

Day 2: Afternoon Session

Vision for the Future

Kathleen Kreiss, M.D., National Institute for Occupational Safety and Health, CDC
CAPT Stephen Redd, M.D., National Center for Environmental Health, CDC

Dr. Kathleen Kreiss and CAPT Stephen Redd facilitated a discussion session entitled “Vision for the Future,” intended to provide workshop coordinators, speakers, and audience members with an opportunity to discuss possible conclusions and recommendations to appear in the Workshop Summary Report.

CAPT Redd began by restating the importance of the problems and difficulties that can arise in addressing indoor environment problems. He made four primary points related to the importance of this issue:

1. Health issues can be hard to define and the impact of indoor environment risk factors hard to measure. From the perspective of promoting well being rather than just the absence of disease, a perspective of the CDC Futures Initiative, measuring health impact can be even more difficult.
2. As work goes on, we are likely to identify more hazards associated with the indoor environment and we need to have a comprehensive strategy in place to deal with them effectively.
3. There is already a gap between knowledge of hazards and remediation practice and action; i.e., there are things we know how to do that are just not getting done.
4. There is a sense of urgency in responding to these problems and providing knowledge that members of the community need to improve their health.

Dr. Kreiss stressed the value of building on the multi-disciplinary approach of this workshop. Workshop organizers may want to refine some of the suggestions made by presenters and members to produce a Workshop Report, she said. To this end, Dr. Kreiss presented a set of questions and asked the group to respond to them (also calling on certain audience members whom she knew have expressed ideas on these topics).

Question 1: What can be done to ensure that the momentum of the multidisciplinary and multi-agency approach of this workshop is sustained?

There are two good models of large successful programs that address health effects from agents in the indoor environment (as described in Mr. Girman’s presentation): radon and ETS. Members of the audience suggested several other programs to serve as models of collaborative multi-agency efforts. A representative of a regional EPA office in New York mentioned a collaborative effort between her office and a CDC Asthma Partnership in New Jersey. EPA funds them to reduce environmental triggers to asthma, but she noted that if they got full state implementation funding, this program could do a lot more in medical management (and allow CDC money to go to organizations outside the state’s implementation plan). An audience member spoke about the National Children’s Study, a longitudinal study of 10,000 children in the United States from before birth to age 21,

including examination of schools, homes and day care centers to evaluate many outcomes and environmental factors, including those related to the indoor environment. This study will be an important vehicle for gaining insight into child health in relation to the indoor environment. The program is at the stage of developing protocols and issuing RFPs for participating organizations. The Web site for this project is www.nationalchildrensstudy.gov and the contact is ncs@mail.nih.gov.

Audience members suggested some additional organizations with multidisciplinary programs in and outside the government that could serve as partners or provide models for collaborative indoor environment programs:

- Building industry organizations, such as the National Association of Home Builders (NAHB), which has a research program.
- State cooperative extension services, an arm of the U.S. Department of Agriculture (USDA), located at state land grant colleges. They conduct community-level education and outreach and have had indoor air quality programs since 1993. This structure also serves as a good model of how to provide information and advice to the public.
- Interagency committees on green building issues and indoor environment quality such as the Interagency Sustainability Working Group (ISWG), the Committee on Indoor Air Quality (CIAQ), the Federal Facilities Council (FFC), the Federal Green Building Council, and the White House Task Force on Waste Prevention and Recycling.
- Professional societies, such as the Association of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and the American Institute of Architects.
- Building maintenance organizations and industry representatives, such as the Association of Facility Engineers (AFE) and the Building Owners and Managers Association (BOMA).

A physician suggested that the solution to indoor air quality issues lies in the materials used for building and renovating. He noted that outgassing from materials used in building construction, which can be a major problem for asthmatics, determines how much ventilation is needed. He recommended the book *Less-Toxic Alternatives*, by Carolyn Gorman, as a good resource on this topic. Most asthmatics already know what products they can and cannot tolerate, and this serves as a starting point to determine what components are dangerous to health. There needs to be more cooperation with groups like the American Institute of Architects (AIA) and building material manufacturers to make use of this body of experience from a community of people who have greater sensitivity to environmental pollutants than does the general population.

Mr. Fisk strongly advocated for more federal agency collaboration. Individual agencies are themselves fairly multi-disciplinary, but they can still benefit from combining their resources and expertise. He supported the specific suggestion made by Dr. Hill, and sustained by Dr. Wilson, to establish a committee in the Office of Science Technology and Policy (OSTP) to serve as the key agency for organizing and promoting a coordinated effort on the indoor environment, noting this office's role in joint planning for research and budget needs. OSTP is in the Office of the President and functions by

setting up committees, subcommittees and task groups in various areas of science and technology, populated by representatives of all agencies involved in that particular area, and charged with developing joint planning for research. OSTP also defines research funding levels (or has in prior administrations), and was responsible for setting the research priority for fuel cells. This would be a good venue in which to bring together the agencies involved in the workshop, as well as to draw in other agencies not represented at this workshop. The mechanism for this would be asking the Surgeon General to contact John H. Marburger, OSTP Director. Mr. Fisk suggested that this is the critical place in the government to “put a lever.”

The moderator asked how the existing CIAQ would fit with an OSTP committee. An audience member noted another executive branch interagency group: The White House Task Force on Waste Prevention and Recycling, in the Office of the Federal Environmental Executive, formed a Federal Green Building Council about a year ago. This is another interagency group concerned with indoor environmental quality. An audience member from the CPSC who served on CIAQ spoke about its history and the present activities of the group. Initially, CIAQ served as a way to coordinate research funding, but as funds to the member agencies have dried up in recent years, it has not been as active. They are still a group that is well informed on what research is going on in each agency, and they review each other’s protocols and provide technical support among agencies.

A participant from HUD’s Office of Healthy Homes and Lead Hazard Control suggested issuing joint RFPs to address specific indoor environment problems that multiple agencies agree are important topics. HUD could apply their funds to the research infrastructure that exists in other agencies to examine, for example, the cost/benefit of integrated pest management, under the HUD Healthy Homes initiatives. There are many small issues that have not been well researched. For example, asthmatics are advised to remove carpeting from their homes, but there is no scientific evidence on how effective that is. A participant suggested the need for a multidisciplinary approach to school issues, including research on green schools and sustainable technology, and health effects for teachers and students.

Question 2: What are the best strategies for implementing the things that we already know need to be done?

The moderator pointed out that strategies must be developed; for example, we know enough about the harmful effects of damp buildings to begin to take action, so what would be the best way to proceed? One participant indicated that, in spite of comments that there has been failure to effectively apply OSHA standards and ASHRAE 62 standards to indoor air quality issues in industry; there is one example of a “success story.” Under the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), there are architects’ guidelines on dealing with aerosols. Since JCAHO determines whether hospitals can bill for their services, they have great leverage in effecting change. They inspect hospitals and require plans and protocols to protect patient safety. It is currently not possible to facilitate construction in hospitals without a

plan for control of particulates and bioaerosols. Similarly, there are requirements for plans to address normal maintenance and water damage issues. Having a quasi-regulatory agency forcing health care facilities to maintain indoor environment standards has been very effective, and may be the only “success story” for a regulatory approach in the last 10 years.

Another participant underscored the need to address the chemically sensitive in any interagency effort, pointing out overlapping concerns for issues like pesticide use. A participant from the NRC stressed collaborative efforts, mentioning the Green Schools program being set up in collaboration with the Commonwealth of Massachusetts. The program will be looking at sustainable technology and its effects on student health and productivity. This individual also stressed the need to move ahead with available technology without waiting for more basic research.

An audience member suggested that a fundamental problem with current building practices is the standard of care used in construction and the use of a “punch list” approach of correcting problems after the fact: “We find that you can’t fix everything effectively, and, consequently, the majority of new buildings have poor indoor air quality.” This individual pointed out a need to document and approve construction at each stage (foundation, backfill, etc.) when it is still possible to take effective corrective measures for good indoor environment as the building is constructed. This has been done for school buildings and hotels, resulting in better indoor environments in the final product. A panel member suggested possibly including indoor environment standards in building codes, but the audience member indicated that most correct procedures are already in the code: the problem is lack of oversight. The same individual also indicated a simple solution for indoor air quality issues during renovations: set a requirement to use negative air pressure to restrict movement of dust into occupied areas. A panel member commented on construction issues, noting that they illustrate the complexity of dealing with indoor environment issues because they impact on so many different interests and professional concerns (architects, construction trades, building owners, insurance industry, medical care providers, etc.) even when focusing only on a single issue, such as water intrusion. As the number-one strategy, he suggested using the Office of the Surgeon General to issue a document that frames the debate on indoor environment, as was done for second-hand smoke. Just choosing one issue to begin with (e.g., dampness) would start to move public policy actions, beginning with changes such as keeping insurance companies from writing policy exclusions for mold.

Dr. Mitchell suggested “changing the metric” for success to focus more on the health of building occupants rather than on the building itself, using the *Tools for Schools* approach as a model. By assessing occupant health and comfort, it is possible to move away from debating issues such as the relative importance of maintenance or initial construction and direct attention to the outcome of good practices in both. The Surgeon General can suggest in his report that focusing on the health of the occupants is an indicator of whether the building is working well.

Another participant discussing implementation strategy pointed out that schools represent a large business with considerable market leverage: it should be possible to motivate businesses to market green materials to schools. In turn, schools have a strong influence on the community of parents and the public at large. Guidelines are needed to allow businesses to know what to market. An industrial hygienist in the audience mentioned the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) Green Building Rating System[®], which has improved building performance; indoor air quality is part of the rating. Their certified and registered products and assessment strategies provide an example of using marketplace forces and increasing consumer awareness of good building practices.

Question 3: Is it appropriate to organize stakeholder input and plans for action by type of building (i.e., differentiating between schools, offices, and residences)? What stakeholders may be brought into the mix by considering buildings other than residences and schools?

Ms. Loftness, who serves on the board of LEED, thought this would be a good strategy. She suggested that it may be better not to address schools as a separate category since their construction varies considerably by age and location (climate). She pointed out that hospitals, nursing homes, and laboratories are other building types that are hard to include in categories because their construction and operation is often very different from other buildings. There would be some issues involving particular stakeholders, that would be limited to their particular type of building, but other issues, such as diagnostic techniques might cut across all types of buildings. Labeling spaces for certain levels of moisture and damage might be a way to cut across various building types.

Dr. Woods thought that a more important issue, from the perspective of accountability, would be building ownership: for example, schools may be privately or publicly owned. Offices may be private, owned by the state, or owned at the federal level, etc. He suggested using the public sector to lead the way in taking health initiatives. In terms of strategy, there are already federal regulations in place (e.g., Code of Federal Regulations, Title 10, Parts 434 and 435) that require energy budgets be set for a building; an analogous mandate for health-quality levels would be relatively easy to put in place. He felt that government agencies could do more to lead by example in the buildings directly under their control.

Drawing from experience with a Maryland task force on indoor air quality, one panel member suggested that a government agency that leases space and writes contract requirements has the most opportunity to specify operational requirements. Mr. Kampschroer agreed that GSA could do more to use their building management activities to set an example, but also pointed out the need to couple good practices with research to demonstrate the effectiveness of any methods that are advocated. There should be continued effort to proving economic and health advantages with demonstration projects. He also pointed out that GSA holds only 40% of the buildings used by federal government agencies, so the other owner agencies could have a substantial impact with their properties as well. Dr. Kreiss agreed, noting that there are also logistical advantages

to involving the military and other government groups in outcomes research: cooperation may be greater than in studies conducted in the private sector, and clearances required for federal studies with regard to public burden do not apply. She mentioned a military indoor air quality study performed in the early 1980s that showed that basic trainees housed in new, tight, energy-efficient barracks had a much higher rate of infectious respiratory disease than those housed in older, leaky barracks, and consequently greater time lost to illness, which required them to begin basic training again. (Brundage JF, Scott RM, Lednar WM, Smith DW, Miller RN. Building-associated risk of febrile acute respiratory diseases in Army trainees. *Journal of the American Medical Association*. 1988;259(14):2108–2112.)

Question 4: How do we unleash market forces to improve indoor environments?

An audience member enumerated some of the organizations that can be approached to apply market forces: ASHRAE, CDC, DHHS, DOE, DoE, EPA, GSA, HUD, and NIH. It is also important to include building operators and maintainers among stakeholders who bring a life-cycle perspective. This commenter advocated a Call to Action from the Surgeon General, as it should be clear that there is a problem, both with regard to public health criteria of scope and to number of people affected. Another audience member who had worked with GSA indicated that, in his experience, government branches that lease and rent space have much more latitude to specify operations and maintenance provisions in their contracts than branches that build them outright. Leasing and renting is one area that could be used to unleash market forces. Another audience member, who had experience working on federal buildings using UV radiation and cleaning air coils for improving indoor air quality and energy use, suggested worker productivity as a primary economic “lever.” The government is able to run their program under orders to improve energy efficiency, and they can show that the same measures that make the building more energy-efficient can make it healthier at the same time. Executive Order 13123 requires energy savings in federal buildings. There has been a lot of research recently on the economic impact of improving the health of building occupants. He suggested the term “presenteeism,” meaning that the worker is physically there, but is unable to work effectively or productively due to health issues. Labor savings from decreased presenteeism and increased worker productivity can be a substantial market force. The moderator pointed out that this is partly a knowledge issue, making companies aware of the potential impact of indoor environment on presenteeism, but it is also an accounting issue, since, as pointed out in the morning presentations, employers must see the cost/benefit effects of their actions.

A consultant commented on the role of GSA in buying huge amounts of goods and services, which acts as a huge “economic motor,” but suggested there is some confusion due to conflicting or uncertain claims and standards for healthy building products. He suggested that a certification program is needed to guide purchasing decisions to products that truly enhance the indoor environment. Another audience member suggested making sure that insurance adjustors, especially those paying for reconstruction after flood damage, ensure that good practices are being followed when buildings are rebuilt. What insurance adjustors say, goes, unless someone wants to take them to court to force better

practices. With large private-sector owners (real estate investment funds, pension funds, partnerships, etc.), there can be a disconnect between risk managers (who deal with fear) and facilities managers (who desire to keep operations costs to a minimum), so there is a need to work at the ownership level to be sure that the communication takes place and “market forces,” such as fear of litigation, are applied.

Question 5: How can we assure that interventions are rigorously evaluated?

One participant commented that if you want rigorous evaluation, you need to be sure that people at the building site have the right tools and the right information. There is a need to reach out to building remodelers and their associations as well as to new home builders to encourage best practices. There should be input to the media and trade press to ensure accurate reporting and follow-up of positive and negative results of research into innovative building practices and hazards. CAPT Redd pointed out that people responsible for building do not necessarily have the research expertise to determine best practices. In radon control, for example, collaborative efforts with physicists were needed to move the program forward. An audience member from HUD noted the importance of good investigative practices, such as adequate sample size and good measures of change with multiple endpoints. Some small asthma intervention studies never had the statistical power to demonstrate anything.

Dr. Mitchell pointed out two barriers he has experienced to conducting good quality, well-evaluated research: (1) the need to identify agencies with specific mandates to fund studies concerning indoor environment (to put in place adequate funding for large-scale, high-quality studies), and (2) fear of liability on the part of building owners, operators, and contractors. Each time he has tried to conduct research in this area; it has been stopped by legal concerns within either the private or public sector (e.g., local government or school boards). Any time ideas are raised about linking health to a building, liability issues are also raised. The legal department puts up obstacles that can severely limit access to the building and its occupants. The moderator asked how that has been overcome. Dr. Mitchell responded that it has not been overcome. Lack of access to the indoor environment and its occupants is a huge impediment. He suggested that if this workshop can address that issue, that would be the single most valuable contribution it could make to further research on indoor environment issues.

An occupational health consultant pointed to the success of NORA and the interest and expertise that NIOSH has in evaluating intervention effectiveness. This process could serve as a model for making some progress in setting priorities in indoor environment concerns. Intervention effectiveness is a research priority for NIOSH, and for the international company senior health and safety managers with whom this consultant works. NIOSH must evaluate interventions in very complex, multi-variable occupational environments. The commenter also indicated the value of case studies and other designs based on social sciences models, suggesting that you do not need double-blind case-control studies to answer every research question.

A safety engineer consultant discussed his experience with a Blue Ribbon Panel in Washington State charged with monitoring school health and safety. The panel used funds allocated to schools by DoE to triage the needs for correcting structural and operational problems presented by individual schools in the state and to give advice on the most effective intervention. While he agreed with Dr. Mitchell that there are legal barriers (because the schools are afraid of confessing or disclosing problems), with \$100,000 awards per school district, they were able to get 100% participation in the program. The panel came up with the top 96 projects and evaluated them with architects, engineers, school nurses, and environmental health professionals. That evaluation, which is available from the Washington State Superintendent of Public Instruction Office, could be used as a model for a national program. Another audience member suggested a specific project: a request for proposals (RFP) should be issued to evaluate changes in GSA-controlled buildings. NIEHS has already suggested that they might be interested in doing this, but it should be a limited and very specific RFP.

Question 6: How can the barriers for implementing widely accepted interventions, such as remediation of water intrusion, be overcome?

The barriers to implementing interventions include issues such as cost, and, in some situations, opposing market forces. Several audience members pointed to the issue of lack of public awareness of the ill-health consequences and the greater long-term costs of not addressing problems promptly. Required disclosure at time of sale in the real estate industry provides one good model of how to overcome this barrier by using market forces. The seller becomes aware of the problem and has to deal with it. Another audience member commented that the elderly on fixed incomes and low-income renters often face financial barriers in meeting the costs of remediation, and lenders are often not responsive to the needs of these people. Weatherization programs that use vouchers and low-interest loans provide one model of how to overcome this barrier. Tax breaks also work for those with enough income to pay taxes. This person also suggested working backwards from the homeowner, dealing with agencies that work with homeowners such as realtors, housing inspectors, code officials, HUD, etc. She also recommended the informational pamphlets produced in English and Spanish by HUD to raise the public's level of awareness.

Mr. Levin suggested that the Surgeon General should use his position to frequently raise consciousness on indoor environment issues at all levels of society. The interests touched by indoor environment concerns are broad and affect every level of society and income level. Having worked in the field since 1978, he believes that no single action will correct the problems, but that each effort motivates the next action by increasing public awareness and by building public and government support for taking indoor environment problems seriously. An audience member referred to an employee relocation program that moves 30,000–40,000 people a year and often deals with mold cases, in Texas and elsewhere. They could not sell old properties affected by mold, and that situation added to the cost of the program. As a reaction to this problem in Texas, J.C. Penney Company, Inc. mounted a proactive videoconference program on operational maintenance, showing that it is financially more advantageous to make repairs on your house to prevent

problems than to pay \$5,000 later for mold abatement. Twenty thousand people responded to the program and the company saw a 25% reduction in their costs in 6 months.

Another audience member stressed financial limitations as an overriding concern: school collecting water in buckets from a leaking roof certainly understands that there is a problem and how to correct it. Funding issues in the public sector might best be addressed with some sort of escrow strategy, establishing a funding source based on holding back a small percentage of new construction funding so that in 20–30 years, funds will be available to allow repairs to be made quickly. The moderator commented that California (through Cal/OSHA) has declared mold in a building as a sanitation issue in the occupational setting, indicated that it is not acceptable, and issues fines to employers who do not repair water damage. This is a simple and effective solution, but only operative in California at present.

Question 7: What are the areas of research for which we have an inadequate knowledge base?

The moderators suggested some candidate areas for research:

- The role of indoor environment in transmission of respiratory infections;
- Ventilation standards and their impact on health;
- Exposure assessment methods for health studies;
- How to get researchers to do multidisciplinary work in linking health risks with environmental measures; and
- The nature of residential exposures.

Dr. Spengler used the SARS outbreak as an illustration. There were articles in the *New England Journal of Medicine* describing how one incident case on a flight to Hong Kong led to 20 subsequent cases and an apparent example of residential transmission of disease from an incident case on the eighth floor of a tower apartment building to an adjacent apartment building, based on ambient airflow patterns. However, basic information is lacking about the spread of viral vectors through ventilation systems and the survival of disease organisms on various surfaces, so the apartment infection pattern cannot be analyzed with precision. There is a fundamental lack of knowledge about how we are infected in our buildings, especially in schools and day care centers, which can be a major factor in spreading disease. This is a major multidisciplinary research problem that needs to involve medicine, engineering, and public health expertise. The infectious disease community, the building science community, and the epidemiology community would have to join forces, and there is no agency that does this at present.

Dr. Woods pointed out that exposures and ventilation are often considered separately, but ventilation is a flow rate, and is just an engineering tool to achieve indoor air quality. Research is needed to understand loads and emission rates of contaminants so that ventilation rates can be calculated. We can get by with about one cubic foot per minute (cfm) per person (or 2–3 cfm/person in submarines) because the respiratory rate is about a 10th of a cfm/person, but we need to know a lot more about optimal rates. He

mentioned Finnish and Danish Institute studies as examples of the kind of research that is needed to calculate ventilation rates. Mr. Fisk mentioned the need for research on how indoor chemical exposures affect allergy and asthma outcomes, for which there is only European research. Other research needs include determining how people are exposed to bioaerosols, and how classroom ventilation rates affect health. Finally, better exposure assessment for bioaerosols in relation to the health effects associated with damp and mold growth is a research need.

Another audience member mentioned neurotoxicology as an endpoint, specifically for toxins such as organophosphates. More basic information is needed on neurotransmitter physiology and immune system function in relation to indoor environment factors, specifically to understand their interaction in health status. Another participant suggested that a better understanding of guideline effectiveness is needed to determine whether guidelines are adequately protective with a high probability. Many research studies are carried out to answer scientific questions, but the answers are hard to apply to operational use. For example, it is necessary to reduce SARS studies to a practical level regarding issues such as how diseases are actually transmitted in the office environment. Another audience member pointed to open questions about the relationship between building material properties and their impact on the indoor environment. For example, research is currently lacking to guide the choice of building products in terms of their ability to support mold growth. Basic information on material properties, such as the capacity of wallboard to hold water, is often not available even from the manufacturer.

Dr. Storey commented on the need to assess the burden of disease attributed to the indoor environment, which would provide some measure of the impact of changes in building conditions over time. While green building innovations are very exciting, the point was already made that 80% of our building stock will still be with us in 20 years, so change in our communities will have to be incremental. She suggested a need to give good advice about dealing with current buildings, and suggested that agencies should give grants only to programs that are seriously multidisciplinary and address components of exposure, mechanisms of disease causation, disease burden, and intervention.

One audience member addressed the element of exposure, pointing out that many indoor pollutants undergo chemical transformations in the indoor environment, and the resulting reaction products may be more toxic than their precursors. NIOSH sponsored a workshop on this topic, Indoor Chemistry and Health (held at the University of California, Santa Cruz, July 12–15, 2004). Information from the workshop will be available on the NORA Indoor Environment Team Web page, and a workshop summary will be published in *Environmental Health Perspectives*.

Damp buildings may be a particular concern because dampness causes hydrolysis reactions, or favors microbial growth that changes the pH of building materials, favoring certain chemical transformations. The moderator commented that we often do not know exactly what these toxic agents are, and therefore what to measure, although it still may be possible to solve a lot of problems by mitigating dampness. In this context, Ms. Loftness suggested classifying specific human health effects that are impacted by the

physical environment by human organs or systems – vision, skin, respiratory, digestive, etc. This exploration would support building material and systems research and their impact on short- and long-term health problems. She also suggested that the importance of access to nature should be in the equation because of its interaction with mental and physical well-being. One participant noted that there are four Japanese environmental medicine units, and they often focus on susceptible populations. She suggested that we should be using this approach as a model for what we do in the United States. The moderator noted the large number of agency programs related to indoor environment discussed or mentioned during the comments, and underscored the evident need for coordinated, integrated federal research effort with more stakeholder input.

Question 8: What are the key economic issues? What provides the cost-benefit rationale for health care payers?

These economic issues are important areas with potential for driving change. One participant suggested that there is great interest among corporate health and safety managers and human resource managers in enhanced productivity as a key economic benefit of improved employee health. An audience member affiliated with a state health department indicated that health care coverage costs were very “disaggregated” from building management costs, making it hard to unite costs and benefits in the analysis (referred to as “the disaggregation problem”) and suggested that there must be a way of reversing this. He used the example of the automobile industry as a model: without market and regulatory pressure, most of the improvements in safety and fuel efficiency would not have come about. Similar pressures now need to be applied to the building industry. Disaggregated stakeholders are a major barrier to progress. If GSA really understood and acted on health care and productivity loss costs attributed to indoor environment issues, it would serve as a good example to motivate change. The moderator returned to the suggestion of commissioning a NAS report on the economic consequences of indoor environment issues as a way of moving people to action.

An audience member from a regional EPA office suggested the need to better inform Medicare, as well as private health care payers, about the economic impact of indoor environment issues. Since private insurers only cover what the contracts say they should cover, the federal government should lead the way in determining what federal health benefits programs cover. Another audience member indicated that Social Security (as insurers of last resort) and state disability programs should take on these costs, and should be included in discussions. State Social Security agencies can consider environmental illness on a case-by-case basis and may dismiss “sick building syndrome” cases as psychosomatic somatoform disorders rather than bill back the costs as work-related disabilities. Changing this practice would bring about a strong economic incentive to make indoor environment improvements.

Another audience member disagreed, suggesting that the slide from Ms. Loftness’ presentation was very convincing from the perspective of a large employer in indicating that the economic impact of health-related productivity improvements resulting from indoor air quality were minor compared to ergonomic and other factors. He predicted

that productivity increases associated with indoor environment quality would be too small to be a prime motivator in industry. In addition, the “charge-back” process and use of market controls are inefficient and ineffective in practice, even for changes with a clearly highly beneficial cost/benefit. The clearest example is the automobile industry, where market forces were insufficient without government regulatory pressure to improve automobile safety. An analogous situation occurs during building construction where basic quality flaws (like poor flashing) result in only minor market pressures on the builder because they are hard to monitor and enforce, but have major long-term negative effects down the line. Quality improvement procedures rather than market forces are needed to effect better building practices.

Another audience member commented on application of life-cycle cost theory: she agreed that market pressures are not very effective in dealing with such issues without regulations and standards enforcement that provide more immediate penalties. It is the federal government’s responsibility to apply tools such as life-cycle management to the problem.

Mr. Fisk suggested that economics may be a stronger incentive than these views indicate, and he advocated using both economic incentive and regulatory action. He suggested that any business that can save money in health care costs will be well motivated because such costs will surely increase. Another participant also disagreed that cost savings associated with improved indoor air quality were too small to be effective, citing statistics from the Washington Business Group on Health and the Integrated Business Institute (IBI) that calculated costs based on employee loss of productivity. The cost of allergy was estimated at \$250 per affected employee per year, \$100 for each employee with asthma, and \$125 for each employee with respiratory infections. As health care costs are escalating each year, there is good potential here for return on investment.

Question 9: What are the best ways to reach the public and those responsible for the performance of buildings?

The moderator mentioned Mr. Levin’s recommendation for a “homeowner’s instruction manual” and indications by others that such materials have already been produced by some agencies. Audience members cited various educational publications, such as *Inspecting a House* from Cornell University Cooperative Extension Service. The USDA Cooperative Extension Service was suggested as a means for outreach to the public. EPA, HUD, and CDC have all produced good materials. There may be more need for training materials on the building practices side. Another commenter recommended the U.S. Green Building Council’s publications on sustainability as a good model of public education. Audience members suggested that there is a need to inventory and evaluate existing manuals and similar material to see what is already available before producing new educational tools.

Several audience members supported the idea of using a Surgeon General’s Report to elevate the public’s awareness of indoor environment as a health concern, while others spoke to the need for instructional materials targeted to the interests of specific groups.

Based on his 30-year history of interest in these issues, Dr. Woods spoke to the need to educate the professions (such as architects and architectural engineers on one hand, and health professionals on the other) to take indoor environment issues seriously. He noted that only 2% of engineering/architecture schools have any component of the curriculum dealing with health issues. On the other hand, he asked, how many health professionals study building materials and performance issues? One audience member mentioned the American Lung Association's Health House: Builder Guidelines and described her own experience with an environmental illness and the problems she had in finding a contractor willing to build to those guidelines. She suggested that while some people are in "desperate need" of housing constructed to high indoor environment standards, they may have difficulty finding informed and willing contractors. This indicates a need for material aimed at builders and remodelers. The Surgeon General's Report from this workshop could provide support to contractors with an interest – pioneers are needed!

Several audience members discussed reaching segments of the public in support of economic incentives. One suggested that different classes of commercial buildings are not uniform; they have different standards and fiduciary requirements, so it may be necessary to explain health benefits in different ways to different business interests. In addition, one architect/engineer suggested the model of the U.S. Green Buildings Council, implying the potential value of a similar "Healthy Buildings Council." An audience member who works at a local health department mentioned that he finds checklists and basic information on issues like water intrusion are effective. Renters and landlords of small properties need to be approached differently from large housing agencies; well thought-out guidelines are helpful.

Dr. Spengler wrapped up discussion of the questions by stressing the need for supporting research and education, suggesting that if well documented toxic effects are found for a particular building product, manufacturers will eliminate it from the market (an example being p-dichlorobenzene, which was recognized as a carcinogen and is no longer used in building materials and now rarely turns up in assessments). Programs such as the EPA's Toxic Release Inventory help to remove such materials from the outdoor environment, but such a labeling requirement does not extend too many products that go into our homes.

Finally, Mr. Levin urged the Surgeon General to take the lead in encouraging and facilitating collaborations among federal government agencies as well as encouraging private sector research and public information programs. Mr. Levin said that the Surgeon General was ideally positioned to raise public awareness and provide the basis for broader application of current knowledge as well as development of the necessary new understanding of the importance of the indoor environment for public health and welfare.

Highlights from Vision for the Future Session

A committee established under the Office of Science Technology and Policy could serve as the key to coordination and collaboration on improving the indoor environment.

Multidisciplinary programs to improve indoor environmental quality exist in and outside government, providing models and partners for new collaborative efforts.

One focus of any indoor environment activities should be improving the health of the occupants.

Good applied research is needed to demonstrate the effectiveness of various building management activities and technologies. Federal government buildings could be used as demonstration projects to model both innovative technology and the use of market forces and contract requirements to motivate better practices.

The Surgeon General should continue to advocate action to improve the indoor environment as a public health policy priority.

To advance healthy indoor environment research, both funding and liability issues need to be addressed. Liability concerns often severely limit a researcher's access to a building and its occupants.

The public is generally not aware that delays in improving their indoor environment conditions, can result in potential long-term costs that can have an impact on their health.

Health care coverage costs are "disaggregated" from building management costs: Medicare and private health care payers need to be made aware that failure to improve the indoor environment can increase long-term health care costs.

How the indoor environment influences the transmission of respiratory infections is poorly understood. Intervention studies may play an important role in clarifying these influences.

If improvements to the indoor environment can reduce the occurrence of asthma, allergic responses, and respiratory infections, the cost savings will be significant.

Programs yielding new approaches must be balanced with programs to apply or enforce known best practices. This approach will produce the greatest incremental health improvement for residential and office building occupants.

As the nation's doctor, the Surgeon General is uniquely situated to advocate for and help to coordinate collaboration to promote healthy indoor environments.

Broad outreach is needed to educate homeowners, builders, maintenance personnel, architects, and planners about healthy indoor environment issues.

A coordinated, integrated federal research effort with more input from stakeholders is needed.