**Chemists and "the Public": IUPAC's Role in Achieving Mutual Understanding**

Report of IUPAC Project #2004-047-1-050

for

Workshop at IUPAC General Assembly, August 2005, Beijing

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## *Executive Summary*

This report seeks to inform IUPAC's intention to enhance the public understanding of and appreciation for chemistry, by evaluating IUPAC's mandate, strengths and weaknesses, and providing insights from a substantial review of the science communication literature. It serves as background material for a joint workshop involving CCE, COCI, Chemrawn, and members of the IUPAC Bureau, to be held at the 2005 General Assembly in Beijing. Following the Beijing workshop, symposia and other contributions on PUC will be held at the 19th ICCE in Korea (August 2006). Feedback from both of these events will be incorporated by Project task group members into a final report to the IUPAC Bureau, assisting it in determining its role and strategy on public understanding of science.

An overarching goal for the present 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. This implies that careful attention must be paid to the nomenclature used to describe these activities, clear articulation of goals and motives for PUC initiatives, and that PUC projects be designed with rigorous evaluation of outcomes from the outset.

Informed by our analysis of best practices for science communication, as outlined in the literature, this report provides the following conclusions and 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 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. Supporting national chemical societies and other organizations

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## *A. Introduction*

> *The panel was struck overall by the general lack of intellectual rigor applied to science and technology communication activities, especially as contrasted with the very rigorous scientific environment in which this communication arises. Public communication ... should be amenable to the same experimental paradigms as laboratory science.*
>
> *Communicating the Future: NASA's Research Roadmap Panel for Public Communication of Science and Technology in the 21st Century*

This report seeks to inform IUPAC's intention to enhance public understanding and appreciation of chemistry, by evaluating IUPAC's mandate and providing insights from a review of the public understanding of science literature, such as the report of NASA's Research Roadmap Panel for Public Communication of Science and Technology in the 21st Century, cited above.

Enhancing public understanding of chemistry is an explicit, central element of IUPAC's strategy to "contribute to the worldwide understanding and application of the chemical sciences, to the betterment of the human condition." The most recent IUPAC strategic plan (2002-2003) includes long range goals to "provide leadership as a worldwide scientific organization that objectively addresses global issues involving the chemical sciences," and to "utilize its global perspective and network to contribute to the enhancement of chemistry education, the career development of young chemical scientists, and the public appreciation of chemistry." Strategic plan (2000-2001), expressed the goal to "advance the public understanding of chemistry and the scientific method."

IUPAC has envisioned a strong role for the Committee on Chemistry Education (CCE) in setting directions for the organization's efforts to enhance the public understanding of chemistry. CCE's terms of reference, listed below, highlight this mandate:

1. To advise the President and the Executive Committee on matters relating to chemistry education, including the public appreciation of chemistry.
2. To maintain a portfolio of educational projects and to coordinate the educational activities of IUPAC.
3. To monitor chemistry education activities throughout the world and to disseminate information relating to chemical education, including the public appreciation of chemistry.
4. To develop liaisons with international organizations such as UNESCO, national and regional chemical societies, chemical education committees, and organizations concerned with the public appreciation of science.

Flowing out of the first CCE term of reference, IUPAC Project # 2004-047-1-050 has the objective of "proposing to the IUPAC bureau an appropriate niche for IUPAC and CCE in promoting public understanding of science." The present report is an outcome of that IUPAC Project, and serves as background material for a joint workshop involving CCE, COCI, Chemrawn, and members of the IUPAC Bureau, to be held at the 2005 General Assembly in Beijing. Following the Beijing workshop, symposia and other contributions on PUC will be held at the 19th ICCE in Korea (August 2006). Feedback from both of these events will be incorporated by Project task group members into a final report to the IUPAC Bureau, enabling it to determine its role and strategy on public understanding of science.

The project task group asked the following questions about IUPAC's motivation and goals for involvement in the public understanding of chemistry:

- Does IUPAC want the public to know more chemistry?
- Does IUPAC want the public to know more about the processes of science?
- Does IUPAC want the public to know more about the benefits of chemistry?
- Does IUPAC want the public to be better equipped to evaluate the potential benefits of chemistry?
- Does IUPAC want to understand more about what the public needs and desires to know about chemistry?
- Does IUPAC want to promote the chemical industry?
- Does IUPAC want a greater public profile for itself?
- Does IUPAC want the public to trust chemists?

We identified 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 CTC 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 knowledge of IUPAC on the part of the general public;

An overarching goal for the present 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. This implies that careful attention must be paid to the purposes and therefore the nomenclature used to describe these activities, clear articulation of goals and motives for PUC initiatives, and that PUC projects be designed with rigorous evaluation of outcomes from the outset.

This goal will be realized in part through consideration of how to draw on insights from the science communication literature to provide focused, credible PUC activities that build on both the strengths and the mandates of IUPAC and CCE.

To facilitate that discussion within IUPAC, in the report below we:

- Clarify nomenclature used in this report for science communication activities
- Summarize insights from the research literature on science communication
- Articulate motives and goals for IUPAC involvement in public understanding of chemistry initiatives
- Suggest public(s) for targeting by IUPAC
- Propose mechanisms for evaluating IUPAC public understanding of chemistry initiatives
- Make recommendations regarding IUPAC's niche in science communication
- Propose steps to implement these recommendations

### *B. Nomenclature for science communication activities*

> *The scientific community and managers of the science enterprise routinely fail to distinguish between understanding of science - and appreciation for science and research-performing institutions.*
>
> *Communicating the Future: NASA's Research Roadmap Panel for Public Communication of Science and Technology in the 21st Century*

IUPAC uses a variety of terms for science communication as do other organizations. Chemists derive great benefit from precision in the use of terminology in their scientific work. Precise use of language will help clarify the purpose of science communication, so we propose the following practical definitions for IUPAC.

**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, its contributions (and potential contributions) to society.

Other terms, such as public attentiveness to chemistry, and chemical literacy are also used in the literature.

## *C. Insights from the research literature on public understanding of science*

*Developing literacy in one particular area of science may be likened to climbing a mountain. It is dynamic, participatory, and it inevitably changes the participant's view of the world. This climbing process is facilitated by science communication. Appropriate skills, media, activities, and dialogue are used to improve individuals' awareness, enjoyment, interest, opinions, or understanding (AEIOU) of science. When viewed at the public level, this is equivalent to moving upward through the continuum of public awareness of science, public understanding of science, and scientific literacy.*

*Science Communication: A Contemporary Definition*
*Burns, O'Connor and Stocklmayer, 2003*

**4. Geographic focus**

The literature on public understanding of science (PUS) focuses almost exclusively on research into, and analysis of, initiatives in the western, developed world, and very little on countries in transition. Perhaps this also reflects a geographical imbalance in the magnitudes of PUS efforts.

**5. What's meant by <u>understanding science</u>?**

It has been generally accepted that there are three main aspects of understanding science:

a. Understanding substantive scientific knowledge (*content*)
b. Understanding the methods of enquiry and progress in science (*process*)
c. Awareness of the impact of science on people, as individuals and as a society (*social*).

There is considerable discussion concerning whether communication of the *process* component should be more overt regarding the tentativeness and the limitations of science, as well as the debates among scientists – particularly those with a societal currency. Some writers argue that scientists are reluctant to admit to uncertainties in their knowledge for fear of losing status (and sources of funding), and that this disguises the true nature of scientific progress.

**6. Analysis of the PUS enterprise**

IUPAC's current concerns mirror those of NASA's Space Science Laboratory which, in the late 1990s, established a panel of highly reputable science communicators, communication researchers, journalists and scientists to make recommendations for its own PUS program, based on a thorough review of the then-current literature on science communication, as well as surveys of science communication activities both in the USA and abroad. Although four years has passed since publication of its report (Borchelt, 2001), it seems sensible to borrow from their findings because of (i) the thoroughness of their analysis, and (ii) the considerable similarity between IUPAC's and NASA's motivations. Much of the following, therefore, is summarized from the NASA report, amplified and/or supplemented by the writings of others.

a. **The status of public understanding of science.** Borchelt (2001) reports:

*The panel was struck overall by the general lack of intellectual rigor applied to science and technology communication activities, especially as contrasted with the very*

> *rigorous scientific environment in which this communication arises. Communication often remains an afterthought, a by-product of scientific endeavor somehow removed from the scientific process itself and often funded by a different mechanism than the scientists who perform the research. The panel firmly believes that public communication of research results is, and should be, integrated into the scientific process itself. It is not an optional activity at the conclusion of a research program. It should be amenable to the same experimental paradigms as laboratory science.*

**b. Modes of science communication and their effectiveness**

In the past, the Public Understanding of Science movement has often been characterized by a one-way transmission of knowledge from those who know to those who know less, and which has been labelled the *deficit model* of communication. This practice has been dependant on identification by the scientific experts of what they think the public ought to know. Underlying this approach is an implicit belief that more of this knowledge transmission will give rise to better understanding of the findings and constructs of science, as well as enhanced trust in science and scientists.

However, despite massive PUS programs in the USA and the UK, for example, measured levels of public understanding of science content remain disappointingly low. Furthermore, there is ambiguous evidence concerning whether there have been benefits in terms of citizen support for the scientific enterprise. Comment has been made that we should not be surprised by this if we look to the analogy of public understanding of politics, where "political ignorance flourishes in spite of heavy coverage, knowledgeable reporting, and media-savvy participants". (Borchelt, 2001)

Increasingly in recent years there has been criticism of the 'deficit model' of communication for attempting to teach science content to people that they may have no interest in knowing. This approach does not fit easily with current views of learning that give high weight to active learner participation, including in the choice of subject matter. A UK House of Lords report was scathing of even the connotations of the label "public understanding of science":

> *... the words imply a condescending assumption that any difficulties in the relationship between science and society are due entirely to ignorance and misunderstanding on the part of the public; and that, with enough public-understanding activity, the public can be brought to a greater knowledge, whereupon all will be well.*

Notwithstanding literature proposals of a range of models for science communication, most of these can be included in a category called a *contextual* model, which demands understanding of the target audience by the scientist, and calls for two-way discussion among equals. The contextual approach recognizes the status of personal values and local knowledge in the decision-making processes in science-related issues. Claims have been made that scientists know just as little about the public as the public knows about science.

After a wave of hostility to the deficit mode of science communication, it seems now that a more rational attitude is becoming prevalent that recognizes that both the deficit and contextual models can be appropriate in particular circumstances.

In summary it can be said without qualification that the process of science communication is a very complex undertaking that is not yet well understood, but certainly involves more than the experts telling more ignorant people that which the experts have decided is appropriate.

### c. The mass media

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 enhancement of understanding of scientific content of adults. It appears that the role of school level (K-12) formal education is far more important than subsequent exposure to science communication.

Furthermore, cautions have been expressed about the popular treatment of scientific material in mass media for reasons imposed by its own demands. According to Trachtman (1981), popular treatment of scientific material is likely to:

- Be highly selective in choice of materials, using questionable selection criteria,
- Oversimplify, and hence to misrepresent, the methods and the character of scientific enquiry,
- Treat scientific news as discrete events and hence to create another false impression of science,
- Draw undue inferences about the meaning and significance of particular lines of research,
- Report on inadequate, incomplete and poorly designed research as readily as on competent research, as long as the subject matter is relevant to immediate popular concerns,
- Create false expectations of what science is capable of doing, and
- Occasionally create stress among readers more damaging than the real risks being reported on.

### d. The public

The NASA report (Borchelt, 2001) finds

> *There is no such thing as a general audience for science and technology communication; rather, there are many people with many different uses for science and technology information and many levels of understanding with which to deal.*

And amplifies as follows:

> *Despite long-standing awareness of the diversity of the consuming publics for science and technology information, the panel noted that most science communication still fell into one of only two categories: peer communication aimed at fellow scientists and technologists and public communication aimed at everyone else. The literature the panel reviewed and the best practices it observed in use make very clear that there is no such thing as a one-size-fits-all public communication message for a mythical lay public. Single messages designed to reach all public audiences typically end up*

> *reaching none of them very well, especially in an information environment with a myriad of media channels (which is growing daily) from which an audience may choose what suits it.*

**e. Confusion of motivations**

Many PUS initiatives have suffered from either (i) their own uncertainty in regard to ambiguous and/or diffuse motivations, or (ii) a mismatch between expressed motivations or goals and the real, but less overt, motivations. In particular, according to Borchelt (2001):

> *The scientific community and managers of the science enterprise routinely fail to distinguish between understanding of science and appreciation for science- or research-performing institutions.*

While it is valid to have either of these goals, the NASA panel believed that far too often programs intended to enhance the reputation of agencies expressed the altruistic intention of benefiting the citizenry. The goals are not necessarily compatible, and can lead to either a confused focus by the agency, or loss of trust by the public.

As we discuss below, precise and clearly expressed goals are a necessary component of effective evaluation.

**f. Designing an effective PUS program**

Gregory and Miller (2004) have recommended a protocol for communication for the (public understanding of) science. Only the titles of each component are reproduced here:

- Acknowledging the place of popularization
- Being clear about motives
- Respecting the audience
- Negotiating new knowledge, understanding and attitudes
- Establishing a basis for trust
- Acknowledging the social in science
- Facilitating public participation

To these we would add (i) deciding which audience is most appropriate in terms of need and accessibility, and (ii) engaging in evaluation of the program.

**g. Evaluation**

Consistent with the views of several other writers, the NASA panel (Borchelt, 2001) expressed the view:

> *The panel also was very concerned about the dearth of formative or evaluative research that underpins the vast majority of science and technology communication in the United States (and as far as the panel was able to determine, the rest of the world). For a data-driven enterprise, science demands very few data from communicators of science,*

> *either to craft and frame appropriate messages and message content or to evaluate the impact of messages on scientific knowledge or behavior*

Reporting on the outcomes from a meeting of the Scientific Committee of the Public Communication of Science and Technology group at a World Conference on Science, Gascoigne (2001) also referred to this common weakness of PUS programs:

> *Furthermore, whenever inadequate evaluation exists, it undermines the credibility of much of what science communicators strive to do in these programs.*
>
> *Unless the benefits of these programs can be demonstrated, skeptical governments are entitled to doubt the programs' achievements and question their continued funding. The proponents of these programs need to be able to show they have made a difference—that the activities they have designed and put into action have led to the desired outcomes. Evaluation is a key issue.*

Gascoigne acknowledges the value of both formative evaluation (conducted during the course of a program, in order to adjust the process according to findings), and summative evaluation (conducted after the program, to assess its effectiveness).

We recognize that defining some goals in measurable terms is not easy.

### *D. Why should IUPAC be involved in public understanding of chemistry initiatives?*

> *Science and technology communication should not be driven by the research enterprise's desires about what the public should know. Communication should be driven by a desire to meet audience needs and interests.*
>
> *Communicating the Future: NASA's Research Roadmap Panel for Public Communication of Science and Technology in the 21st Century*

While we may not agree with this polarized characterization of science communication, IUPAC has yet to define clearly its motivation and goals, targeted public(s), desired outcomes, and methods of evaluating success for participation in public understanding of chemistry initiatives. This lack of clarity has led to (and perhaps resulted from) imprecise and sometimes transposable use of nomenclature such as public understanding, public appreciation, and public awareness of chemistry.

**Suggested articulation of IUPAC's motivation and goals for PUC initiatives**

Building on IUPAC's overall goal to support the development by chemists around the world of new knowledge with potential benefits to society, we suggest the following description of IUPAC's motivation for PUC.

1. IUPAC wants to provide leadership to enable chemists to address global issues that involve the molecular sciences
2. IUPAC acknowledges that the public ultimately decides whether and to what extent the benefits of chemistry are realized.

3. Chemists therefore need to engage with the public to create a climate in which the potential benefits of chemistry can be realized.
4. To create and support effective two-way communication, chemists need to understand the needs and concerns of the public
5. Good decision-making in society depends on mutual understanding and trust between chemists and the public
6. IUPAC needs strategies to promote this mutual understanding

The media and the public will see through any imbalance or confusion of motives and will spot anything that is self-serving.

### *E. IUPAC's publics*

> *Despite long-standing awareness of the diversity of the consuming publics for science and technology information, the panel noted that most science communication still fell into one of only two categories: peer communication aimed at fellow scientists and technologists and public communication aimed at everyone else. The literature the panel reviewed and the best practices it observed in use make very clear that there is no such thing as a one-size-fits-all public communication message for a mythical lay public. Single messages designed to reach all public audiences typically end up reaching none of them very well, especially in an information environment with a myriad of media channels (which is growing daily) from which an audience may choose what suits it.*
>
> *Communicating the Future: NASA's Research Roadmap Panel for Public Communication of Science and Technology in the 21st Century.*

Who are the public(s) IUPAC should be trying to reach?

IUPAC can be considered to be at the centre of a set of concentric circles each of which represents a "public" with which IUPAC may wish to interact in relation to PUC.

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.

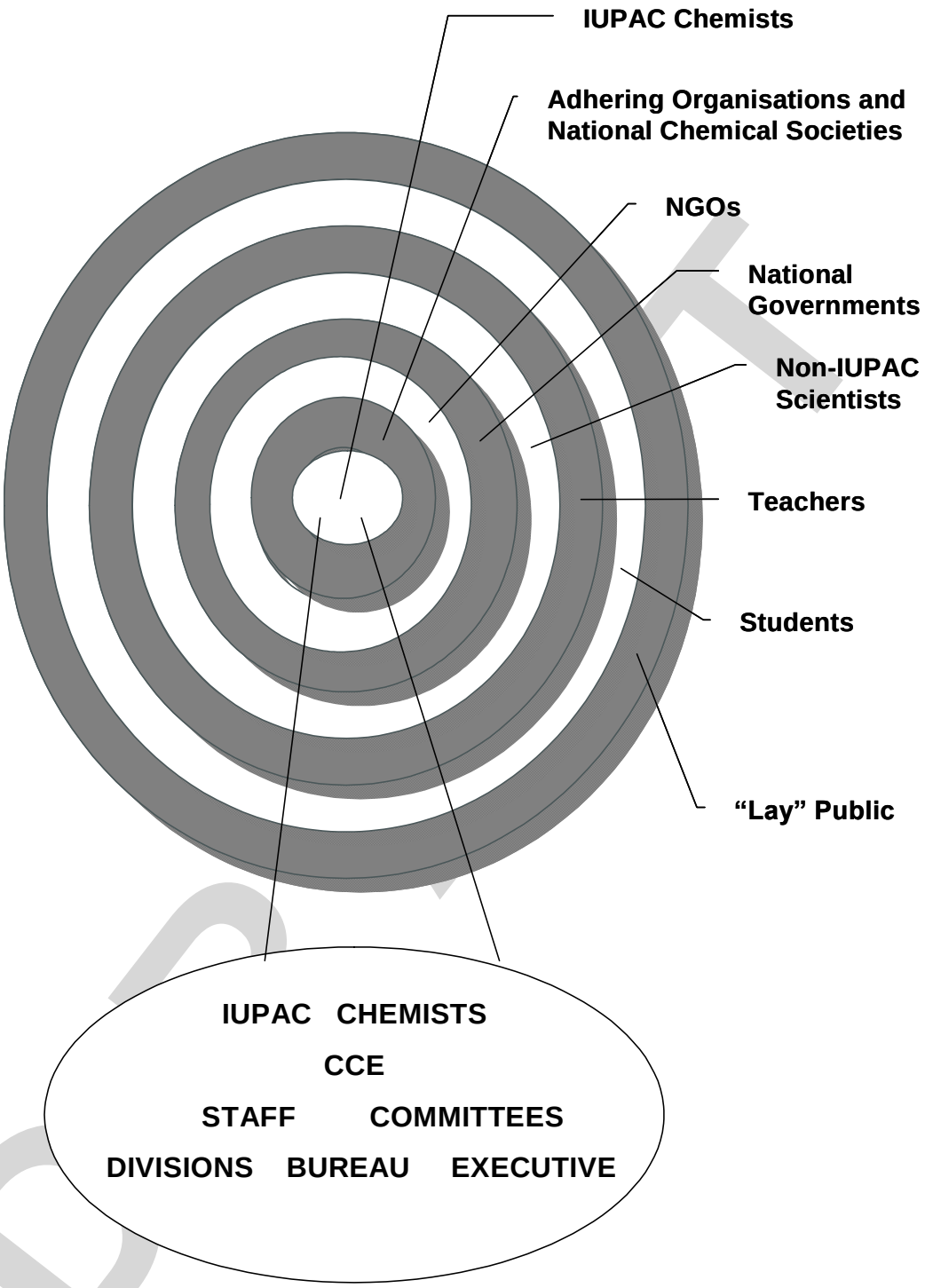


**Figure 1. IUPAC and its Publics**

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).

Primary publics for IUPAC are therefore those chemists that are closely associated with IUPAC, to ensure that the organization is capable of engaging in PUC activities, and other organizations that IUPAC can influence and assist.

Individual chemists, educators, students and the lay public are generally most effectively addressed indirectly through adhering national organizations, national chemical societies, and scientific and educational arms of national governments to which IUPAC chemists and educators belong.

This is explored more fully in Section G where we identify particular roles for IUPAC and the publics it is best equipped to address.

### *F. Evaluation Built into any IUPAC PUS Initiatives*

> *The panel also was very concerned about the dearth of formative or evaluative research that underpins the vast majority of science and technology communication in the United States (and as far as the panel was able to determine, the rest of the world). For a data-driven enterprise, science demands very few data from communicators of science, either to craft and frame appropriate messages and message content or to evaluate the impact of messages on scientific knowledge or behavior.*
>
> *Communicating the Future: NASA's Research Roadmap Panel for Public Communication of Science and Technology in the 21st Century.*

Gascoigne (2001) proposes a simple model that could be used for the evaluation of programs or projects that aim to change or influence public views on science and technology. This model includes the following five steps:

1. Identify clear objectives for the program or project, for example, to increase the awareness of high school students about career opportunities in science. This project could have as a performance indicator the students' level of awareness about science career options.
2. Identify the audience to be influenced, and then establish baseline data. For the example of high school students, this baseline data could be a measurement of the current awareness of students before implementation of the awareness project.
3. Identify the most appropriate method to assess change by choosing from the range of assessment tools listed earlier. Using the school example, the selected method could be to conduct telephone interviews with a representative sample of students.
4. Carry out ongoing assessment during a project as a way to shape the program. The aim is to improve effectiveness and to save time and money. Again, in the school example, the project team may discover that the photographs of scientists used in the project reinforce negative images, and so the material needs to be revised. This revision can be made while the project progresses.
5. Carry out post-project assessment, again by choosing from the possible tools listed earlier.

***G. Conclusions and recommendations to IUPAC***

1. In keeping with its mission to "contribute to the worldwide understanding and application of the chemical sciences, to the betterment of the human condition," 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 more effective than those aimed at the general public.

3. 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 can not 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.

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**

***Goals:*** A crucial first step is for scientists involved in reaching out to the public to understand the needs and aspirations of their target audiences. IUPAC first needs to educate itself in this regard. The analysis of PUS initiatives presented in this report should provide the basis for beginning this process of self-education. IUPAC, its Executive, Divisions, Standing Committees and staff should support chemists and educators within the IUPAC family to enhance their understanding of the public(s) they seek to address by defining the target public, clarifying motives, nomenclature, strategies, resources, approaches to evaluation, etc.

***Examples:*** Dissemination of the outcomes of this project, together with publication of resources on the CCE web site, the Symposia on Public Understanding of Chemistry at the 2003 IUPAC Congress in Ottawa and the forthcoming 19th ICCE are examples of this strand.

***Targeted public:*** The "public" addressed `in this strand is IUPAC itself and those closely associated with it.

**(b) Influencing international organizations**

***Goals:*** A key strength of IUPAC is its scientific expertise and scientific credibility. IUPAC should build upon this strength and the work that it is already doing by bringing this work more effectively to the attention of key international organizations. As a global organization IUPAC is well placed to interact with multinational Non-Governmental Organizations, scientific unions, etc.

***Examples:*** Recent examples of IUPAC initiatives which could be effectively communicated at other levels to targeted publics would include endocrine disruption, chlorine, and medicinal chemistry. This would require an explicit goal of dissemination to NGOs, close collaboration with CCE, appropriate Divisions, standing committees, and commitment by the Bureau and Executive Committee to promote such reports to decision makers in key organizations.

***Targeted public:*** The "public" addressed in this strand is Non-Governmental Organizations, such as WHO, UNESCO, ICSU, ICASE, and the World Chemistry Leader's Meetings.

**(c) Supporting science education systems, particularly in countries in transition**

***Goals:*** IUPAC has the international standing and the expertise within its networks to support the development of science education in countries in transition to raise public awareness and understanding of chemistry to meet basic human needs. This means working at a national or regional level, often in partnership with other agencies, rather than with individual institutions, whose needs are better met by other organizations.

***Examples:*** Examples of this type of activity are Young Ambassadors for Chemistry (YAC) and the new Flying Chemists program. Partners include organizations such as UNESCO and Science Across the World.

***Targeted public:*** The "public" in this strand is national governments and education systems in developing countries.

**(d) Supporting scientists and educators by communicating relevant findings from IUPAC projects and activities at an appropriate level**

***Goals:*** An international organization with the scope of IUPAC has the scientific expertise to make available authoritative information on a non-partisan basis on major global issues. It can make unique contributions in serving the needs of scientists and educators for an awareness and understanding of issues. If scientists and educators are to engage with their own particular audiences they must have access both to authoritative scientific information as well as guidance on how to use it.

***Examples:*** Examples of such issues are many topics which have been the focus of special issues of Pure & Applied Chemistry, such as green chemistry, the science of sweeteners, chemical and biological weapons, climate change, endocrine disrupters and chlorine. While some of these issues have been addressed at a level appropriate for IUPAC specialists, scientists and educators could benefit by communication at other levels.

***Targeted public:*** The "public" in this strand is scientists and educators, who are mainly reached through national societies for chemistry and for science education.

**(e) Supporting national chemical societies and other organizations**

***Goals:*** IUPAC is poorly placed to undertake public understanding initiatives in individual countries. It has neither the expertise nor the human and financial resources to do so. It is, however well placed to facilitate communication among IUPAC member countries regarding existing PUC initiatives, and provide ideas and resources that can be adapted and adopted by countries in transition to initiate sustainable and appropriate PUC activities and, where appropriate and resources permit, suggest ways to coordinate such activities.

***Examples:*** Examples of such activities would be a world chemistry poster competition, activities for National Chemistry Weeks, a World Chemistry Day/Week and internet links (the latter probably brokered by a major chemical society).

***Targeted public:*** The "public" in this strand is national chemical societies and other organizations.

It is equally important to note what we are **not** recommending as part of IUPAC's strategy. We do not think that IUPAC is sufficiently close to, nor has the expertise or resources for itself to interact directly with the general public, whether that part of the public that attends educational institutions as teachers or students, or the lay adult public. These are the tasks of other organizations that are much closer to the target audiences. IUPAC's work therefore is indirect in enhancing public understanding.

***5. Implementation.***

***We recommend that IUPAC take the following steps toward developing a clearer strategy for public understanding of chemistry initiatives and activities.***

(a) Adopt the strategy outlined in Section G1 – G4, and communicate the strategy within the IUPAC family, NAOs, and partner organizations.

(b) Educate itself about effective methods for delivering PUS initiatives, including understanding the public's needs and requirements.

(c) Build PUS considerations into relevant projects and IUPAC activities from the outset. IUPAC might consider amending the project form, to require consideration of public understanding dimensions to proposed projects. Divisions and standing committees might be asked to regularly consider ways to more broadly communicate initiatives to appropriately targeted publics. Regular liaison with CCE is a critical component.

(d) Ensure initiatives are carefully focused and can be undertaken within available human and financial resources.

(e) Build an evaluation component into any supported PUS initiatives.

(f) Evaluate success in implementing this strategy (Section G1 –G4).

(g) Suggest practical strategies and activities to NAOs for enhanced public understanding of chemistry.

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