

# COSMOS

## Consortium of Organizations for Strong-Motion Observation Systems

### Senior Advisory Council Meeting

7 February 2002

7:30 PM–9:00 PM

Westin Hotel

Long Beach, California

Summary prepared by W. U. Savage

#### Participants:

John Ake

Bob Ballard

Jim Davis

Farzad Naiem

Woody Savage

Jennifer Swift

John Anderson

Bruce Bolt

Bill Iwan

Bob Nigbor

Tony Shakal

Ralph Archuleta

Allin Cornell

Claire Johnson

Maury Power

Carl Stepp

The meeting was called to order by Chairman Allin Cornell at 7:30 PM. Chairman Cornell posed three questions as the topics for the evening's discussion. Each question is presented, followed by its discussion.

#### **Topic 1. How should data, including metadata, for buildings and other structures be stored and disseminated to most effectively serve the earthquake engineering community?**

Archuleta led this discussion topic. He noted the absence of guidance and databases for storing data on buildings versus the kind of data that are stored for reference strong-motion instruments. Cornell noted that the funding may also be different, and could fall under the purview of NSF, not the USGS. This is an engineering responsibility. But economies of scale and technology could save money in storing building data along with data from the COSMOS Virtual Data Center (VDC), and there could be joint funding for both.

Anderson noted that UNR is planning to merge the different types of data in the absence of any further direction. Shakal noted that there is much additional preparation needed for organizing and storing the extensive building metadata, compared to what is needed for the reference shaking data. The Engineering Data Center under CISN will be set up to serve both building and reference data and metadata. Archuleta noted that it is not a simple add-on to the data, and that thinking needs to start early to assemble the structural plans, etc. Savage noted that the plans could be available to those needing the data, without making them publicly available. There are data at the VDC from the USGS CD that come from buildings. Shakal pointed out that the building data and metadata could be treated just like reference station data.

Stepp asked if there was anything fundamentally different about the building database structure compared to other recordings. The metadata are different, and the 3-D nature of the instrument locations in the building needs to be addressed. The instrument layout needs to be presented graphically, and filters are needed to enable searches for types of buildings. Stepp summarized that the critical issue is documenting and retrieving the metadata much as station data are stored. Naiem noted that this is true as long as the building doesn't change, such as would be the case if the building were damaged. If there are changes, they need to be put into the metadata.

Shakal noted that most of the buildings instrumented to date have been instrumented by CSMIP and the USGS in California, and procedures to put metadata on the web are being solved by these two organizations. If a building instrumented in New York were being done with involvement of the USGS, then the metadata could be stored in the same manner as is being developed in California. Stepp suggested that the real issue here is a greater emphasis on metadata; it may be possible to use existing technology as is being done for the COSMOS Geotechnical database project. The action might be to review what is available, and to plan what is needed. Power noted that the COSMOS Geotechnical Database could be used for all of the site geotechnical and geophysical data, and be linked from the VDC.

Archuleta raised the question of access to building plans and other information after an event has occurred. Naiem pointed out that the plans could be obtained if there is a legitimate use. The locations of the instruments need to be described, even though the building plans may not be available to everyone. Then a search for buildings with particular instrument configurations could be done. Naiem gave an example from the building database project he worked on for CDMG. The hard part is setting up the building information database. ANSS needs to know what the minimal building information should be. The sensitive information should be left out of the publicly available data.

Cornell noted that for studying nonlinear performance, more detailed information about the building would be needed. Naiem noted that the typical structural engineer would not be using this database as a means to address his design problem. This application is really needed for research in engineering, to see how buildings behave. That person would have to retrieve the data from CSMIP or the USGS. Cornell asked what kind of commitment should be obtained from the building owner before investing \$100,000 in instrumenting the building. Naiem noted that what CSMIP has put into place is pretty workable. If there is a legitimate research use, then the interested parties can proceed to get more information from city building departments, under specified security procedures. Savage asked about access to post-earthquake condition information for a building. CSMIP does not have that kind of information, and it is difficult to get, particularly in a timely manner. Access should be more assured if the building is publicly owned. Power suggested that a building should not be heavily instrumented unless the detailed drawings are made available, and written permission for access following an earthquake is provided. Naiem suggested doing as many public buildings as possible. CSMIP has found that instrumenting public buildings is complex in terms of getting permissions, and Shakal is uncertain that access would be provided to data on the post-earthquake condition of public buildings. Some owners and operators are concerned about having information released about building damage. The USGS and ANSS have promised Congress that monitoring will be installed in the urban environment, so lack of access to critical post-earthquake information could undermine Congress's intentions. The COSMOS Workshop successfully included representatives from the ANSS regions, and made progress in

planning for ANSS-funded building instrumentation. Stepp noted that such access is a substantial legal problem and implementation problem, not an engineer's problem.

Nigbor suggested that COSMOS establish a guideline for metadata requirements for buildings, along with a couple of examples. Using Naiem's examples developed for CSMIP, this could be accomplished rather quickly, perhaps even by CSMIP and the USGS working together. COSMOS could be involved. Iwan raised the matter of treating building data just like network data. Cornell and Naiem noted that sensors other than accelerometers, such as strain gauges, might be placed in buildings. Anderson noted that any time series data could be processed through the recording streams. Iwan pointed out that in TriNet the data are not archived at 200 samples per second, after a week. Shakal noted that the data going in are at 100 samples per second, even though it is desired to have 200 samples per second. There are questions about how the TriNet data are actually stored.

Cornell raised the question about possible competition among strong-motion databases. Archuleta raised the concern if CISN makes data available with no link to COSMOS. The TriNet data have been available through the SCEC data center at Caltech. The issue is if the data can be searched. Although the data can be linked to COSMOS, they can also be obtained directly from the original archives. The COSMOS VDC provides flexible search capabilities. All the legacy data at USGS, CSMIP, and elsewhere could be converted to COSMOS format, if desired. Shakal noted that currently, there are no formal agreements between the COSMOS VDC and the individual COSMOS agencies. He suggested that such agreements might be useful to avoid misunderstanding. He further noted that the idea of having from participating databases reside at the COSMOS VDC central hub is fundamentally against what COSMOS is trying to do. [Data from data providers that do not maintain a database do reside at the COSMOS VDC central hub.] The COSMOS VDC is a place to have a search engine. Shakal noted that the COSMOS VDC must coexist with the source agencies, and we must not lose sight of that. Archuleta agreed that the VDC does not distribute CSMIP or other agencies' data, unless explicitly agreed to, as in the case, for example, of New Zealand. Stepp suggested that this question is an administrative matter that is critically important, and agreed with the need for stability of understanding by all parties. (It will be addressed during the coming year with the objective of establishing suitable agreements.)

**Topic 2: What actions could or should COSMOS take to define the needs of the emergency response community and local government agencies for earthquake information to support emergency response and recovery? This topic includes the scope of information and communication infrastructure.**

Shakal led the discussion of this topic. He noted that these communities don't know what they don't know, and there is a need for action to educate them about their unrecognized needs. Savage commented that in CISN, the state OES is set up as the primary user of CISN information; maybe the CISN-OES relationship would be a good vehicle for OES to fund a planning or education program in this area. Davis sees a national implication as well, with the CISN as a template for other regions. COSMOS could play a facilitative role in this. We are looking at a frontier in terms of applications. We have strong-motion data in urban areas—how could the engineering community use these data in the short period after an earthquake to consider the damage to buildings and the safety of entry and occupancy of buildings. This is a topic that needs to be considered, perhaps in developing a guideline

for the response that OES is trying to do. OES personnel attended a workshop at Caltech to learn about ShakeMap when it was still in a conceptual stage. Two years ago in Seattle, the director of OES was excited about the possibilities for ShakeMap. He got the Governor's office to put it in the budget for the next year. This could be a template for other states. States need to buy in and make that kind of commitment in areas of significant earthquake risk. This could also raise the level of funding of ANSS at the national level. This is a grand opportunity that goes beyond the immediate issue. It extends to critical facilities and lifelines, and a variety of applications. Shakal described a recent meeting hosted by Zan Turner in San Francisco to consider what role seismic instrumentation could play in evaluating buildings for post-earthquake use. The meeting was somewhat contentious, with strongly divergent opinions about the value of the data. Stepp noted the importance of this issue, and that it has many dimensions. The users need to deal with many issues, and we probably don't know much about them or the communication links and infrastructure to achieve what the building owners want to achieve, and the building department doesn't know what is needed either. This is an area of great service that COSMOS could provide. Shakal noted that the City of San Francisco wanted to adopt the same code that Los Angeles has for building instrumentation. Cornell noted that the issue of amount of instrumentation to really understand the building was probably orthogonal to the instrumentation plan in the proposed code ordinance. Ake also noted that the same problem exists with trying to integrate instrumentation with rapid response for dams, with people arguing that the inspector goes out to look, and either the dam is there or not. Naiem said that ShakeMap is not enough for assessing the condition of a building. Power noted that the data from a few instruments in a building is not enough without knowing a lot more about the redundancy in the design, etc.

Savage commented that OES is a likely funding agency for this topic. Stepp noted that right now this is a big gap.

### **Topic 3: What action could or should COSMOS take to promote the development of new and perhaps less expensive strong-motion instrumentation and other monitoring technologies?**

Nigbor led the discussion of this topic. He wanted to modify the question to address new technologies for instrumentation. In the COSMOS Building Instrumentation Workshop, the suggestion was made to set aside some of the ANSS funding to explore the introduction of new technologies. The two areas of needs were direct measurement of interstory drift as a performance measure, and direct measurement of base rotation. Neither is being done now. A third area was the whole issue of real-time data. The suggestion was made that ANSS should provide real-time data to users for some buildings, but maybe not all. A driving issue is that the building data are really important for research, but real-time data are also important for promoting the instrumentation. The technology is there now to provide the data. Nigbor summarized some of the new instrumentation technologies that are addressed in the COSMOS Building Workshop report.

COSMOS could come up with a recommendation statement that these new technologies should be considered. Some internal COSMOS funds could be used for this. Stepp noted that the Workshop strongly urged that ANSS funding should include new instrumentation technologies. He also suggested that there could be a meshing of this interest with NEES experimental research in instrumentation of buildings, such that there are a few buildings in high seismic zones where we're experimenting with how to place the instruments and what the measurements could give us. Bolt noted that we are

facing a cusp in what structural engineers are thinking now. Following the 1989 earthquake, and for the Golden Gate Bridge, instrumentation was installed by CSMIP in a “temporary” fashion, to be modified following completion of finite element analyses of the bridge. There was a request for displacement measurements, but no definitive requests for accelerographs, beyond what was already in place. Naiem said he was interested in all kinds of data, but as a basic set of measurements, we still need accelerations. Stepp asked if you had the money, would you know how to get the information you want? There was no clear answer, except that the concept of having the money was wonderful. The NEES cooperation was enthusiastically supported. Archuleta noted that there are questions about large displacements that can be measured by differential GPS. Savage noted the problem with getting adequate sky view except at the roof. Naiem said that if the objective were to see if the building has had enough displacement so that its integrity is questionable, then the GPS measurements would work. If the question is what is needed to research how building components behave, then we need more information, multiple levels of instrumentation: ground, code, and in some cases more extensive instrumentation. Archuleta noted that the scale of the deformation needs to be considered. Integrating acceleration is generally very hard to do. Naiem noted that it is not just displacement needed, but also rotations and other measurements that we cannot get from accelerometers. Savage noted that these issues are important, but nothing will happen until something is written down as guidance that regional committees can apply. He also pointed out that ANSS procurement is currently aimed at high-end specifications of accelerographs, and no others. The specifics of using several levels of instruments as well as several types of instruments are not being addressed. Archuleta noted that the ANSS authorization focused on accelerometers, not other types of instruments. Anderson echoed the tradeoff of numbers of instruments versus their performance and cost, and urged that this group could bring important perspective on this matter. Shakal noted that for bridges and base-isolated buildings, his group is measuring relative displacements right now, and the cost per sensor is about \$1000 no matter what you use. Cornell and Bolt noted that we want displacements for inter-story drift in the non-linear range. Naiem wants different types of instruments: displacement meters, velocity meters, etc. The same instruments should not be installed everywhere. Iwan suggested that the Millikan Library could be used as a test bed for installing and evaluating all these types of instruments. Stepp said that these issues were addressed the COSMOS workshop on strong motion instrumentation of buildings, but they were not developed in detail either as recommendations to NSF or ANSS. Davis suggested that COSMOS could be an effective communication means between the structural engineers and other players in real-time seismic monitoring; a single discipline is not sufficient. COSMOS could promote a multidisciplinary assessment of the use of emergent technology, filling a unique and valuable role. Savage agree that this would be useful, and suggested that the directives within ANSS should allow for this. He also noted that the USGS external research program could provide an avenue to research building instrumentation. Cornell noted that statements in this area sent to NSF by COSMOS would be useful.

Chairman Cornell closed the meeting at 9:00 PM, with thanks to Archuleta, Shakal, and Nigbor for leading the discussions.