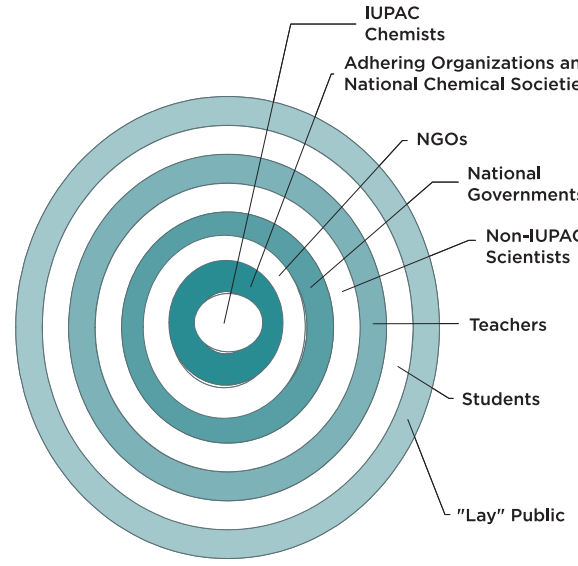

"IUPAC has neither the resources, nor the expertise to address all of these 'publics'. It needs to concentrate its activities with those publics with which it is well placed (and perhaps better placed than others), while interacting indirectly with those publics that are more remote (and who are better addressed by others)." —Extract from Mahaffy's draft report.

Chemical Education in Korea, 12–17 August 2006, before being formally submitted to IUPAC for approval. A few highlights from the report, followed by conclusions and recommendations are listed below. The full task group report is available from the project webpage at <www.iupac.org/projects/2004/2004-047-1-050.html>.

Many organizations and associations consider themselves stakeholders in the public understanding and appreciation of science. One of the task group challenges was to think about the strengths and limitations of IUPAC as an organization for communicating chemistry to the public. Strengths include IUPAC's international make-up, with special attention given to the needs of developing countries; IUPAC's considerable scientific credibility in setting global standards on nomenclature, physical constants, and other areas; IUPAC's links to other unions and international organizations; and IUPAC's track record of support for formal chemistry education through the work of the former Committee on Teaching of Chemistry and the present CCE.

On the other hand, IUPAC's effectiveness in public understanding of chemistry initiatives may be limited by lack of IUPAC chemists' understanding of the public(s) who might be served by initiatives; limited knowledge within IUPAC of the research base for educational and PUC initiatives; insufficient articulation of motives, goals, and outcomes for PUC initiatives; limitations of a largely volunteer organization without central resources to support substantial PUC initiatives; and lack of public knowledge about IUPAC.

The task group felt it helpful to clarify nomenclature. The report gives generally accepted meanings for terms such as: public understanding of chemistry, public awareness of chemistry, and public appreciation of chemistry (see box p. 14), and notes that confusion is created because these terms are often used interchangeably.

Insights are drawn from the research literature on public understanding of science, including observations that the general public in highly developed countries often has a remarkably high level of expressed and demonstrated interest in science-related programs—higher than scientists in these countries perceive to be the case. Despite this, there is evidence that

the mass media are an ineffective vehicle for enhancing understanding of science among adults. It appears that the role of school-level (K-12) formal education is far more important than subsequent exposure to science communication.

Building on insights from the literature review, the task group articulates the following motivation for IUPAC's involvement in PUC initiatives, and notes that the media and the public will see through any imbalance or confusion of motives and will spot anything that is self-serving.

- IUPAC wants to provide leadership to enable chemists to address global issues that involve the molecular sciences.
- IUPAC acknowledges that the public ultimately decides whether and to what extent the benefits of chemistry are realized.
- Chemists therefore need to engage with the public to create a climate in which the potential benefits of chemistry can be realized.
- To create and support effective two-way communication, chemists need to understand the needs and concerns of the public.
- Good decision-making in society depends on mutual understanding and trust among chemists and the public.
- IUPAC needs strategies to promote this mutual understanding.

Noting that "one size fits all messages" are ineffective, the report addresses the question: Who are the public(s) IUPAC should be trying to reach? IUPAC can be considered to be at the center of a set of concentric circles, each of which represents a "public" with which IUPAC may wish to interact in relation to the public understanding of chemistry (see figure p. 15).

IUPAC is closest to and/or can readily interact with its own adhering bodies and national chemical societies, other multinational organizations, and the scientific and educational arms of national governments. It is relatively remote from most chemists, who are members of national bodies rather than of IUPAC itself, and very remote from teachers, students, and the general public.

IUPAC's primary targeted public should be IUPAC chemists and educators

IUPAC has neither the resources, nor the expertise to address all of these "publics." It needs to concentrate its activities with those publics with which it is well placed (and perhaps better placed than others), while interacting indirectly with those publics that are more remote (and who are better addressed by others).

This final point brings us back to our title: "Chemist's Understanding of the Public." Primary publics for IUPAC are those chemists who are closely associated with IUPAC, and one of the first steps for IUPAC is to assist its chemist-members in understanding the needs and aspirations of their target audiences.

The report concludes with the following recommendations:

1. IUPAC has an important role to play in enhancing public understanding of chemistry.
2. Public understanding of chemistry activities aimed at supporting teachers and students within the formal school system are often more effective than those aimed at the general public.
3. IUPAC's primary targeted public should be IUPAC chemists and educators, and IUPAC's most important role is to help them understand and work with a variety of other publics.
4. We propose IUPAC's niche as focusing on activities that indirectly enhance public understanding, such as the following:
   a. helping scientists identify and understand their publics
   b. influencing international organizations
   c. supporting science education systems, particularly in countries in transition
   d. supporting scientists and educators by communicating relevant findings from IUPAC projects and activities at an appropriate level
   e. suporting national chemical societies and other organizations, particularly in countries in transition

One of the important steps in the project is to disseminate findings broadly to the IUPAC membership for suggestions—this communication to you is one step in that process, and you are invited to send comments to <peter.mahaffy @kingsu.ca>. Following a review of feedback, the project group will meet at the 19th ICCE in August 2006 and prepare a final report.

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www.iupac.org/projects/2004/2004-047-1-050.html