Real-time Visualisation and Recording: Total Station, Rhinoceros and Termite

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Abstract:
Although perhaps appropriately categorised as an ageing technology, the total station still warrants a place among more advanced recording instruments; both from a consideration of practicality, but also because some recording tasks, for example ships, require the interpretative freedom offered by the manual total station. In order to optimise the process of total station recording, both in terms of efficiency and accessibility, facilities for visualising recorded data on a computer in real-time has long been available, albeit mainly through costly surveying software. This paper presents the Termite plug-in for the Rhinoceros 4.0 software, which adds this functionality to the inexpensive and widely adopted CAD platform. By enabling constant control with data quality and structure, as well as allowing analysis and editing during recording, post-processing requirements can be dramatically reduced. With a graphical interface for data manipulation, the set-up and operation of the total station is furthermore simplified significantly.

Key Words: *Total Station, Rhinoceros, Data Acquisition, Ship Recording*

Introduction

While technological innovation keeps opening new avenues of archaeological investigation, there nonetheless remains good sense – both economically and practically – in a continued effort to optimise the application of existing and established recording technologies. That there might be a financial incentive in extending the lifetime of ageing instruments, and thereby postponing new investments, is hardly a surprising idea. More than this, and perhaps less obvious, is the value of maintaining a varied methodological arsenal in spite of apparent obsolescence since, regardless of sophistication, some mature technologies still warrant serious consideration.

This paper will present a piece of software developed by the author, which is intended to provide a measure of optimisation to one such technology: the total station. The software is an add-on, or plug-in, for the increasingly popular Rhinoceros 4.0 CAD (computer-aided design) programme. The fundamental function of this plug-in, Termite, is to establish an interface between the virtual CAD environment and a connected Leica total station. This connection allows for a number of real-time operations between the two, and ultimately sharpens the capabilities of the total station as a primary tool for detail recording. The main features as well as some of the principal methodological advantages are outlined below.

Technologies

Having already commented on the rather established status of the total station, it probably requires but the briefest of presentations: the total station is an optical surveying instrument which can acquire relative coordinates of single points in three dimensions. From the direction of the telescope carefully aimed by the operator, the on-board computer calculates these coordinates by measuring the angular differences on the vertical and horizontal axes, as well as the distance to the target. This distance measurement originally relied on a time-of-flight calculation of an infra-red beam to a prism and back, but many instruments now also allow operation in a reflectorless mode, greatly simplifying the detail recording process. The default destination for this raw data is then either the instrument's own internal storage or an externally connected data stack. Both options, however, share the major downside that the operator remains more or less blind to the progress and quality of the recording: although some instruments support built-in screens for visualising data, these remain of limited utility and not until after the session, when the instrument or data stack is connected to a computer and the data transferred, are the results fully apparent. While experience and careful planning may naturally render even such 'blind' recording perfectly successful, Matt Bradley (2006, 31) certainly has a point in claiming that the usefulness of the total station 'is increased exponentially' with the ability to see recorded data in real-time. Fortunately most manufactures allow their instruments to establish an external connection during recording, and to transmit data this way rather than straight to storage. A computer with CAD software on the other end of such a connection could therefore serve to visualise data points as they are being recorded.

The Rhinoceros software may not ring quite as familiar as the total station, but it nonetheless seems to be gaining great popularity within archaeology. Although developed mainly for design and modelling, the Rhinoceros CAD programme excels particularly at creating fair lines and curves, which is naturally a major advantages for nautical application (see also Campbell 2009). Unlike AutoCAD, which has long appeared the sole contender for archaeological CAD software, Rhinoceros is quite accessible in terms of both operation and investment. For these reasons, and not least because it offers out-of-the-box support for digitising arms, Rhinoceros has been adopted by a significant number of projects and institutions in recent years. What Rhinoceros obviously does not, is interface total stations directly.

Justification

In the face of the amount of attention being devoted to advanced documentation technologies relying on scanning or photographic principles – the present volume being no exception – resources spent patching up a simple total station perhaps warrant justification, or at least explanation. Since a laser scanner and a total station produce fundamentally the same kind of data, the former only at incomparably higher speeds, it seems that the larger investment may be more than compensated by the relative efficiency. An argument for financial benefit would therefore be invalid, or at least stubbornly short-sighted. This apparent logic does, however, largely miss the point. Firstly because there is naturally more to financial benefit than initial investment, but more seriously because total stations and scanners are different tools for different purposes and as such cannot be subjected to direct comparison.

Wolfgang Böhler (2006, 90) has attempted to indicate this difference, or rather the appropriate (in terms of cost-efficiency) application of different technologies, through considerations of object size and complexity. Although the resultant picture is a patchwork of overlapping applications from hand drawings to satellite imagery, the more or less obvious point is well illustrated: archaeological recording poses no single challenge and accepts no single solution. Böhler's sketch of technological overlap is, however, also a hint that there are more factors than size and complexity to consider.

In many areas, and particularly in nautical archaeology, one such factor is the ability to undertake 'intelligent' recording. Because the

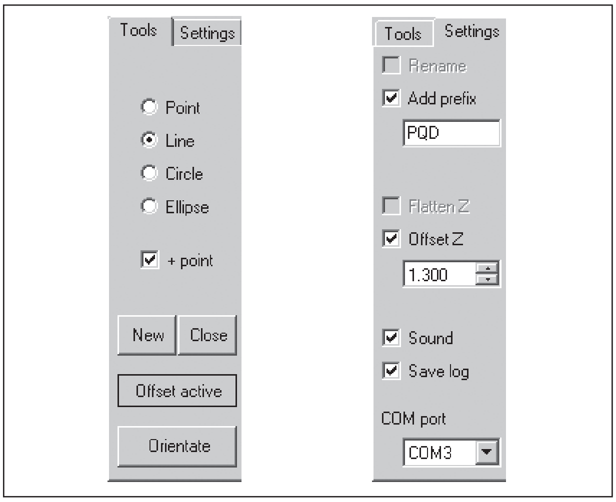

Figure. 1 The Termite 1.0.2 interface.

documentation of ships is largely a functional investigation of construction and composition, the recording itself necessarily constitutes an active interpretation of the vessel, and perhaps more urgently so than with other types of objects. To base this interpretation on a secondary model from scanned or photogrammetric data might render levels of this interpretation unreasonably difficult, or perhaps even impossible. Furthermore, the high level of surface detail which might be represented in such a model would often be of only secondary importance to the structural interpretation. The strength of the total station here lies in the operator's ability – and indeed obligation – to interpret and deliberately choose how and what to record, arguably impacting both post-processing requirements and output quality. While others are concerned with further automating the total station (see for example Scherer and Lerma 2009), the philosophy behind Termite has rather been to facilitate and ease manual interpretation, and maintain the intelligence outside the instrument.

Although the total station is the subject of this paper, there are other available technologies which could, and do, fulfil this requirement for interpretative recording. The most popular of these is no doubt the digitising arm, allowing for more or less continuous three-dimensional recording within the range of the articulated arm. Particularly FARO's products have been adopted widely for use in recording smaller artefacts or disarticulated elements. However, since the instrument requires physical contact between measuring probe and object, tasks demanding a larger span than the length of the arm become problematic (although not necessarily impossible, see for example Overmeer 2009, 22). This limitation, their price tag, and their mechanically delicate nature render digitising arms well suited for workshop use, but of limited applicability to field surveys. A novel solution which eliminates at least some of these limitations might be Nikon's iSpace system (see Avern, this volume), but for now the total station seems to retain its usefulness for more extensive tasks.

Termite

The concept of real-time connectivity between total station and CAD software is no novel idea. Plug-ins for both AutoCAD and MicroStation have been available for many years, offering exactly this functionality. Even GIS/CAD software such as Penmap has shipped with direct connectivity as a standard feature since the 1990s. In this regard, Termite is a very particular solution and as such no direct alternative to any of these, but rather forms a part of the economical alternative in conjunction with Rhinoceros.

The Termite software is a small application which runs inside Rhinoceros and has no stand-alone capabilities. The plug-in is freely available from www.termite-for-rhino.com. Once loaded (no actual installation is required), Rhinoceros is able to receive and manipulate data from a Leica total station over a serial connection. The functionality has been created with accessibility and efficiency as the main concerns, aiming at a simplification of total station operation through the elimination of unnecessary technical obstacles.

Most obviously, the interface means instant visualisation of data: the moment a point has been measured with the total station, it appears as a three-dimensional point object within Rhinoceros. This allows the operator an immediate check on the quality of the data and the option to edit or delete data deemed unsatisfactory. The recording density can be monitored and adjusted as a session progresses, and gaps filled with little concern for underlying continuity. Since the management of the data takes place in Rhinoceros rather than the total station, it is also the CAD software's extensive capabilities for data layering which structures the incoming data. So, whether the recording is planned in advance with a layer template or the operator defines the structure on the spot, the data can be organised in appropriate groups, styles and colours while the recording is still in progress. Beyond merely visualising incoming data, Termite can also create geometry to connect the raw data—for example continuously connecting incoming points—with a click of the mouse. Rhinoceros' functionality as CAD software naturally remains fully operational throughout the recording process, so the whole dataset may be analysed and edited at any time. Apart from offering quality assurance, these features dramatically reduce time required for post-processing: since the dots are already connected, as it were, and the data already structured and more or less clean, what remains is largely considerations of formatting and presentation.

Basic data manipulation, such as assigning point names or ID numbers, or applying offsets is also easily attainable from within Termite, meaning that operators will rarely have to resort to the total station's own, often cumbersome, menu system.

Moving the total station around an object or site is potentially one of the most complicated and time consuming operations during a recording project. It requires a carefully planned control network, and either a thorough understand of surveying techniques or ample time to manually merge and register different data sets during post-processing. With Termite, the operation requires neither of the three because everything is handled step-by-step in Rhinoceros, and since there is no fundamental difference between control point objects and detail point objects, control networks can be defined and altered *ad hoc* during recording. As a result, it should take less than a minute to orientate the total station and continue work at a new station, and because the data from each station simply becomes a direct continuation of the previous, there is no data to merge during post-processing. Even for larger projects with established control networks, separately recorded data from unconnected parts of the network require no further alignment or registration.

Conclusions

While the idea of feeding total station data directly into a CAD environment is by no means original, the growing popularity of Rhinoceros has warranted the addition of this functionality through the Termite plug-in. Both software and hardware is quite cheaply available, and in many cases already present within companies or institutions. The combination does, however, amount to more than a cheap alternative to more advanced and automated technologies, since total station recording remains an interpretative exercise in the hands of the operator. Especially for nautical documentation, this conscious and selective factor is arguably highly desirable.

With real-time communication in place, total station data can be visualised, analysed and edited continuously during recording. No specialist knowledge is necessary to operate or relocate the set-up, and the increased accessibility should significantly affect efficiency. Particular post-processing times could be reduced significantly, owning to the control of data quality and structure during the recording process itself.

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