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The Geotechnical Data Journey – How the Way We View Data is Being Transformed

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Abstract. In 1998 'the geotechnical data journey' laid out a workflow to aid the efficiency of the site investigation reporting process. This essentially represented a digital version of a previously paper driven process. However, developments in technology and from elsewhere suggest that a more evolved process is required to suit the current requirements of industry. This paper reviews and refines 'the geotechnical data journey' for the present day.

Keywords. Geotechnical and geo-environmental data, AGS, BIM

1. Introduction

Chandler and Hutchinson [1] laid out the principles of the geotechnical data journey. The application of a clearly codified digital workflow, this illustrated how efficiencies could be gained over conventional reporting methodologies. The AGS data transfer format was exploited at each phase of the project, a previously paper based process being replaced by a digital one:

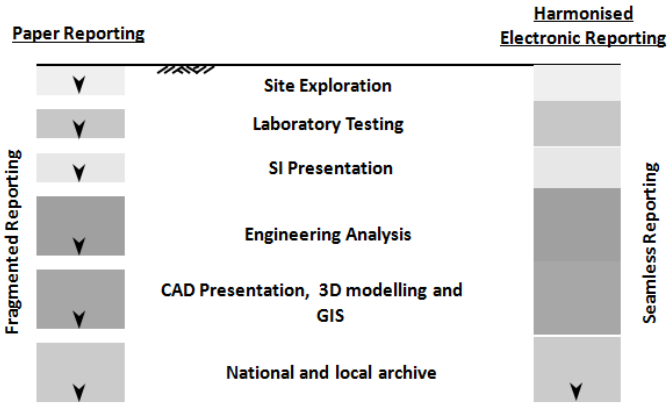

Figure 1. The Data Journey (Chandler & Hutchinson [1])

AGS is now used routinely, driving many larger or high profile site investigation projects. However, the site investigation landscape has evolved again, both through

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changes in technology and elsewhere, meaning the 'data journey' itself must also move on.

This paper identifies the changes and challenges which renders the data journey a now incomplete picture. Key principles in the new 'data journey' are summarized as a methodology to implementing a more comprehensive approach, a broad range of benefits then becoming possible.

2. The Sources of Change

The sources of change which carry implications for the data journey can be broadly categorized into two sources of influence – those which have come from within the industry itself (broadly in the form of specification, best practice and government policy) and those which stem from advances in technology which are not specific to site investigation.

2.1. Intra-Industry Changes

The much anticipated *UK Specification for Ground Investigation* outlines the routine issue of AGS data (Environmental Scientifics Group & Association of Geotechnical & Geoenvironmental Specialists [2]). This encourages the issue of data in preliminary stages as well as final versions. Further, the issue of AGS could also support the requirements for daily reporting outlined in the same document.

Laying out a best practice framework, the *Code of Practice for the Management of Geotechnical Data* guidance document (British Standards Institute [3]) is undergoing review at the time of writing. This document outlines a structured approach to the management of data across an organization, accountabilities being established at executive level, to which KPIs are reported from the management tier. This in turn filters down to practical project specific guidance which is then applied by engineers and technicians.

Version 4.0 of the AGS data transfer format broadens the capacity of data which can be exchanged between parties. In addition to other improvements, specific new tables have been included to detail the exchange of samples (CHOC), laboratory schedules (LBSG, LBST) and the digital data itself (TRAN). Further, the inclusion of a universally unique sample identifier (SAMP_ID) seeks to facilitate such data exchange in a more robust fashion than previously possible (Association of Geotechnical & Geoenvironmental Specialists [4]).

2.2. Extra-Industry Changes

Although the concept of BIM (Building Information Modelling) pre-dates the Data Journey – Van Nederveen & Tolman [5] are credited the first use of the term in 1992, although the approach can be traced back further still - it has taken some time for UK government policy to create a key driver for major infrastructure projects (Cabinet Office [6]). The process encourages the development and exploitation of a digital model, rather than paper based representations of the same. Models are made available across disciplines and stakeholders, ultimately providing a valuable reference to clients. The accessibility to and interaction with continuously developing models is a key implication of the process. Further, models are not merely spatial representations but

reflect the dimensions of time and cost, allowing components to be identified during the post-build maintenance phase, for example.

The availability of software applications and data storage in 'The Cloud' (i.e. stored and secured on non-specific hardware, theoretically available anywhere) lends itself to more open systems. This development in particular serves the need to collaborate, as promoted by the BIM process. The provision of instructions to drillers, data from site, remote monitoring and client access all create a new expectation of transparency on behalf of key stakeholders.

Cloud technologies coupled with the mobile revolution create an impetus for the industry to deliver and interact with data on demand. With handheld technologies becoming a household approach, let alone industry, economies of scale realize the possibility of affordable hole side logging, specialist hardware no longer being the only cost effective approach.

3. Implications of Change

With each of these influences data management is no longer an approach but a requirement. Supporting procedures need to be more stringent than in the past, the key considerations of quality, timeliness, security and audit being particularly relevant. The British Standards Institute [3] document is especially pertinent in this regard, establishing as it does a process framework.

Under modern practices the data journey is clearly less relevant in its previous form. Although it brought clear advantages over the full traditional approach to site investigation reporting it nonetheless represents a digital interpretation of a primarily paper driven process. With the influences above the methodology now needs replacement, rather than refinement.

Instead of the traditional clearly defined stages at which data becomes available being the norm, data is available throughout the life of the project. It may be subject to revisions and improvement throughout, but availability can be a much more fluid process than seen previously; that is, data delivery is no longer an act but an ongoing process. The following diagram illustrates this:

Figure 2. The data journey transformed.

In this model, access to data is constant, allowing controlled collaboration with other disciplines. The preparatory stages of desk study can be informed by, for example, readily available mapping datasets. Hole locations can be planned and passed through to contractors with instructions, possible access issues having been informed by aerial photography and the like. Should it be necessary to relocate holes these revisions can be communicated back via AGS. Details of the extracted samples can be passed digitally to laboratories, complete with their associated testing schedules. With a process robust enough to ensure the unique identification of samples being applied (Association of Geotechnical & Geoenvironmental Specialists [4]) the samples obtained by site crews can be referenced effectively alongside the laboratory test results associated with them. Correctly referenced, test results – both laboratory and *insitu* – can be analysed effectively and efficiently, this feeding back into site based decisions if necessary. All this leads to the effective interpretation of ground conditions and characterization of the site, visualizations being generated by 3D and GIS packages which tap directly into the same data source. But the process need not end there, data being made readily available in the form of a digital archive. In this way even historical projects inform current decisions, a repository of past undertakings providing a valuable insight to tenders for work.

4. The Data Journey Transformed – Previous Principles Revised

As the industry from which the Data Journey (Chandler & Hutchinson [1]) was borne has evolved so too has the Data Journey itself. No longer are the "two golden rules of data entry", as proposed by Chandler subsequently [7], sufficient to lever the benefits possible under such changes. Instead, consideration must be given to the five overarching principles:

Figure 3. The knowledge management principles of the data journey.

4.1. Plan

The approach to data should be explicitly planned as with any other key aspect of a project. An organization which has an established data management strategy has a clear advantage as the project already has a context into which it can be placed. The required standards for reporting, either industry (e.g. Eurocodes) or AGS format, can be easily established. Expectations for data versioning complete with status and frequency can be laid out, providing a clear delivery framework. The ownership of potentially controversial aspects of data, such as geology related picklists (Environmental Scientifics Group & Association of Geotechnical & Geoenvironmental Specialists [2]; Child [8]), can be determined unambiguously.

4.2. Capture

Employing data validation techniques within data capture tools can help to minimize human error. Similarly, the 'golden rules of data entry' (Chandler [7]) of "only enter data once" and "get someone else to do" can be further enhanced with the addition of "log as close to source as possible" (this facilitates the recording of the unique sample identifier as early as possible). These three rules encourage efficiencies avoiding not only the time benefits associated with the re-keying of data but also by reducing the opportunities for mistypes.

4.3. Utilise

Recent developments in technology present new opportunities which can be exploited. Data can be accessed or created using a wide variety of devices, mobile solutions becoming commonplace as many organization support a BYOD (Bring Your Own Device) policy. As such, the software solutions they consider need to be as platform agnostic as possible in order to support their employees diverse preferences in hardware. Connectivity issues which have prevented the effective use of mobile technologies previously are being eroded as the availability of secure high speed connections increase. This has clear advantages for field based data capture and reporting but also for the worldwide access of data.

4.4. Refine

A continuous interaction with data allows data validation, quality assurance and auditing to be a constant process, rather than being isolated to set phases in the life of the data. This facilitates iterative improvements, additional data being augmented as it becomes available.

4.5. Share

A culture of isolationism has given over to one in which specialists from multiple disciplines can collaborate readily and so streamline project delivery. Open data transfer standards (e.g. the Construction Operations Building Information Exchange or 'COBie' (East [9])) promote interoperability, reducing a reliance of vendor led proprietary formats, this in turn liberating organization to use their software tool of choice.

5. Conclusion

Previously the data journey has been presented as a rather linear process, the passage of data occurring at clear stages within the life of a project. As a translation of a paper process to its digital equivalent this was entirely appropriate for its time. However, as the industry needs to work in a different way, the boundaries between phases often being blurred, so too our understanding of the form of the data journey also needs to be different. In the past, data was a part of a process to produce deliverables; now data is one of the deliverables and knowledge management the

process itself. That is, while we previously believed the data journey to be flat we now understand it to be round.

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