

*Consortium of Organizations for  
Strong-Motion Observation Systems*

**COSMOS**

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June 10, 2001

**Meeting of the Senior Advisory Council**

**DoubleTree Hotel**

February 8, 2001  
6:00 PM – 7:30 PM  
Monterey, California

**Attendees:**

John Ake	US Bureau of Reclamation
Bob Ballard	Army Corps of Engineers
Bruce Bolt	COSMOS
Roger Borchardt	USGS
Lloyd Cluff	PG&E
C. A. Cornell	Stanford University
Jim Davis	CDMG
Mike Davister (for Jeff Kimball)	DOE
Greg Deierlein	Stanford University
John Filson	USGS
Moh Huang	CDMG
W. D. Iwan	Caltech
Claire Johnson	COSMOS
Farzad Naeim	John A. Martin & Assoc.
Robert Page	USGS
Maury Power	Geomatrix Consultants
W. U. Savage	PG&E
Tony Shakal	CDMG
Melinda Squibb	UC Santa Barbara
Carl Stepp	COSMOS
Yi-Ben Tsai	Central University, Taiwan

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## **Opening of Meeting**

The meeting was opened at 7:30 PM by Chairman Allin Cornell. Chairman Cornell reviewed the objective of the Senior Advisory Council, to think more expansively about questions of concern to COSMOS and to address matters of COSMOS policy regarding the earthquake engineering profession. He identified three specific topics for discussion during the evening: building measurements needed for performance-based design; the nature and degree international involvement of the Advanced National Seismic System (ANSS); and the current status of ANSS and the future role of COSMOS with respect to ANSS.

## **Building Measurements**

COSMOS Secretary Woody Savage brought forward a question on building instrumentation needs that arose in the ANSS Instrumentation Subcommittee. Chaired by Tom McEvelly, the first meeting of that subcommittee raised the question of the importance of making direct measurements of building deformation, i.e., displacement, interstory drift, along with the current practice of strong-motion recording in buildings, to earthquake engineering practice and research. Basically, what are the needs, currently and into the next decade, for acquiring data from buildings that would directly relate to engineering procedures and research that ANSS should be aware of as planning proceeds to specify sensors and data acquisition systems for the national implementation of ANSS. Tom McEvelly wanted to assemble a group of engineers to address this question, however, in consideration of the difficulty of getting such a group together, Secretary Savage interviewed individuals on this question and was invited to bring this question before the SAC. Secretary Savage noted that the ANSS plan involves installing 3000 strong-motion instruments as reference stations and 3000 instruments in buildings, with the potential for collecting additional instrumentation data.

Chairman Cornell commented that the question is a good one. Performance-based engineering implies that engineering assessment and prediction of behavior will be pushed into the inelastic regime. That means we will get away from direct relationships between force and displacements, with force dropping out and displacements being the most important quantities to measure. The current practice of measuring accelerations leaves something to be desired in that it is necessary to integrate to get displacement. Of particular interest is the possibility for ANSS to provide hardware and information technology to collect displacement data.

Chairman Cornell discussed this problem with Greg Deierlein, who has a lot of experience in trying to compare the predictions that engineers make of linear and nonlinear behavior in buildings with some available observations from recent earthquakes. Dr. Deierlein commented that this displacement information is critical to performance-based design in validating performance or simulation models. There are limited data available, particularly from the field. Usually (as from SMIP-supported analysis of building recordings in the Northridge earthquake), the building information is not of high enough resolution (not enough instruments per floor), and the measurement of interstory drift is critical. Current instruments are of limited usefulness in this regard. Unfortunately, we do not have any good devices for doing it, except ones that have to reach between one floor and another. Shake-table experi-

ments and field measurements of low-rise buildings would be much more successful if we had devices that would measure deformation in 3-D space, similar to GPS but with higher local resolution. At present we must rely on accelerographs. The idea of putting capabilities in the ANSS instrumentation to plug other devices into in the future was raised. This would allow for local strain gauges or deformation meters to be added later. Bob Ballard noted a new company called Mezure that has some new patents that offer 10-Hz GPS sampling and real-time transmission of data via satellite, with sub-centimeter accuracy. President Bolt noted the importance of velocity meters for bridge measurements in Japan, as reported in the October 26-27, 2000, COSMOS workshop "Recommended Guidelines for Instrumental Diagnostics of Seismic Response of Bridges and Dams." This gets us closer to measuring displacement. Carl Stepp noted that in the 1930s, when the strong-motion program was initiated, buildings were instrumented with displacement meters, but they never evolved. Tony Shakal noted that we should consider both absolute and relative displacement measurements. For example, the Golden Gate Bridge has installed relative displacement sensors at hinges and across base-isolated planes, with accuracy of hundredths to a quarter of an inch, to complement accelerographs. Greg Deierlein noted the need to get measurements of the soil-foundation-structure interaction. John Ake noted the importance of radiation damping and that it cannot be measured by a single instrument in the foundation of a structure. Bill Iwan noted the bottom line: it is necessary to allow for additional bandwidth in instrumentation (both lots of channels and wide dynamic range). Bob Page noted that the ANSS vision did not clearly address the multiple numbers of instruments needed for buildings versus a single instrument at a reference station. Chairman Cornell observed that displacement meters may not need to be very expensive in themselves, but the installation could be costly. Tony Shakal and Bill Iwan suggested that there is a need to heavily instrument at least a few buildings or the detailed answers to building performance discussed by Greg Deierlein will never be obtained. Perhaps instead of instrumenting 1000 buildings, only 10 or 20 should be instrumented very thoroughly. Carl Stepp noted that the COSMOS virtual strong-motion database is intended to host building data as well as free-field data. He also asked that further thoughts on how these topics could be addressed in the future by COSMOS would be helpful. Bob Ballard mentioned the upcoming ANSS Regional Organizational Meeting on March 8th for the New England region, with the Core of Engineers (Bob Ballard and others), Lamont, Weston, and others in attendance. He suggested that COSMOS should be represented. Bill Iwan noted that COSMOS should be integrated with such projects as the one the EU is about to fund, to heavily instrument buildings in three different countries (Mexico, United States, and Europe) and make the data available on the Internet. Julius Solnus is the Principal Investigator.

### **Status of the ANSS**

Bob Page distributed a handout that summarized the status of the implementation of ANSS. He reviewed the management structure of ANSS, noting the participation of COSMOS in the National Steering Committee and three EERI representatives to provide earthquake engineering input. He also reviewed the status of the Regional Committees and the Technical Integration Committee. The Regional Advisory Committees also provide broad engineering input. Jim Davis reported that the California governor's budget now has a proposed budget line item for \$6.8M for real-time monitoring. These state funds would augment ANSS funding, and the regional advisory input will cover both sources of funding.

Woody Savage reported on the role of the Technical Integration Committee and its subcommittees in developing written standards and other guidance for the design and construction of the ANSS. July is the target date for providing written guidance. John Filson reported on the near-final status of the ANSS Management Plan prior to its being reviewed by the Steering Committee. The challenge of installing 7000 new instruments in 5 years is very daunting. The instrument purchases need to be concentrated in the early years. Some structures will be instrumented in the current fiscal year; plans have been developed for San Francisco Bay area, Salt Lake City, and Seattle area buildings. Last year there were 86 strong-motion instruments installed, with 100 planned for this fiscal year.

Carl Stepp asked for ideas regarding the optimization regarding the interface between the ANSS program and COSMOS. John Filson emphasized the importance of COSMOS' guidance into how to best accomplish building instrumentation and how to archive and distribute strong-motion data. There are good options available for storing seismological data, but he would look to COSMOS for how to store engineering data. Carl Stepp noted that COSMOS has had a long-term goal of developing guidelines for many aspects of strong-motion data. He noted a need for a more general discussion of the strategies for types of instrumentation, types of buildings to be instrumented, and what should be put in various classes of buildings. John Filson agreed, noting that the ANSS regions need to have guidelines to be able to implement the regional strategies. Chairman Cornell and others suggested that there needs to be guidance on how to set national priorities for selecting areas to instruments in terms of hazard levels, types of buildings or other structures to be instrumented, transferability of building information from one region to another (this is an important cost-effective strategy to optimize the likelihood of getting building performance data in one region that could apply to the types of buildings in other regions). Chairman Cornell pointed out that, from the engineering point of view, the objective is not to get empirical data from each and every type of building, but to validate analytical models. There may be some regionally specific types of buildings that pose separate problems for which more locally applicable data would be needed. Jim Davis noted that the nation must better understand the effectiveness of mitigation strategies in building retrofitting. Woody Savage emphasized that since the planning in the regions is underway, the need for the guidance being discussed is immediate. Bill Iwan suggested that the national-level guidance could say, "instrument buildings in the regions of higher seismicity that are reasonably typical of new construction throughout the U.S. (thus increasing the likelihood of getting nationally useful data in the shortest time); in the regions of lower seismicity, instrument those buildings that are peculiar to the regions and have unique features that would not be constructed in the other regions." Bill Iwan further suggested that the ANSS regional committees in lower seismicity regions should identify unique buildings in their regions, but they should not pick a moment-resisting steel-frame 20-story building in an Eastern city if the same type of building could be picked in San Francisco or Los Angeles. Farzad Naeim noted that one had to be careful to note that building detailing, construction practices, etc. can be quite different between California and other regions of the country, even though the modeling tools are the same. Chairman Cornell reconfirmed that the validation of modeling capabilities is the priority objective, however, regional attenuation properties and source properties would need regional data. Chairman Cornell summarized that COSMOS should encourage the development of guidelines that would be useful at the national level for national issues—what buildings should be instrumented and how should the selected buildings be instrumented for the purposes of analytical model validation.

John Ake asked if bridges and other critical structures would be included in the ANSS instrumentation plan. John Filson said that the initial concept for ANSS focused more on the general building stock rather than unique structures. "Representative structures" is perhaps the best term.

Claire Johnson asked if such guideline activities could be done under the auspices of the Strong Motion Programs Board, perhaps with the help of a contractor. Carl Stepp responded that there is probably a need for some integration between several of the ANSS technical subcommittees and COSMOS' efforts. This could involve some small workshops, for example, to get multiple interdisciplinary inputs and a comprehensive effort. Claire Johnson suggested the Bridges and Dams workshop might be an appropriate model for holding a two-day kind of meeting on this topic, perhaps co-sponsored by PEER and ANSS. Tony Shakal wondered if the ANSS Regional Committees might not be receptive to national guidance given the high level of regional autonomy. Bob Page responded that, from a national perspective, the effort must add up to a rational whole, and that the choices need to be made more carefully if the instrumentation of structures moves toward more detailed instrumentation of a smaller number of structures. John Filson noted that the technical committees really want input from the engineering community and would really use it extensively. He also noted that the planned distribution of instrumentation is heavily weighted to high-seismicity areas. Bill Iwan suggested that perhaps the structural instrumentation could be done on a kind of competitive basis, not on a regional basis, such that the national level could request proposals from the regions and then evaluate them against guidelines and national priorities. This could assure a more coherent outcome. John Filson noted that each region is asked to provide instrumentation plans that will be reviewed at the national level. Guidance is needed to select what type of structures to instrument where; this is needed before the detailed plans for regional instrumentation are developed. Bill Iwan noted that it is very important to clearly state how the data are to be used. The building instrumentation system must be designed to meet specific and stated objectives. This is why the national guidelines must be explicit in requiring that a clear objective be stated for the proposed instrumentation of a building. John Filson noted that the regional acceptance of national objectives is important. Bill Iwan observed that knowledgeable individuals on the structural side from the national level need to meet with regional groups to provide this input. Further discussion of how to proceed with these ideas is needed between COSMOS and the USGS.

### **Status of Virtual Data Center**

Melinda Squibb has been working at UCSB with the database and the VDC for about three months. She summarized enhancements that she is working on. She invited input from users to provide more services from the database; there are no barriers to linking with other databases. Carl Stepp asked for input from the SAC regarding relative emphasis on the U.S. engineering community, or should there be a stronger effort to go after worldwide data for use by U.S. and international engineers. There are real problems with data quality, but there is strong interest in participating in a virtual data center. Europeans are so enamored of the idea of COSMOS that they are forming their own COSMOS, with links to the COSMOS VDC. There are many details to be addressed in working internationally, such as the variety of data formats.

Chairman Cornell noted that for some data sets, such as the Chi-Chi earthquake, there are some reservations about using the data for U.S. design purposes. For one project, there has been a decision to wait before the data are included in a large database for U.S. use. The question of how should free-field records or building records from the Chi-Chi earthquake be used was discussed extensively. Farzad Naeim noted that there are many differences in design and construction between Taiwan and the U.S.

John Ake urged that neglecting data can adversely affect uncertainties, although it must be properly understood. Frazad Naeim noted the conservatism of structural engineers, but he felt that having data available for consideration is valuable and can lead to improved understanding. Bob Page noted that with each earthquake we learn more about what the earth is doing; therefore, with every earthquake we learn more about what the earth is capable of. Chairman Cornell noted that it is unlikely that anyone is going to stand up and say they're against motherhood and data, but what are we giving up if we incorporate such huge data sets. Mindy Squibb noted the importance of having metadata along with the records themselves. John Filson suggested that the metadata need to be evaluated before assessing the usefulness of the data; there need to be standards to accept the data. Roger Borchardt discussed Willie Lee's interest in getting the Chi-Chi data processed, and that there are efforts being made to provide site data. He emphasized the efficiency of using a virtual database, but Taiwan is not planning to set up a database. Rather, the data would actually reside at COSMOS, with proper credit going to the Central Weather Bureau. Carl Stepp noted that the other two international liaisons also wanted COSMOS to host the data. Thus this is different from the virtual vision of COSMOS.

Bob Page wondered if a tradeoff might be made by promoting the use of COSMOS data by engineers in the U.S. Carl Stepp noted the principal goal of COSMOS has been to optimize the accessibility of strong-motion data to practicing engineers who don't normally now access data directly because of the cost and processing effort. The tradeoffs are to either focus on this optimization or reduce that effort in favor of expanding the database, unless there is additional funding available. He sees the need to set priorities according to the level of funding available. Bob Page wondered if COSMOS could look forward to making an appreciable difference in the use of strong-motion data by the practicing engineers, which is an important objective that should not be overlooked. Maury Power concurred with this objective.

Willie Lee's plan is to provide the data in an accurately identified, DC-corrected, COSMOS format. There was some uncertainty about the degree of processing that would be done. Several individuals commented on the huge size and the comprehensive nature of the data set. Roger Borchardt said that making such a data set available has to be a high priority—it is unprecedented. Other possible data sets available to COSMOS are much smaller.

Chairman Cornell passed out a "brief" prepared by Willie Lee regarding the characteristics of the Central Weather Bureau (CWB) data set (including 30,000 records before the Chi-Chi event, and 30,000 records of aftershocks). He is seeking funding to determine absolute time, correct mislocations of sites and other errors, and make the data available through the CWB. He would assemble sets of records for individual earthquakes numbering about 300, taking about 5 years. The data then would be available for

proper filtering. Chairman Cornell noted the importance of the smaller shocks for seismological purposes. There are questions about the availability of the data in general. Farzad Naeim expressed the importance of having the data available, regardless of timing issues. Moh Huang noted the need to establish the useful bandwidth of the data. Chairman Cornell noted the great importance of the data set for this earthquake and the need to give this data set proper attention.

Chairman Cornell put forth the issue of COSMOS taking a stand on this issue of putting the data on our server. Carl Stepp noted that the matter of authority over the data is not clear; to get NSF funding, this needs to be made clear. Could the CWB become a member of COSMOS? Woody Savage reported on a brief conversation with Ben Tsai earlier in the evening. Ben Tsai expressed the view that the CWB had no particular interest in retaining control over the data or restricting access, but that others in Taiwan wanted the opportunity to use the data first. He expressed that the same problem of using the data openly was a problem for the PEER Lifelines Program as well. The data set seems to be available primarily for directed use. Chairman Cornell reported that Willie Lee believes the data would be available one to six months after the data have been processed. Claire Johnson noted that the availability of the original data set was very complex. Jim Davis suggested that more information be obtained before any action be considered. Chairman Cornell concurred, but asked the question of how much interest there is in what parts of the data set. John Filson asked about the distribution of the events as a function of magnitude. Carl Stepp noted the need for careful planning, with a priority for the most important earthquakes. This may not be consistent with a single five-year program. Carl Stepp reiterated that it is of critical importance to get this data set into the hands of the users, with ideally COSMOS in a central role. Farzad Naeim noted that there are only ten or fifteen events that are really important. Tony Shakal noted the importance of having confident site data and location information in any data analysis. Chairman Cornell returned the discussion to the need for obtaining more information to service the needs of both engineering and seismological communities. Carl Stepp invited the participants to send ideas and comments to him and others to stimulate the process.

The meeting adjourned at 10:00 PM.