Introduction by John Dunnicliff, Editor

This is the 92nd episode of GIN. Just one article this time, on my favourite subject, Human Factors. In the red book I called these People Issues, but the former is a more common and better term. The article is followed by some discussions by manufacturers of instruments (which I found very interesting) and a closure.

A 'Must Read' Manual for Anyone Using an Inclinometer

"Use of Inclinometers for Geotechnical Instrumentation on Transportation Projects

State of the Practice", Transportation Research Circular Number E-C129, October 2008. By George Machan, *Landslide Technology* and Victoria G. Bennett, *Rensselaer Polytechnic Institute (RPI)*.

Although written nearly ten years ago, I've only just discovered this. By far the best document that I've seen on this challenging subject.

http://onlinepubs.trb.org/onlinepubs/circulars/ec129.pdf

A Tale to Reinforce your Faith in Human Goodness

Last week my wife Irene went shopping in a town about 5 miles away, population 25,000.

When she returned to her car, she discovered that she'd lost her wallet. Annoyed with herself! So she went to the nearby police station to report the loss.

A few hours later the phone rang – a policewoman saying that the wallet had been handed in. "Are you going to be in this evening?" A puzzled, "yes". "We'll see you in about an hour". Wow!

About 2½ hours later the phone rang, and in a voice interrupted with laughter, "We're lost!" Now, we live down some narrow lanes in a National Park, but we're NOT isolated. She described where they were – not far away, so I started to give directions, mentioning a nearby hotel. More laughter, "We've passed that lots of times this evening. We have SatNav, but it's just told us to go to the end of this lane, park and walk. Let's meet at the hotel".

So we did. They were in a largeish police van (probably a 'paddy wagon'), policewoman A driving. Policewoman B jumped out, laughing, "I've been bursting for a long time" and rushed into the hotel. (This explained why they wanted to meet at the hotel rather than at our house!). "We've been driving around and around – we'll never forget this evening!" Both were in their 20s.

More chat, more laughter. Wallet returned. Nothing missing. Receipt signed. Repeated "We'll never forget …". Hugs all round (Kevlar jackets, we think). Vigorous waving goodbye.

Profuse thanks sent to the finder.

An afterthought – what would have happened if we had called the emergency number because we were burgled?

Down the hatch (England)

Gezondheid ("To your health"). Netherlands

Some remarks on the importance of human factors in geotechnical and structural monitoring programs

John Dunnicliff

In my experience as a 'getting hands dirty' practitioner for geotechnical and structural monitoring, I've learned that technical issues take us only half way to success. The other half consists of what I used to call 'People Issues' and my Italian colleague Giorgio Pezzetti has found a better term: "Human Factors". Failure to attend to the human factors has so often led to failures of monitoring programs. As my fellow octogenarian Elmo DiBiagio, from the Norwegian Geotechnical Institute, recently wrote to me, *"We have solved most of the 'what to measure problems' and we have well proven instruments. The people may be the weak link in an instrumentation proj-*

ect." Nearly all the technical journal, conference and symposia papers about monitoring have been about technical issues, which in my view demonstrates a significant failure in our communication with each other. Therefore I want to focus here on the cruciality (that's a new word!) of these human factors, and to encourage you to pay more attention to them in the future than you have in the past. For those of you who have heard all this before, yes, I AM going to sing my usual old song.

At the end of this brief article I'll include some references, one of which is a link to a video of a lecture by Allen Marr of Geocomp in Massachusetts, given in Cambridge, England last year, in which he talked about many human factors associated with performance monitoring as a risk management tool. Watch, listen, learn and act!

Another valuable reference about human factors is an article in GIN by Martin Beth of Sixense-Soldata, with the title "Eight common sense rules for successful monitoring". When I told Martin how useful I thought this was, he replied, "But everyone knows these rules". Not true. Read, learn and act!

Here are some common sense rules from my own experience, many of which do, in fact, sing my usual old song. There are nine of them.

1. Every instrument on a project should be selected and placed to assist with answering a specific geotechnical question: if there is no question, there should be no instrumentation. When reviewing the need for each planned instrument, ask "What's the question?"
2. It doesn't make sense to ask "How much should we spend on monitoring?"
3. When planning and executing a monitoring program, use a multi-stage systematic approach. Full benefit can be achieved from monitoring programs only if every step in the planning and execution process is taken with great care. There's a reference to a 13-step planning procedure at the end of this article. Instrument selection must be made as part of the designer's systematic planning process, which includes the identification of the geotechnical questions.
4. Low-bidding for monitoring field work usually results in poor quality data. There's no need to convince readers of GIN about this, because I think that I'm preaching to the converted. But we have to work hard to convince decision-makers in the offices of project designers and project owners that it is NOT in their interests to allow low-bidding. The strongest argument is that it will cost more. (See the 13-step planning procedure just mentioned).
5. When monitoring data are crucial to a project, as they often are, don't let anyone try to stop you from spending the necessary money to monitor properly. If you're not heard by decision-makers, play Allen Marr's video to them.
6. Motivate the people responsible for instrumentation field work – installers, data gatherers, maintainers – by explaining not just HOW to do it, but WHY their work is so important. You'll get far better commitment. Of course this recommendation applies to issues much broader than monitoring. I've encountered so many people in positions of authority who only say the HOW to their subordinates – this is very short-sighted.
7. A tale against myself:
   - I arrived on a site to install some instruments
   - I met the driller and explained to him what I was going to do
   - He said "that won't work"
   - I was self-confident and "did it my way" (you know the song!)
   - It didn't work
   - The lesson learned: Listen to the driller!
8. I'm going to address a contentious subject, and say something about how I believe designers of monitoring programs and instrument manufacturers should interact with each other. We all know that we and they are dependent on each other, and that we can work well as a team. We're all in it together. But I think we need to recognize a logical dividing line between what we each do. Some designers rely on manufactures to advise them on what instruments are needed on their project, and some manufacturers will do this without charge. Yes, it's an easy way out for the designer who has insufficient experience with instrumentation. And yes, it's understandable that some manufacturers go along with this, to cement a sale. But, to be blunt, in my view this is not in the good professional interests of our monitoring community.

"In my view this is not in the good professional interests of our monitoring community"

As I said earlier, instrument selection must be made as part of the designer's systematic planning process, which includes the identification of the geotechnical questions. We need to do all that we can to get this message to designers. If designers don't have enough experience, logic says that they should team up with someone who does. No, that's not self-marketing – I've retired from consulting!

9. Following on from my previous point, if manufacturers advise on what instruments are needed on

their customer's project, are they exposing themselves to professional liability concerns? Remember Nicoll Highway in Singapore!

In closing, I encourage you to pay more attention to human factors in the future than you have in the past. As Ralph Peck said to us, *"We need to carry out a vast amount of observational work, but what we do should be done for a purpose, and be done well"*.

References

Link to a video of a lecture by Allen Marr, given in Cambridge, England last year: *www.youtube.com/watch?v=67gAXmxcokA*

Martin Beth's article in GIN, titled "Eight common sense rules for successful monitoring". www.geotechnicalnews.com/instrumentation_news.php. June 2016.

A 13-step procedure for systematic planning of monitoring programs. I've published various versions of this. For the latest, e-mail me at *john@dunnicliff.eclipse.co.uk* or visit Geokon's website (see below).

Author's/Editor's Note

I invited eight manufacturers of instruments from North America and Europe to send me discussions of the above points 8 and 9, in the hope that we'd be able to agree on how to chart a way forward with these issues. Six sent me discussion, which follow, in alphabetical order of company names.

Discussions of above points 8 and 9 by manufacturers of instruments

David Richardson, Durham Geo Slope Indicator

At DGSI, it is not our practice to provide recommendations to the designers of monitoring programs on what instruments are needed on their projects. We will assist by offering advice for the appropriate style of a sensor (e.g. pneumatic vs. vibrating wire piezometers or traversing vs. in-place inclinometers), but we will not recommend which sensors should be installed.

As the manufacturer, we typically do not know the detailed information about the site, and we are rarely provided the geotechnical or the proposed structural loading information required to make informed recommendations about the most appropriate instrumentation. Even though we have geotechnical engineers on staff, providing "consulting services" is not our practice.

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Tony Simmonds. Geokon Inc.

I discussed this with Barrie Sellers (President Emeritus, Geokon Inc.) and believe he sums up the concern regarding designers of monitoring programs and instrument manufacturers very well with the following;

I think you could say that manufacturers represent a valuable source of knowledge and expertise on the choice of instruments and methods to accomplish a certain measurement but they are not the ones to decide which measurements are necessary to answer which geotechnical questions or concerns – these should be within the purview of a registered geotechnical engineer.

In keeping with this and, as an added resource to those customers who approach us in need of direction, we have included a link on the Projects page of our website (www.geokon.com) to John Dunnicliff's article "A 13-step procedure for systematic planning of monitoring programmes using geotechnical instrumentation". [This article is the same as the one included as the last of the three references above. JD].

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Martin Clegg, Geosense Ltd

There are three basic responsibilities in instrumentation. The Engineer's, The Instrumentation & Monitoring Contractor's and the Manufacturer and/or supplier's:

The Engineer's responsibilities are:-

1. To identify the need (why) for monitoring.
2. To identify the what (parameter) & where (e.g. dam body) to monitor.
3. To make the specification for the instrumentation.
4. To analyse & understand the data from the instrumentation.
5. To use the data from the instrumentation to carry out the necessary calculations required by the designer for verification and/or validation.

The Instrumentation & Monitoring Contractor's responsibilities are:-

1. To install instruments to the Engineer's specification.
2. To provide data to the Engineer's specification.

The Manufacturer/supplier's responsibilities are:

1. To provide the Instrumentation & Monitoring Contractor with hardware and/or software to meet Engineer's specification.

There will always be a place for Engineers, Instrumentation & Monitoring Contractors and Manufacturers to interact to discuss and understand the application and performance of instruments especially where new technology is evolving. However, there will inevitably be a degree of commercial influence during these discussions.

As the success of any instrumentation monitoring program depends on the understanding of the objectives and the quality of the specification it is vital that the Engineer does not impose or rely too heavily on Manufacturers for this. The understanding of the individual application and each sensors performance together with its limitation should be fully understood by the Engineer before specifying it. We as a manufacturer are seeing too much emphasis being placed on us to explain "unexpected readings" which more often than not means that its use is not fully understood. Sensor failure is very rare.

With the amount of published literature now readily available on instrumentation and their application plus various training courses available the information is there. It just needs a willingness to find and study it.

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René DeBlois, Roctest Ltd

Manufacturers can play an important role in the design of a geotechnical and structural monitoring solution. We know the capabilities and limitations of our instruments and we have thoroughly tested our products and have a full understanding of the most suitable applications for their uses. Adding years of experience with numerous projects in a large range of applications, manufacturers such as Roctest can assist users with their challenges related to geotechnical and structural instrumentation. Instruction manuals, websites and dedicated in-house experts are always available to support users in the implementation of their projects. However, a manufacturer's knowledge of the specificities of a project, its weaknesses and critical aspects, is sometimes very limited and prevents us from going beyond the manufacturer's scope of work. Therefore, questions about the selection of a type of instrument(s), the required quantity or the expected measuring ranges (among others) should be directed to project designers and not to manufacturers.

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Bruce Ripley, RST Instruments Ltd

Human factors in engineering are about the quality of communication within a project team, to draw on and utilize the deep knowledge and experience of all the specialists required for project success. On a large infrastructure, mining, energy or water project, the number of specialists required can be large, and therefore the number of relationships to be managed is large and complex. Instrumentation is just one of many speciality relationships

to be managed by the owner/designer/contractor.

Most often, only the instrumentation supplier and the instrumentation installer eat, sleep and breathe instrumentation, and therefore accumulate the deep instrumentation knowledge and experience that can benefit the project. Owners, designers and contractors can access this knowledge and experience by engaging instrumentation suppliers and installers early in the project development phase to explore options to meet the instrumentation objectives and to finalize the instrumentation requirements.

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Giovanni Caloni and Daniel Naterop, SISGEO SRL

When we talk about the relation between designers and instrument manufacturers, the link should be really close. And in this close relation the "human factor" plays a key role.

Designers know very well the geotechnical problems in their projects, but they do not know enough about instruments and technologies available, to monitor if their assumptions will be confirmed during construction.

We often see drawings and specifications of projects where the monitoring solutions are clearly wrong or, maybe worse, they are a "copy and paste" from other previous projects: it means that, for some designers, the monitoring programme has a very low importance.

SISGEO helps a large number of designers to plan a good monitoring programme: sometimes we were asked to do it for free (in most cases) and sometimes we receive a fee for our technical consulting.

Designers calling the manufacturers in order to have suggestions on the instruments is indicative that the designer takes care about the monitoring system. This will help them during construction time, with the aim of checking and, if needed, changing the designing solutions in nearly real-time.

Maybe the right behaviour from designers' part would be to call the manufacturer not just when needed, but to keep a continuous relation in order to be constantly updated on the available technologies and solutions.

If the manufacturer considers itself only a "manufacturer" and thinks that its job is limited to receiving quotation requests and selling instruments, this could lead to a great misunderstanding. This is why SISGEO staff are always collaborating with designers and with final users.

All the parts involved into this process must have clearly in mind their final target and their mutual relationship. Manufacturers can help designers, giving them suggestions on the available instruments, but the final decision on the monitoring solution to be adopted must be up to the designers who have full knowledge about the geological conditions and the features of the structures under construction.

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Closure

John Dunnicliff

Some manufacturers indicate that their role is limited to supply of instruments. Others believe that they have a larger role to play. So my "hope that we'd be able to agree on how to chart a way forward with these issues" was clearly unrealistic. We're all entitled to our opinions!

If any reader wishes to send me a discussion about ANY issues relating to the important topic of human factors, that would be welcome, and I'll publish them in later episodes of GIN. Send them to me at *john@dunnicliff.eclipse.co.uk*. Included in this invitation are all the manufacturers who I invited earlier: those who opted out and those who would like to say more after reading what their competitors had to say. My deadline for receiving more discussions is **July 10** this year. If you send me a discussion, please follow the above format. If you prefer to write a stand-alone article, please follow "How to Submit Articles to John Dunnicliff for GIN" in *www.geotechnicalnews.com/instrumentation_news.php*.