Geotechnical Instrumentation News

John Dunnicliff

Introduction

This is the twenty-eighth episode of GIN. Three articles this time, a discussion and closure, a report on an exciting conference in London, a book review, and two letters - quite a mixed bag!

Instrumentation of Embankment Dams

The question "Should we install instruments in all embankment dams?" is often asked. It was asked again by engineers for Federal Energy Regulatory Commission (FERC) and Corps of Engineers during the March 2001 instrumentation course in Florida, and Ralph Peck answered. Since then I saw Ralph Peck's discussion, prepared for the recent ICOLD (International Commission on Large Dams) congress in Beijing and, recognizing it as yet more words of wisdom, have his and ICOLD's approval for reprinting it here. So, please read the discussion and stop asking the question!

Contract Practices — Again

A favorite topic, as many of my colleagues will know. The first episode of GIN, in September 1994, had 33 pages on the topic, with contributions by Hanson Bratton, Roy Cook, Charles Daugherty, Dave Druss, Eric Eisold, Gordon Green, Chris Groves, Red Robinson, Nick Shirlaw, Siamac Vaghar and myself. The major message was "use a professional service method rather than a low-bid method".

Since returning to live in England I've seen that low-bid methods are often used here (despite the fact that when I worked for an English consulting firm in the 1950s and 1960s, a professional service method was always used by the firm for instrumentation of the dams on which I worked). Continuing the campaign, Alan Powderham and I submitted a paper for a conference at Imperial College in London in July 2001 (see page 40 for a report on the conference). With the approval of the organizers of the conference, an 'Americanized' version of the paper is in this episode of GIN. There is also a discussion by Fritz Klinger, and a 'temporary' closure.

I've been beating the drum on this topic for many years and sometimes become despondent that the message is rarely heard by decision-makers. However, the fact that owners of two very large tunnel projects (see Tables 3 and 4 in the article) have favored a specialist instrumentation firm to supply, install and read the instruments, via a direct contract with the owner, is a very encouraging trend. Perhaps readers who agree with this approach, and who are in a position to bend senior minds about this make-or-break topic, will find this article and the discussion useful when campaigning with decision-makers.

Continuing Education

Another favorite topic — how to get the best out of continuing education programs. I've learned a few tricks through the years, but a recent discussion with Jerry DiMaggio of FHWA (Federal Highway Administration) made me realize how much more I have to learn. Jerry has presented over 250 seminars and workshops for professionals, related to the design and construction of bridges, retaining walls and earthworks. He has also instigated numerous training programs on geotechnical topics that have been taught by others to State highway departments, and I've worked with him on about 25 instrumentation courses as part of that program. So I thought I knew him well, but was startled by the innovativeness of his ideas, passed along over a few glasses of red wine recently in New York. So much so that I asked him to put them in writing. Here they are.

Jerry DiMaggio's suggestion about randomly selecting a group to present their thoughts via a spokesperson, to the entire class after working on a 'quiz', reminded me of an alarming experience during one of my courses several years ago. It was a four-day course (one of Norbert Schmidt's University of Missouri-Rolla ones, for those of you who remember those), and on the front row was someone who insisted on interjecting comment, whether relevant or not, many times during each lecture. After two days of this he (yes, of course the person was male!) was really getting under my skin.

We had a quiz, worked on in groups of four. Each group appointed a leader. He, of course, became a (self-appointed?) leader. During the quiz there was a fistfight in that group, with the leader as the target! Have you ever tried to cheer without letting anyone know?

Conference on the Response of Buildings to Excavation-induced Ground Movement

I've just returned from an excellent conference in London, during which there was a session "Management of the Monitoring Process". A report on the conference is included in this episode of GIN. The proceedings of the conference, together with the associated two-volume book, provide a goldmine of information for tunnel designers and constructors.

Book Review

I recently read, rather belatedly, the proceedings of an ASTM (American Society for Testing and Materials) instrumentation symposium that was held in Atlanta in June 1998. There are some very useful practical papers - see page 41.

Letters to the Editor

This episode of GIN includes two letters to the editor of this magazine, relating to an article by Stephane Carayol and Jeremy Sweetman in the March 2001 episode of GIN, "Vibrating Wire In-place Inclinometers — a Case History."

Gary Holzhausen's concern about "undisclosed conflict of interest" is based on the fact that SolData was listed on Geokon's web site as their sales agent in Hong Kong. I was not aware of this until after the article was published.

On Gary Holzhausen's concerns about technical issues, I'd like readers to be aware of the policy of *Geotechnical News* with regard to content of articles. These are summarized regularly in the magazine, the latest being on the inside back cover of the June 2001 issue:

> *Invitation to Authors ..All submitted articles will be reviewed by the section editor for clarity, but will not be refereed. Geotechnical News will not be responsible for the views and opinions expressed by the authors.*

In a separate message to me the Publisher, John Gadsby, wrote:

> *If anyone does not agree, or dislikes a comment made in an article we encourage that person to write to us. We will publish the letter in GN and pass on the comment to the author, who then has the opportunity to respond, and we will publish the response.*

I hope that will clarify this case and the general case.

Patrick D.K. Smith

Patrick Smith of Slope Indicator Company sadly died on 22 April 2001, after a long and courageous battle against cancer. Over the years I've had regular interactions with Patrick, and have always respected him greatly.

I asked Chris Rasmussen of Instrumentation Testing & Monitoring (ITM) in England, who had a very close personal and professional relationship with Patrick, to write some words about him for this episode of GIN.

He has sent me the following:

To those of us who knew Patrick, he was a unique and very welcome member of our geotechnical instrumentation 'club'. With the approval of his wife Bridgit, I've edited some words that she wrote towards the end of April.

Patrick was born Scotland in 1938. He trained as a mechanical engineer while working at the Geotechnics Division of the Building Research Station (BRS, now Building Research Establishment) in England under the leadership of John Burland. His major work at BRS was the development of a precise borehole extensometer, now known to us all as a magnetic or magnet/reed switch probe extensometer, and a seabed pressuremeter.

Patrick moved to the United States in 1979, where he was employed by Terrametrics in Golden, Colorado. Terrametrics was purchased by Slope Indicator Company in 1984, and the family moved to Seattle. Patrick wore many hats at Slope Indicator, including working as a design engineer and as technical service manager. He travelled to many parts of the world representing both Slope and the geotechnical industry with professionalism and integrity.

Patrick's health progressively deteriorated during the last ten years. After a year of pulmonary problems in 1996, a biopsy revealed lung cancer. Patrick fought for his life with courage, humor and dignity, and in doing so was a powerful example to those of us who may follow with a similar burden. A striking aspect of this was his belittling of his physical and emotional pain, to ease the distress of those around him.

We will miss him.

More on Strain Gages and Temperature

I've received the following clarification from Dave Druss, relating to his discussion of Boone and Crawford (2000). The discussion was on page 24 in the December episode of GIN.

In my discussion of the Boone and Crawford article entitled "The Effects of Temperature and use of Vibrating Wire Strain Gauges for Braced Excavations" *in the September 2000 issue of GIN, pp 24-28, an alternative method of determining the stiffness of the strut-wall-soil system was suggested.*

In summary, I proposed taking direct measurements of strut elongation at varying temperatures, in an assumed constant-load condition. Then, using the change in load (presumably due to temperature effects only), as measured by the vibrating wire strain gages, the composite axial stiffness can be simply determined by dividing the change in length by the change in load.

On the basis of subsequent explorations into the matter, and feedback received on the discussion, it is now concluded that direct measurement of strut elongation remains a correct, but not practicable, means for determining the composite axial stiffness. The method originally presented by Boone and Crawford, which entails using incremental changes in <u>load</u> and <u>temperature</u>, both determined from vibrating wire strain gages, is a more accurate and practicable means of determining the axial stiffness.

The other five "conclusions and lessons learned", that were included in the discussion, are still valid.

Toasts — I Need Your Help

Some of you will remember Birger Schmidt's beer mat, with toasts in many languages, and that I've been using these and other toasts to close each episode of GIN. But I now need help, as the cupboard is almost bare. (Do North American's have 'nursery rhymes'? Do they know about Old Mother Hubbard?). **If you like to read GIN, you have an obligation to send me at least one toast, with the country of origin!**

Closure

Please send contributions to this column, or an article for GIN, **and a toast**, to me as an e-mail attachment in msword to *johndunnicliff@attglobal.net, or by fax or mail: Little Leat, Whisselwell, Bovey Tracey, Devon TQ13 9LA, England. Tel. +44-1626-836161, fax +44-1626-832919.*

Saha wa afiah (Morocco)!

Embankment Dams
Instrumentation versus Monitoring

Ralph B. Peck

The following is a discussion prepared for Technical Session, Question 78, "Monitoring of Dams and Their Foundations", at the 20th Congress of the International Commission on Large Dams (ICOLD), Beijing, China, September 2000, and is reprinted here with the permission of ICOLD.

Hydraulic-fill dams, the principal type of earth dams before soil mechanics, usually proved to be stable if they survived construction. In some instances seepage was collected and measured by means of weirs, otherwise few quantitative observations were carried out to monitor their behaviour. With the simultaneous introduction of large earth-moving and compaction equipment and of the new discipline of soil mechanics, the newer embankment dams were compacted, had much steeper slopes, and did not usually experience seepage pressures until their reservoirs were raised. The validity of the design assumptions, based on the new subject of soil mechanics, could be evaluated only by measuring movements, pore pressures, and seepage. There was a need to know what the settlements and differential movements actually were and how they compared with predictions based on the assumptions derived from soil tests and theory. There was also need to determine whether filters and drains performed their functions. In short, was soil mechanics useful in connection with embankment dams? To answer this question, there was interest in developing and installing devices to measure both geometrical changes and seepage within the body of a dam during and after construction.

Thus, in those days of the developing art of compacted embankment-dam design and construction, instrumentation was needed to assess the state of the art. Much fundamental knowledge was obtained in this way. The knowledge, however, came at a price. Almost all the measuring devices interrupted the continuity of the structures. If they were installed, say by insertion in trenches or by extending pipes or cables through the dam, they inevitably degraded the homogeneity of the zone of the embankment in which they were located. The regular compaction equipment had to be detoured around the installations, and special fill or compaction procedures were required around the instruments or the cables or pipes extending to them. In spite of great care, the otherwise normal distribution of stresses in the fills was altered. Particularly around vertical installations such as inclinometers and piezometric riser pipes, not only was the stress distribution altered but also the permeability. The alterations led occasionally to local distortions, especially to "sinkholes" around riser pipes that to a greater or lesser degree constituted defects in the dams and sometimes raised questions about their integrity. Such questions, which sometimes became matters of public concern, were rarely discussed rationally in the media.

It is no longer pertinent to install instruments only for the purpose of investigating whether soil mechanics is applicable to embankment dams. It may even be a surprise to modern-day engineers that the question was once a serious issue. Certainly the fundamental rule today should be that no instrument should be installed that is not needed to answer a specific technical question pertinent to the safe performance of the dam. A related question should be whether the information could be obtained by non-intrusive means that do not hold the potential to compromise the dam's behaviour. Thus, in general, the measurement of seepage by such means as collector pipes and weirs, when allowance is made for precipitation, is a far safer and, incidentally, more reliable indication of developing defects than depending on the chance presence of a piezometer at a critical location.

Systematic measurements of the clarity of the seeping water, moreover, provide vital information that piezometers cannot supply. Indeed, walkover inspections by trained staff, on a systematic basis, often furnish the first and most significant indication of deterioration. They may even, under some circumstances, demonstrate the need for instrumentation to clarify understanding of a new development, but the instruments would then be located in strategic places, not on some routine geometric basis.

At the present mature state of earth-dam design and construction, it is unjustifiable to install instruments, which inevitably introduce anomalies into an embankment dam, for the vague purpose of advancing the state of the art. Only if there are specific questions, specific uncertainties about foundation or abutment behaviour, or specific geometries, materials, or foundation conditions that depart from precedent, can intrusive instrumentation now be considered essential or even desirable.

Monitoring of every dam is mandatory, because dams change with age and may develop defects. There is no substitute for systematic and intelligent surveillance. But monitoring and surveillance are not synonymous with instrumentation.

Ralph B. Peck, Civil Engineer: Geotechnics, 1101 Warm Sands Drive, S.E.,
Albuquerque, New Mexico 87123
Tel. (505) 293-2484
Fax. (505) 323-7760

Recommendations for Procurement of Geotechnical Instruments and Field Instrumentation Services

John Dunnicliff
Alan Powderham

It is axiomatic that those who have the greatest interest in reliable and high quality field data should have a major role in specifying the requirements and obtaining the data. Despite this, many contracts assign the responsibility for selecting geotechnical instruments and for field instrumentation services to people with fragmented roles and limited interest in the overall process. Two general categories for procurement of geotechnical instruments, and for the associated field instrumentation services are considered in this article: the lowest-price method and the professional service method. Pros and cons of both are discussed, and recommendations made for the use of the latter. The various tasks that relate to geotechnical instrumentation and monitoring are defined, and references are cited that give the views of others in the profession.

The authors hope that this article will be useful when trying to convince decision-makers to adopt professional service methods.

1. Purposes of Geotechnical Instrumentation and Monitoring

The term *geotechnical instrumentation and monitoring* will be used in this article to denote the entire process of planning and executing a monitoring program that uses geotechnical instrumentation.

Purposes of geotechnical instrumentation and monitoring include:

- Protection of third party property
- Control of the construction method
- Fact-finding in a crisis situation
- Providing legal protection
- Enhancing public relations
- Advancing the state-of-the-art

2. The Tasks

After the geotechnical instrumentation and monitoring program has been established by the project designers (including preparation of drawings, specifications and assignment of "response values" — those measured changes which will lead to the initiation of response actions), the various tasks that need to be assigned are shown in Table 1.

The eleven tasks in Table 1 represent the key links in a chain — any weakness or discontinuity will threaten the quality of information and increase risk. The importance of communication and co-operation among the participants in these tasks will be emphasised, and also that the responsibility for the tasks should be assigned to those who have the greatest interest in securing reliable and high quality data.

3. The Golden Rule for Assignment of Tasks

The golden rule for assignment of the tasks in Table 1 is:

> **To provide the best basis for securing reliable and high quality data, and hence for securing best value, the people who have the greatest interest in the answers to the questions should have a major role in obtaining the data.**

However, many contracts award geotechnical instrumentation and monitoring tasks on the basis of lowest price, and often also divide the responsibilities among several parties. At best this tends to create a major challenge in communication, but is more likely also to result in fragmentation and poor quality data.

4. Available Methods for Procurement

The following basic procurement methods are considered. The first two methods in each category can be considered as professional service methods.

4.1. Procurement of Geotechnical Instruments

(a) The people who have the greatest interest in the answers to the questions procure the instruments directly, making the selection on the basis of proven past performance, and negotiate prices with suppliers.

(b) The project designers enter an estimate of procurement cost in the construction contract bid schedule, and indicate that this is an "allowance item". The site supervision team (SST) in close coordination with the designers,

Table 1. Tasks That Need to be Assigned

Term Used in This Article	Task
Procurement of geotechnical instruments	Procure instrumentation hardware and software, and make factory calibrations
Field instrumentation services	Perform pre-installation acceptance tests on hardware and software
	Install instrumentation hardware and software
	Establish baseline readings
	Maintain and calibrate instrumentation hardware on a regular schedule
	Establish and update data collection schedule
	Collect data
	Process and present data
Interpretations and response actions	Interpret and report data
	Review need for response actions
	Implement necessary response actions

Table 2. Some Arguments for and against Professional Service Methods

Arguments Against	Counter-Arguments, For
The lowest-price method will give us the lowest price, which is what we want	What we need is reliable and high quality data, and we do not often get that when lowest-price methods are used. Lowest-price methods usually involve discontinuities in responsibilities and tasks, creating barriers to effective communication and teamwork
If geotechnical instrumentation and monitoring work is not performed by the construction contractor, responsibility and liability will be taken away from the construction contractor, thereby increasing responsibility and liability for the project designer	These concerns can be addressed through appropriate forms of contract, and by arrangements such as partnering
If field services are performed by the SST, this work may conflict with the work of the construction contractor, mutual scheduling will be a problem, and responsibility for damage will be unclear	These concerns can be resolved through a team approach backed by appropriate contractual clauses
We've always done it this way, therefore we're going to do it this way	This is not a helpful argument, because it doesn't acknowledge the need for reliable and high quality data. Construction contractors may see little or no direct benefit in the geotechnical instrumentation and monitoring, and may consider them a nuisance
We're required to do it this way	As immediately above
It is the sort of work that a technician can easily do	Yes, some of this work can be done by technicians, but a significant part cannot

Table 3. Example of Task Assignments. Amsterdam Metro North/Southline

Term Used in This Article	Task	Task Assignment
Procurement of geotechnical instruments	Procure instrumentation hardware and software, and make factory calibrations	Specialist instrumentation firm under contract to the owner [see 4.1(a) above]
Field instrumentation services	Perform pre-installation acceptance tests on hardware and software	Specialist instrumentation firm under contract to the owner [see 4.2(a) above]
	Install instrumentation hardware and software	
	Establish baseline readings	Data collected by specialist instrumentation firm under contract to the owner. Data evaluated by the owner and project designers. All parties, including the construction contractor, sign agreement to these readings before start of construction work
	Maintain and calibrate instrumentation hardware on a regular schedule	Specialist instrumentation firm under contract to the owner
	Establish and update data collection schedule	Data collection schedule, both for automatic and manual readings, is defined in the contract between the owner and the specialist instrumentation firm.
	Collect data	Data, both automatic and manual, collected by the specialist instrumentation firm, and transferred on line to the project designer, owner and construction contractor. Penalty clauses in the contract between the owner and specialist instrumentation firm for late presentation of data. Project designer has developed a database / visualisation system (GIS) for rapid processing and presentation of data on-line, which will also be used by the construction contractor
	Process and present data	
Interpretations and response actions	Interpret and report data	Interpretation by an "Engineering and Construct" (EC) team, consisting of owner, project designer and construction contractor, including if necessary the specialist instrumentation firm
	Review need for response actions	EC team, with appropriate contract clauses addressing the responsibilities
	Implement necessary response actions	Construction contractor

For further information about the monitoring system and strategy for the Amsterdam project, referece is made to Netzel and Kaalberg (2001).

subsequently selects appropriate instruments for the construction contractor to procure. Price is negotiated between the SST and suppliers of instruments, who then become "assigned suppliers". The construction contractor places orders on the instructions of the SST, pays suppliers' invoices, and is reimbursed at actual cost plus a handling fee.

(c) The instruments are procured on the basis of lowest price

4.2. Procurement of Field Instrumentation Services

If the construction contractor has a dominant interest, he will be typically responsible for all field services. Where the owner and project designers have the dominant interest, the following contract methods are considered:

(a) The SST performs field instrumentation services that require specialist instrumentation skills. If necessary, the owner or SST retains the services of a firm that specializes in instrumentation, using a professional service (time and materials) method for payment. Supporting work (that which does not require specialist instrumentation skills) is performed by the construction contractor.

(b) The project designers provide an estimate of the cost of specialist field instrumentation services, include it as an allowance item in the construction contract bid schedule, and indicate that this is an item for an "assigned subcontractor". The SST subsequently selects an appropriate specialist firm, using a professional service (time and materials) method for payment. If the construction contractor has had previous bad experience with the selected firm, he has the right to reject the firm as a subcontractor, and the SST then selects an alternative. The firm is employed by the construction contractor to perform field instrumentation work that requires specialist skill. The firm is paid by the construction contractor, who is reimbursed at actual cost plus a handling fee. The construction contractor performs supporting work.

(c) Field instrumentation services are undertaken either by the construction contractor or his subcontractor, on the basis of lowest price, usually by including them as line items in the bid schedule or as part of a lump-sum bid.

5. Discussion of Available Procurement Methods

If the geotechnical instrumentation and monitoring program has been initiated by the construction contractor, it is reasonable to assume that the construction contractor will select procurement methods that are most likely to secure reliable and high quality data. This particularly applies to applications of the observational method (Peck, 1969; Powderham, 1988) and to value engineering (Powderham and Rutty, 1994; ICE, 1996). It also applies to design/build contracts. The interest of the construction contractor in reliable and high quality data is usually very evident with these contractual arrangements.

The remainder of this discussion assumes that the geotechnical instrumentation and monitoring program has been initiated by the project designers in consultation with the owner, as this is the case for which the golden rule is often forgotten.

The four professional service methods above [4.1 (a), (b) and 4.2 (a), (b)] are much more likely to result in the goal of securing reliable and high quality data than the two lowest-price methods [4.1 (c) and 4.2 (c)].

When the 4.1 (a) and 4.2 (a) methods are used (geotechnical instrumentation and monitoring work not performed by the construction contractor), a concern is sometimes raised that responsibility has been taken away from the construction contractor, particularly in the event that instruments malfunction. In the experience of the authors this can be alleviated by appropriate specification wording, and the instruments are much more likely to work well if professional service methods are used.

When the 4.1 (b) and 4.2 (b) methods are used (assigned suppliers and assigned subcontractors) a concern sometimes centres on the efficiency of communication channels among the SST, the subcontractor and the construction contractor. In the experience of the authors, this has not been a problem in practice. Within an effective team environment such risks are minimized. There are benefits to using assigned suppliers and assigned subcontractors for geotechnical instrumentation and monitoring work, with allowance items in the bid schedule. These methods allow the SST to retain control over the selection of instruments and the personnel who will perform instrumentation field services. They also create flexibility to accommodate the changes that are inevitably required during construction. The cost is included in the construction budget — often a significant issue. It is important to note that the amounts for allowance items that are entered in the

Table 4. Example of Task Assignments. Multi-section Tunnel Project in North America

Term Used in This Article	Task	Task Assignment
Procurement of geotechnical instruments	Procure instrumentation hardware and software, and make factory calibrations	Specialist instrumentation firm under contract to the SST [see 4.1 (a) above]
Field instrumentation services	Perform pre-installation acceptance tests on hardware and software	Specialist instrumentation firm under contract to the SST [see 4.2 (a) above]
	Install instrumentation hardware and software	Specialist instrumentation work by firm under contract to the SST. Support work by construction contractor [see 4.2 (a) above]. In addition, construction contractor installs any additional instrumentation that he deems necessary to ensure the safety of the work
	Establish baseline readings	SST, together with construction contractor. Both sign agreement to these readings before start of construction work
	Maintain and calibrate instrumentation hardware on a regular schedule	SST. In addition, construction contractor performs these tasks for any additional instrumentation that he deems necessary to ensure the safety of the work. Construction contractor also collects data from instruments that have been installed by the specialist instrumentation firm, to the extent that he deems necessary to ensure the safety of the work
	Establish and update data collection schedule	
	Collect data	
	Process and present data	
Interpretations and response actions	Interpret and report data	SST in conjunction with project designer. Also construction contractor
	Review need for response actions	
	Implement necessary response actions	Construction contractor

bid schedule by the project designers should not be regarded as limiting, and the contract price should be increased by change order if needed.

Additional guidelines on use of professional service methods are given by Dunnicliff (1988, 1993).

Some of the arguments that the authors have heard against professional service methods are included in Table 2, together with the counter-arguments.

6. Examples of Task Assignments

Tables 3 and 4 gives examples of task assignments for two projects, and illustrate the adoption of professional service methods for geotechnical instrumentation and monitoring. The listed tasks are the same as those in Table 1.

7. Summary of Some Comments in the Literature

The quotations in Tables 5 and 6 refer to procurement methods and performance of geotechnical instrumentation and monitoring.

These quotations can be useful as precedents when trying to convince decision-makers to accept a professional service method. In the event that, despite strong attempts to convince them otherwise, they insist on using the lowest-price method, specifications for procurement of instruments and for field service must be clear, complete and correct. Guidelines on the content of such specifications are given by Dunnicliff (1988, 1993, 1999).

8. Summary

The authors strongly believe that geotechnical instrumentation and monitoring should be considered as a professional service, rather than a lowest-price construction item. Professional service methods within a team environment are the best way to ensure best value for the expenditure on instrumentation, an integrated win-win approach and good motivation, and therefore reliable and high quality data.

Acknowledgements

This article is based on Dunnicliff and Powderham (2001), and is printed here by permission of the Director General of Construction Industry Research and Information Association (CIRIA), for which the authors express their thanks. That paper includes significant content describing the contractual environment in the UK, which emphasizes the principles of trust and cooperation within a contractual framework.

The authors would like to acknowledge the Project Organisation of the North-South Metroline in Amsterdam for providing the information in Table 3.

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Table 5. Comments Relating to Procurement of Geotechnical Instruments

Comment	Reference
The cheapest type of instrument to use is often the most expensive to buy, because reliability is essential and the cost of instrumentation is mainly in the installation, reading the instruments and analyzing those readings	ICOLD, 1996
A customer generally gets what he pays for. This practice [of low-bidding] also promotes use of marginal and inferior materials. A manufacturer's dilemma is created because there is little incentive to make product improvements and use higher quality materials that increase the product costs. Unless more informed buyers come forth and a change in the practices of low-bid procurement occurs, desirable advances in field instrumentation will be slow and unsatisfying	Mikkelsen, 1982
Cost ..should not be a deciding factor, however, because the total relative cost of instrumentation is too small to justify making economies in the overall project cost by choosing instruments of minimum cost	Sherard, 1981
The common *or acceptable equivalent* clause, combined with competitive bidding, leads inevitably to excessive emphasis on economy, with the result that high-quality instruments cannot compete. This keeps the quality of the average instrument on the market just above the *acceptable* level, a highly undesirable situation	Sherard, 1982

Table 6. Comments Relating to Procurement of Field Instrumentation Services

Comment	Reference
The following are generally not true when the contract for instrumentation is between the owner and the general contractor: (1) Contract is issued to entity most familiar with instrumentation. (2) Technical issues involving instrumentation system are resolved directly between owner and instrumentation specialists. (3) Staff is skilled in instrumentation issues. (4) Instrumentation issues are given top priority. (5) No additional markup on instrumentation system cost. All the above five factors are generally true when the contract for instrumentation is between the owner and an instrumentation company	ASCE, 2000
...it is important to select a motivated professional firm	Cook, 1994 (Superconducting Supercollider, Texas, USA)
The owner chose to use a [low] bid specification ..it would have been better to have most aspects of the instrumentation under the control of a single entity answering directly to the owner..A switch to construction manager controlled monitoring was made after the experience and there was a marked upturn in the effectiveness of geotechnical instrumentation in the remainder of the tunnel system	Daugherty, 1994 (Multi-section tunnel project, USA)
The responsibility for the instrumentation should be in the hands of the party who needs the data the most, normally the owner's engineer or geotechnical engineer. Fragmentation of responsibilities frequently leads to problems... Geotechnical field instrumentation needs to be treated as a professional service with an accent on quality. Low-bid procurement of services and instruments almost always leads to low quality. This is in no one's best interests	Green, 2000
One procedure that is not recommended is for the instrumentation ..to be ... billed in individual items for the main contractor to price	Kennard, 1973
Our experience with the [low-bid] arrangement is that regardless of the contract requirements, the quality and performance of the instrumentation program is often low on the list of contractor concerns. The natural result is that the quality of instrument installation suffers, readings are often missed, and reports are incomplete and/or late. The project owner agreed that the instrumentation installation, monitoring and reporting for this project should be performed as a professional service under the construction management contract	Klingler, 1997 (Downriver Regional Storage and Transport System, Michigan, USA)
It is ..considered that the monitoring forms part of the owner's inspection of the performance of the work, rather than being an integral part of the construction work. On this basis, and to ensure timely acquisition of data, the majority of the specified monitoring program is to be carried out by specialists retained directly by the [owner]	Shirlaw, 1994 (Rapid Transit Expansion Program, Toronto, Canada)
Despite being specified as his responsibility, a construction contractor typically will do all he can to minimise his effort with instrumentation work. In reality, the site supervision team will not stop construction because of this. Instrumentation work should be the responsibility of a professional organisation, with owner-control	Resident engineer, 2000. (Multi-section tunnel project, Hong Kong)
An informed choice of instruments, proper installation and a suitable monitoring regime are required to gain the maximum benefit from the financial commitment	Watts, 1999

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***John Dunnicliff**, Geotechnical Instrumentation Consultant, Little Leat, Whisselwell, Bovey Tracey, Devon TQ13 9LA England Tel: +44-1626-836161 Fax: +44-1626-832919*
email: johndunnicliff@attglobal.net

Alan J. Powderham, *Director — Transportation, Mott MacDonald Group, St Anne House, Wellesley Road, Croydon, Surrey CR8 2LU, England Tel: +44-20-8774-2538 Fax: +44-20-8681-5706 email:alan.powderham@mottmac.com*

Discussion of: "Recommendations for Procurement of Geotechnical Instruments and Field Instrumentation Services", by John Dunnicliff and Alan Powderham

Fritz J. Klingler

Introduction

Dunnicliff and Powderham have presented an excellent summary of the current options for procurement of geotechnical instruments and instrumentation services, and offer a compelling list of endorsements against the "low-bid" procurement method. Their presentation of typical tasks for geotechnical instrumentation programs is also very helpful in breaking down the responsibilities on a project so that the various instruments and services on a given program may be procured using the most appropriate method, and that the effectiveness of the program can be maximized.

The Current "Lowest Price" Standard

Unfortunately, many geotechnical instrumentation programs are handicapped from the start, and cannot necessarily be procured using the most appropriate or effective method. This is because owners have historically been very reluctant to view geotechnical instrumentation programs as a professional service, but instead are more likely to include them in the contractor's lump sum bid. In doing this, owners are attempting to obtain the lowest price, but in fact may be compromising the value of the instrumentation program and increasing the overall cost of the project.

Dunnicliff and Powderham mention that the "golden rule" for assignment of instrumentation tasks is for the persons with the greatest stake in the "questions" involving potential movements, to have the primary role in obtaining the data. Since these "questions" are usually not evident until the design is well underway, the magnitude and/or the necessity of the geotechnical instrumentation program is usually not apparent to owners until after they have established their design and construction engineering budget. As a result, they often view the instrumentation program as an added expense, which would require an amendment to the site supervision team (SST, also known as "construction engineering" or "construction oversight" team) budget. Owners are therefore much more inclined to include the instrumentation program as part of the (low-bid) construction contract.

Since the design geotechnical engineers best understand the risks associated with the design, they are in the best position to recognize developing problems on the basis of the instrumentation data.

Drawbacks of the "Assigned Subcontractor" Approach

Dunnicliff and Powderham [Sections 4.1 (b) and 4.2 (b) of the article] mention the use of provisional "allowances" in the construction contract, with "assigned suppliers" and an "assigned subcontractor". This writer has found that the "assigned subcontractor" approach is much preferable to the "low-bid" method of instrumentation program procurement, but can present several problems in itself. These problems arise mostly with the tasks involving procurement of field services and interpretations related to the geotechnical instrumentation program (see Table 1 in Dunnicliff and Powderham).

In particular, the geotechnical instrumentation monitoring (and sometimes interpretations of results) is performed by a third party (i.e. the "assigned subcontractor"), who was not involved in the original design, and may not fully understand the original "questions" that the program was intended to address. In addition, the design geotechnical engineer (who presumably has a role on the SST) is then somewhat removed from the process, and often becomes a reviewer after-the-fact. As a result, a powerful tool for the owner/construction manager to control the construction operation is weakened.

Another potential drawback of the "assigned subcontractor" approach of procurement is increased cost, either real or perceived, because assigning a subcontractor necessarily involves the use of a provisionary allowance to pay for the instruments and/or services. Owners often try to avoid provisionary allowances, because they perceive (sometimes correctly) that they will pay significantly more for the instrumentation program using a "time and materials" method for payment. The cost can sometimes be inflated further because the prime contractor controls the payments to the "assigned subcontractor" and has no incentive to control expenditures of the subcontractor. Based on this writer's experience, the cost issues using provisionary allowance methods can usually be controlled using good contracting and management practices.

A third drawback to the "assigned subcontractor" approach is that the assigned instrumentation monitoring subcontractor is paid by the contractor and may feel an obligation to protect the interests of the contractor over those of the owner. This problem can be reduced through partnering efforts, but probably not eliminated.

Advantages of Designer-Provided Geotechnical Programs

Dunnicliff and Powderham [Sections 4.1 (a) and 4.2 (a)] discuss the option of geotechnical instrumentation services provided either directly by the SST or by a specialist instrumentation firm under contract to the owner. Although such services could be provided by a qualified firm not involved in the original design, the natural choice would be for these services to be provided by the design geotechnical engineer.

Since the design geotechnical engineers best understand the risks associated with the design, they are in the best position to recognize developing problems on the basis of the instrumentation data. As such, it is more efficient for the data to be collected and interpreted directly by the design geotechnical engineer working as part of the SST. This can be the critical difference for projects where uncontrolled ground movements can cause significant adverse impacts to the construction and to adjacent properties.

Although the use of the geotechnical designer (or other specialist) working as part of the SST is not currently the typical procurement approach for geotechnical instrumentation programs, this method has been very successfully implemented on several projects with which the writer has been involved. Dunnicliff and Powderham in Tables 3 and 4 of their article, also refer to use of this method for most of the task assignments identified.

Summary

This writer very much agrees with the authors that geotechnical instrumentation and monitoring should be considered a professional service rather than a lowest-price construction item. I would add however, that between the two general types of professional service procurement: services performed by the geotechnical designer as part of the SST vs. by an assigned subcontractor; the former is much preferable.

Since the geotechnical instrumentation program is intended to answer questions best understood by the geotechnical designer of a project, the instrumentation should be considered as an extension of the design, should be under control of the designer, funded as a professional service, and performed as part of the SST.

Fritz J. Klingler, Vice President, NTH Consultants, Ltd., 277 Gratiot, Suite 600, Detroit, MI 48226 Tel: (313) 965-0036 Fax: (313) 237-3900
email: fklingler@nthconsultants.com

Temporary Closure

John Dunnicliff
Alan Powderham

We've added the word 'temporary' to the heading, because we don't want to inhibit anyone from submitting a further discussion. Additional discussions will be welcome, and will be published in later episodes of GIN.

Thank you to Fritz Klingler for the contribution. We agree whole-heartedly with his view that the geotechnical designer (as part of the SST) is the preferred choice for performing field instrumentation services, as opposed to an assigned subcontractor.

We included the option of an assigned subcontractor for cases where the owner will not accept the geotechnical designer for this task. Owner's reasons with which we are familiar include:

- The cost of the services must be in the construction budget
- In recommending themselves for these services, the geotechnical designers are acting out of self-interest, with a profit motive
- If geotechnical designers performs field work, they will get in the way of the construction contractor, and cause conflict (the third point in our Table 2)

Finally, it was not our intention to suggest that an assigned subcontractor might interpret results. The maximum tasks for an assigned subcontractor would be those listed for "field instrumentation services" in our Table 1, but excluding "establish and update data collection schedule".

Geotechnical Engineering. Tricks to More Effective Training

Jerry DiMaggio

This brief article will provide some thoughts on active technical teaching. This is a miscellaneous collection of ideas, tricks and things that I have learned from others over the years, and now routinely apply in my training style. They are largely common sense, and I certainly claim zero credit for any of these suggestions. But from my own experience I firmly believe that they can and do work for our highly technical training programs in geotechnical engineering, and that they greatly improve the end product. Unfortunately, in my opinion many of the available technical training programs in geotechnical engineering fail to make use of many of these techniques. My personal experience with training and education is fairly diverse varying from graduate courses in a university environment to multi-day short courses. I have presented some form of training program in all fifty states and my "typical audience" is highly dependent on the course topic, location and sponsoring agency. The participants are often a mix of public and private specialists and generalists in civil engineering. The specialist participants include geotechnical engineers, engineering geologists, structural and roadway designers, and an occasional secretary. In my opinion the suggestions provided below can be applied to all types of training programs although some venues may be more difficult than others. For example the most difficult, and the ones that I find most unsatisfactory, are the one-day programs involving more than two presenters where "getting to know" participants becomes extremely difficult, and because of time constraints the discussions must be tightly controlled.

What is the Objective?

Persons attend training programs for many different reasons. They have no hobby (poor golfer), nice location (vacation), serious wish for continuing education, bad employee (punishment), good employee (reward), to learn, to create change. In my view the training is generally wasted unless the participant is thinking of **change** as part of the motivation for being there. This can and should be facilitated by the instructor/presenter. The general **strong** message to participants is: ***based on this training program, think of what you will do differently in your practice***. If the answer is nothing, then something went wrong at either the transmitting or receiving end.

Workshop/Seminar/Course

These terms are routinely used interchangeably but have very different meanings. At seminars we listen, whereas at courses and workshops the participants work and interact as part of the program. Retention of information by the participants will of course depend on the structure of the program, but more importantly it will depend on the tone and level of communication set by the presenters. Workshops and courses should be presented in a coordinated and logical manner, with each lecture building on the previous one. All too often technical programs are fragmented, with individual presenters being redundant or even conflicting. This provides a mixed message to participants. Who is right? How can I use fragmented information to solve a problem?

The program schedule must allow for questions and discussions. Including several 20-30 minute time slots for discussion is helpful for time management, as well as for setting the right tone. Ideally if the presenter is comfortable, questions during the program should also be welcome.

Workshop/courses should incorporate student problems and 'quizzes', to provide feedback to the presenters on the effectiveness of the training. Quizzes can either be looking for ideas or for solutions. Ideally each activity should take 20-30 minutes to complete. The participants should be provided with the ideas or solutions at the end of the quizzes. Encourage the participants to work in groups. For more effective interaction, you can randomly select a group to present their thoughts (via a group spokesperson) to the entire class. A common reaction among experienced geotechnical presenters when they are first exposed to this idea is: "Wow, this will take a bunch of time! How will I ever get through all my slides?" Certainly these activities require some time, but they cause the presenter to plan the program better. Don't show as many slides, and don't try to solve a problem in depth. The objective is **not** to present the maximum amount of material, but rather to present the **most important and valuable material** to the participants in an effective way.

Who are They and Why are They Here?

Begin each workshop/course by asking each participant to introduce themselves in 25 words or less (who are you?). In addition each presenter should provide a brief background which demonstrates his or her knowledge and skills related to the subject matter. Develop a brief 'fill in the blank' form to determine the education, background and experience of each participant. The presenters should collect the completed forms at the first break and develop a quick summary. At the beginning of the program ask each participant to list three **specific** things that they wish to learn from the workshop/course on a separate sheet of paper (no names, and again collect these at the first break). This early feedback will allow the presenters to set the level of presentation, and to focus the technical materials towards the **needs of the participants**. The participants at each workshop/course will be different (background, education, experience), so if the course/workshop is part of a repetitive series (multiple locations) the presenters must be flexible to meet the specific needs of each group. Provide feedback on the information received on the background forms and 'learning wish list', and state whether or not the needs of participants will be addressed. Not all presenters will be comfortable with on-the-spot changes, but ideally presenters should not determine their visual aid sequence and presentation material emphasis until they know who they are talking to and what participants want to hear.

Not all participants will be comfortable with asking questions in an open forum. Encourage participants to ask questions at breaks and lunch. This invitation suggests that the presenters are very approachable, and it sets the stage for better interaction during the entire program.

Periodically during the program ask participants to write down one or two things that they have learned during the past few presentations. Then develop a summary and provide feedback on this information.

Setting the Room/Visual Aids

We often have to present training programs in poor facilities. Even when the facilities are good, presenters often don't use their imagination and skills to make the most of the facility. Before beginning the program, experiment with the lighting to determine the best lighting for the various parts of the program. Arrange tables and chairs for comfort and view. Set the visual aid devices correctly (use only the top half of a screen since, depending on the room, the lower half is often blocked beyond the first row), maximise the screen image size (height and width) and set the focus sharply. At the beginning of the program check for audio level (when using microphones use them correctly, and if possible arrange for a radio microphone). When videos are used, encourage participants to move so they can see and hear. Learn the appropriate use of pointers, especially the laser type.

Make arrangements, before starting, for spare overhead and slide projector bulbs (this isn't as easy for computer projectors). Arrange for some way of drawing during question and discussion times, such as a white board, flip chart or blank overheads and pens. Don't use red or green markers on flip charts and white boards (most lighting will quickly reduce their clarity over short distances). Check the day before that the PowerPoint projector connects properly with presenters' laptops. If a presenter brings CDs or floppies, check that they will project clearly. Other miscellaneous items which should be available include laser pointer and spare batteries, radio mike and spare batteries, name tags, tent cards and evaluation forms.

Regarding visual aids - be frugal when developing word slides and images. Use the minimum number of words possible. **Please, please** don't read the slides or overheads unless for emphasis. Routinely ask the participants for individual feedback or input by either selection or volunteers. "Mary, what do you think of this statement?" This doesn't require a great deal of time but provides valuable feedback to the presenters.

Evaluation forms should be distributed the last day or half day of the program. Repeatedly remind participants that you sincerely want their feedback and opinions. Ideally the form should be structured to solicit comment and feedback rather than a simple checklist, which as a presenter I generally find to be useless. The evaluation form should also request feedback on what the participants liked or didn't like. This provides an opportunity for instructors to avoid making the same mistake repeatedly.

Agenda/ Manuals and Handouts

At the beginning of each program and periodically thereafter, briefly discuss the agenda. Tie the program together - *we started there and now we're here, and were heading this way.* Presenters should present their material such that it is consistent with the agenda - a road map so we know where we were and where we are going. This greatly helps learning and retention.

Tie the presentation to the handout materials. Too often 20 pounds of paper are distributed during a multi-day program, without any reference or use. If the participants don't become familiar with the general content and scope of the handout materials during the program they will most likely never use them in the future. **What a waste of trees**! At the beginning of each presentation the presenter should state what section of the handout materials is pertinent, and invite participants to follow along in the handout during the presentation (set the lights accordingly). During the presentation periodically refer to figures, tables and pages in the text. At the end of a presentation the presenter should page through the reference materials and take a few moments to discuss the key reference material. *Wow this will take a lot of time!* Not really.

Acknowledgement
Thanks to John D for the suggestion to put these ideas in writing, for additional ideas on content, and for editing.

Jerry DiMaggio, Principal Geotechnical Engineer, US Federal Highway Administration (HIBT-20), 400 7th Street SW, Washington D.C. 20590 Tel: (202) 366-1569, Fax: (202) 366-3077 email: jerry.dimaggio@fhwa.dot.gov

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Report on Conference "The Response of Buildings to Excavation-induced Ground Movements"

John Dunnicliff

Introduction

This international conference was held at Imperial College in London on 17 and 18 July 2001. The conference had its origins at the parliamentary hearings for the bills that would permit construction of the Jubilee Line Extension (JLE) in London, an extension to the London Underground (London's subway, or 'tube' system). The absence of good case history information became a stumbling block in efforts to convince governmental decision-makers to accept the project. This shortcoming both lengthened the questioning and weakened the authority of engineers who were supporting the project. The cost of the hearings was considerable, the cost of the undertakings given to building owners was very high, and the cost of the protective works that were planned as a result of uncertainties was also very high.

A fundamental decision was taken to conduct sufficient research during the design and construction of the project by gathering the best possible field data. The overall objective was to put the data in the form of coherent case studies so that the engineering of future soft ground tunneling projects (both bored tunnels and open cuts) could be undertaken with more confidence and at less cost. A condition of funding was that the research would be published.

The international conference was part of the dissemination effort, as also will be the proceedings and a two-volume book — see later.

The conference was organized by Construction Industry Research and Information Association (CIRIA). CIRIA is the UK construction industry's independent research association. Its mission is to improve the performance of all concerned with construction and the environment. For more information, see www.ciria.org.uk.

The Conference

After a keynote address by Professor Robert Mair of Cambridge University, the conference consisted of six sessions, followed by a closing address by Professor John Burland of Imperial College. The titles of the sessions, and the numbers of papers, were:

1. Prediction of damage to buildings, including subsurface structures and utilities from tunneling (9).
2. Effectiveness and viability of protective measures, particularly compensation grouting and other new techniques (7).
3. Management of the monitoring process (9).
4. Case studies from the JLE (9).
5. Prediction of damage to buildings, including substructures — from open excavations (6)
6. Effects of building stiffness, different configurations and time (8).

Instead of the traditional format in which papers are presented in turn, each session consisted of a brief summary of the papers by a 'rapporteur', followed by an open discussion. Despite some initial fears that there would not be enough discussion to sustain this format, the discussions were highly successful, intense and lively, and continued after formal closure of the sessions. [As a sideline, your reporter encourages other conference organizers to adopt this format. Also to disallow pre-prepared discussions, as these tend to make potential open-discussers feel inhibited because they have not had the chance to prepare to the same extent. The format requires a vigorous discussion leader and a clear statement of discussion topics on a visual aid]. Of particular interest to your reporter, during a Session 3 discussion about methods for procurement of field instrumentation services, the consensus strongly favored a direct contract between a specialist instrumentation firm and the owner.

In his closing remarks John Burland made many key points, only a few being reported here. First, that the lessons learned during the project have worldwide applicability, and that the case study information is a goldmine for the engineering community. Second, the quality and comprehensiveness of the data are outstanding. Third, volume loss is the vital parameter to be controlled to prevent building damage in response to tunneling, as it is a process parameter, although it has to be supplemented by measurement of other parameters that reflect building performance. He referred to volume loss as being the neck in the hourglass between the tunneling process and building performance, and he thought that this parameter could provide the basis for specifying required tunneling performance rather than defining absolute trigger levels (response values) for the deformation of buildings. Fourth, compensation grouting has proved remarkably successful and precise in controlling movements, but it does not stop long-term settlements. In this respect we need to monitor pore water pressure distributions and how they change.

The Publications

There will be three volumes resulting from the conference and research.

The proceedings of the conference will be available later this year, and will include all papers submitted to the conference together with edited transcripts of the discussions. The proceeding can be ordered via the CIRIA web site, www.ciria.org.uk/conferences_ground .htm. The price is not yet determined, but is expected to be about £80.

The results of the research will be published in a two-volume set, titled *Building Response to Tunnelling: Case Studies from Construction of the Jubilee Line Extension, London,* and edited by John Burland, Jamie Standing (Cambridge University) and Fin Jardine (CIRIA).

Volume 1, *Projects and Methods,* has 21 chapters and 344 pages, and is already available. It includes descriptions of the JLE, the methods of settlement prediction and building damage assessment used on the project, and the objectives of the research. There are chapters on the geology, the history of the project, the tunneling methods and protective measures, and details of design and construction of various sections of the project. The closing chapter, by John Burland, provides a summary of the results of the research. The volume is extremely well organized and edited, with very clear format and figures.

Volume 2, *Case Studies,* will be published later this year, and will present twenty-seven case studies in their geographic sequence along the project alignment. The case studies will present descriptions of the buildings, the construction work that affected them, the protective measures, and the monitoring to record the response of the buildings to tunneling. They will include two instrumented greenfield sites and several examples of prestigious buildings in London's west end that were protected by compensation grouting.

The two-volume book can be ordered via the CIRIA web site or from the publisher *Thomas Telford, either via orders@thomastelford.com or www.thomastelford.com, for £135.*

Review of Field Instrumentation of Soil and Rock, ASTM 1358, Gary N. Durham and W. Allen Marr, Editors

John Dunnicliff

This is a very late review of a very useful publication. The publication contains 28 papers that were presented at a symposium on *Field Instrumentation of Soil and Rock* in Atlanta, Georgia, on June 18-19, 1998.

The following are the topics that the reviewer found particularly useful. They are in the same order as in the publication.

The publication can be obtained from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Tel (610) 832-9585, fax (610) 832-9555, web site www.astm.org. Price is $74 in North America, $81 elsewhere.

Author(s)	Topic(s)
Pinto, Anderson and Townsend	Comparison between strain gage and inclinometer data for determining load transfer during lateral load tests of piles
Montanelli, Recalcati and Rimoldi	Strain gage measurements on geogrid
Marr	Tiltmeters on faces of buildings, with wireless data acquisition system. Determination of how much of the measured tilt was caused by instrument temperature sensitivity and how much was real tilt
McGrath, Selig and Webb	Monitoring soil-culvert interaction during backfill placement, with a wide array if instrumentation
Deming and Good	Simple mechanical system for measuring depth and detecting sediment at the bottom of slurry-supported excavations
Byle, McCullough, Alexander, Vasuki and Langer	Comprehensive instrumentation of a solid waste landfill, including commercial sources, installation methods and performance
Thomann, Khoury, Rosenfarb and Naplitano	Comprehensive instrumentation of a solid waste landfill, including automatic data acquisition system, and instrument performance
Hawkes and Marr	Automatic and manual data acquisition and management of a huge instrumentation program. Problems encountered, and recommendations for future automatic monitoring to increase efficiency

Letter to the Editor, July 12, 2001

I compliment authors Sweetman and Carayol on their informative case history (March 2001 Geotechnical News) about monitoring a diaphragm wall in Hong Kong with in-place inclinometers. Articles that spread the word about this powerful monitoring method are good to see on the pages of GIN and elsewhere. I am obliged to point out, however, that the authors have an undisclosed conflict of interest with the manufacturer of the product spotlighted in their article.

The authors sing the praises of vibrating-wire in-place inclinometers, but don't disclose that their company is the Hong Kong sales agent for the manufacturer of the very product whose virtues they extol. Succumbing further to temptation, they criticize the performance of all in-place inclinometers that use electrolytic tilt sensors, without offering data to support their claims. They either do not recognize, or simply choose not to inform the reader that more than one company manufactures in-place inclinometers using electrolytic sensors, and that their experience is confined to a single manufacturer.

On page 28 the authors state: "The fact that the vibrating-wire tilt sensor is a force sensor means that temperature changes ... have only a very small effect on the sensor output ... (usually less than 10 arc seconds/°C) .... This is a marked improvement over the electrolytic level types ...." This statement is misleading for several reasons. First, there is no inherent reason why a "force sensor" should have a lower temperature coefficent that any other type of sensor. There are ample sources of temperature sensitivity in vibrating-wire inclinometers, including thermal expansion/contraction of the hinge, wire, housing and coil. Furthermore, the authors' claim that 10 arc second/°C is a "small effect" surprised me. This value is about double the temperature coefficient of at least one widely marketed, low-cost, wide-range in-place inclinometer that uses electrolytic tilt sensors. Higher-precision electrolytic instruments have even smaller temperature coefficients. Finally, the authors suggest that only vibrating-wire sensors are capable of stable signal transmission over long cables. This may have been true 30 years ago, but no more. Modern electronic design enables electrolytic inclinometers, and most other instrument types, to operate routinely and with high signal stability over cables greater than 1 km in length.

A detailed explanation of temperature effects on electroltyic tiltmeters, and on the structures to which they are attached, was published by this writer in the September 1997 issue of GIN. Thanks, as always, for making this an open forum for all of us who work in the instrumentation field.

Gary R. Holzhausen, Ph.D.
President,
Applied Geomechanics Inc.
holzhausen@geomechanics.com

Response to Dr. Gary R. Holzhausen, July 19, 2001

I wish to thank Dr. Holzhausen, in return, for his compliments on our article on monitoring the diaphragm-wall with in-place inclinometers,

Regarding the possibility of a conflict of interest between Soldata (Asia) and Geokon, we trust that the readers of GIN are sophisticated enough to understand that the existence of a client / supplier relationship should allow Sol Data (Asia) to mention Geokon's instruments in a technical article, and that this does not preclude the likelyhood that opinions expressed and experiences recounted might be honest and truthful.

Nevertheless, as far as relationship is mentioned, let it be known that:

- Soldata (Asia) is not a Geokon agent and has never sold Geokon instruments to anybody except for and through its own projects.
- Geokon is a "preferred supplier" for Soldata (Asia)
- Sol Data (Asia), as a professional instrumentation contractor, buys a lot of instrumentation from Geokon as well as from nearly all the other manufacturers on the simple basis of quality and price, for the use on its own projects.

The pages of GIN are hardly the proper forum in which to conduct a possibly long and boring technical squabble between rival instrumentation manufacturers. Any reader interested in a detailed refutation of Dr. Holzhausen's technical remarks should contact the authors of the article directly, or Geokon for queries directly related to its technology.

However, for readers more interested in guidance in the choice of in-place inclinometers (IPIs), Sol Data Group has initiated and financed a large-scale and comprehensive test program on eight different commercial versions of IPIs — Applied Geomechanics, Geokon, Glotzl, Interfels, Roctest, RST, Sisgeo, Slope Indicator. The test program is outlined in the article "In-place Inclinometers — A Significant Test Program", *Geotechnical News, Vol. 19 No. 1, March 2001, pp 33,34.*

This is the first ever independent blind-test on in-place inclinometer sensors, with the specific objective of comparing various technologies from various suppliers.

Testing and reporting is being done independently by the French National Testing Laboratory - Laboratoire National d'Essais (LNE). LNE is one of the major independent testing houses in Europe for testing the quality and technical conformity of measuring equipment. A test report should be available soon. Sol Data expects to recover part of the cost of this test program by selling a detailed report of the results. Readers of GIN, consultants, designers and specialists in the geotechnical instrumentation field should be particularly interested in the results of these tests. Expressions of interest for this report can be posted on www.soldatagroup.com

With kind regards, special thanks to the editor of GIN for allowing right of answer, and wishing this forum to stay on the technical side.

Stephane Carayol
General Manager, Sol Data (Asia) Ltd
stephane.carayol@soldata.fr
www.soldatagroup.com