SETTING UP A DATA TRANSFER INTERFACE BETWEEN TOTAL STATIONS AND THE COMPUTER AIDED GRAPHICS SOFTWARES

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Abstract – It is well known that total stations are mainly used by surveyors and civil engineers, either to record features as in topographic surveying or to set certain features. The technical evolution and the wide variety of total stations has impose the large scale use of the total stations due to the high efficiency but also due to the different sectors of activity where they can be use.
CAD, or computer-aided design and drafting (CADD), is technology, which replaces manual drafting with an automated process.
The paper aims to show how to perform a data transfer interface from the total station to the computer to obtain data files that can be used by various data processing programs.
Keywords: total station, topographic, transfer interface, robotic total stations, CAD software.

1. INTRODUCTION

At present total stations are widely use in surveying activity. Basically the optical theodolites whether they are classic or electronic are already exceeded for certain surveying operations.

The instrument is used to measure sloping distance of object to the instrument, horizontal angles and vertical angles. This built in computer unit, enables for computation of data collected to further calculate the horizontal distance, coordinates of a point and reduced level of point.

Total stations are mainly used by land surveyors and civil engineers, either to record features as in topographic surveying or to set certain features (such as roads, houses or propriety boundaries). Practically total stations are used in all branches of activities where measurements are required.

Lately, total stations with remote control have begun to appear. Robotic total stations allow the operator to control the instrument from a distance via remote control. Robotic systems offer reflector less measurement superior to any other instrument available – capable of precision measurements this technology has tremendous benefits for every user. This eliminates the need for an assistant staff member as the operator holds the reflector and controls the total station from the observed point. The remote positioning unit, which is attached to a prism pole, has a built-in telemetry link for communication with the total station. Even a person is not needed near the total station. The total station automatically moves and locates the target. A person is required at the target at different survey locations. The Robotic Total stations speed up the survey work and reduce the manpower.

Also, some total stations also have a GNSS interface which combines the advantages of these two technologies (GNSS – line of sight not required between measured points; Total Station – high precision measurement especially in the vertical axis compared with GNSS) and reduce the consequences of each technology's disadvantages.

One of the common problems however, is how the result of these measurements, which in the case of total stations is obtained from the data processing of the measurements made, can be sent to a computer for further processing in a certain desired format (usually a suitable format for CAD software)

Here, at this point, the interfaces are interfering. In most of cases the total station manufacturer offers a wide scale of adequate software for each delivered equipment.

As follow, the paper will present the way in which, with the help of a software provided by the company that produces the total station, a transfer interface can be made, in order to obtain results that can be used both by CAD programs and in CSV or ASCII format.

2. THE INTERFACE STRUCTURE

Prior to build the interface we have to know for which kind of software is destined. We have for instance, CAD data exchange is a modality of data exchange used to translate data between different Computer-aided design (CAD) authoring systems or between CAD and other downstream CAx systems.

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The exchange process targets primarily the geometric information of the CAD data but it can also target other aspects such as metadata, knowledge, manufacturing information, tolerances and assembly structure.

There are three options available for CAD data exchange: direct model translation, neutral file exchange and third-party translators.

Direct data translators provide a direct solution which entails translating the data stored in a product database directly from one CAD system format to another, usually in one step. There usually exists a neutral database in a direct data translator. The structure of the neutral database must be general, governed by the minimum required definitions of any of the modeling data types, and be independent of any vendor format. Major CAD systems, such as SolidWorks, PTC Creo, Siemens NX and CATIA can directly read and/or write other CAD formats, simply by using *File Open* and *File Save As* options. This option is limited by the fact that most CAD formats are proprietary therefore direct translators are typically unidirectional, partially functional and not standardized.

Considering Third-party translators we can say that several companies specialize in CAD data translation software that can read from one CAD system and write the information in another CAD system format. There are a handful of companies that provide low-level software toolkits to directly read and write the major CAD file formats. Most CAD developers license these toolkits, to add import and export capabilities to their products. There are also a significant number of companies that use the low-level translation toolkits as the basis for building standalone end-user translation and validation applications. These systems have their own proprietary intermediate format some of which will allow reviewing the data during translation. Some of these translators work stand-alone while others require one or both of the CAD packages installed on the translation machine as they use code (APIs) from these systems to read/write the data.

Neutral file exchange, uses an intermediary neutral format to translate data between CAD systems. This method starts from a pre-processor embedded in the original CAD system, which generates the neutral file from the originating CAD format. The target CAD system post-processes the neutral file and converts it into the target native format. Some neutral formats are defined by standards organisations such as IGES and STEP while others are proprietary but still widely used and are regarded as quasi industry standards.

We are going to stop at the Neutral file exchange, specifically to the DXF (Drawing eXchange Format) that is our purpose in building the appropriate interface.

Basically, the Drawing eXchange Format, DXF – developed by Autodesk in 1982 as their data interoperability solution between AutoCAD and other CAD systems. The DXF is primarily 2D-based and its format is a tagged data representation of all the information contained in an AutoCAD drawing file, which means that each data element in the file is preceded by an integer number that is called a group code indicating the type of following data element. In fact, this value also indicates the meaning of a data element for a given object (or record) type. Virtually all user-specified information in a drawing file can be represented in DXF format. As most commercial application software developers have chosen to support Autodesk's native DWG as the format for AutoCAD data interoperability, DXF has become less useful.

DXF was originally introduced as part of AutoCAD 1.0, and was intended to provide an exact representation of the data in the AutoCAD native file format, DWG (Drawing), for which Autodesk for many years did not publish specifications. Because of this, correct imports of DXF files have been difficult. Autodesk now publishes the DXF specifications as a PDF on its website.

As AutoCAD has become more powerful, supporting more complex object types, DXF has become less useful. Certain object types, including ACIS solids and regions, are not documented. Other object types, including AutoCAD 2006's dynamic blocks, and all of the objects specific to the vertical market versions of AutoCAD, are partially documented, but not well enough to allow other developers to support them. For these reasons many CAD applications use the DWG format which can be licensed from Autodesk or non-natively from the Open Design Alliance.

ASCII versions of DXF can be read with any text editor. In order to create the exchange file, it is very important to know the basic organization of a DXF file. Basically the structure of a DXF file is as follows:

- **HEADER** section – It must contain general information about the drawing. Each parameter has a variable name and an associated value. Each variable is specified by a 9 group code giving the variable's name, followed by groups that supply the variable's value
- **CLASSES** section – Holds the information for application-defined classes whose instances appear in the BLOCKS, ENTITIES, and OBJECTS sections of the database. Generally does not provide sufficient information to allow interoperability with other programs.
- **TABLES** section – This section contains definitions of named items and they are as follows.
  Application ID (APPID) table, Block Record (BLOCK_RECORD) table, Dimension Style (DIMSTYLE) table, Layer (LAYER) table, Linetype (LTYPE) table, Text style (STYLE) table, User Coordinate System (UCS) table, View (VIEW) table, Viewport configuration (VPORT) table
- **BLOCKS** section – This section contains Block Definition entities describing the entities comprising each Block in the drawing.
- **ENTITIES** section – This section contains the drawing entities, including any Block References.
- **OBJECTS** section – Contains the data that apply to nongraphical objects, used by AutoLISP and ObjectARX applications.
- **THUMBNAILIMAGE** section – Contains the preview image for the DXF file.
- **END OF FILE**

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3. FORMAT MANAGER, A TOOL FOR EDITING THE INTERFACE FILE

Format Manager is the software that is used to create format files. It is automatically installed onto the PC when we install LeicaGeoOffice.
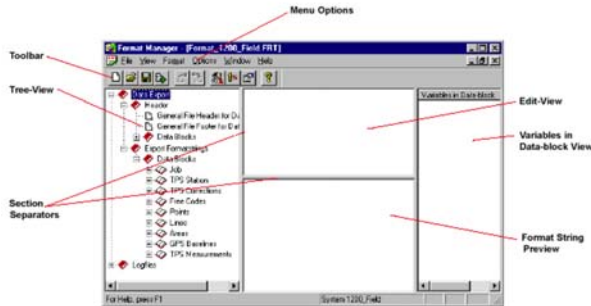

Figure 1.The main window of Format Manager

The Format Manager screen is divided into four sections - the **Tree-View**, the **Edit-View**, the **Format String Preview** and the **Variables in Data-block** view. The **Menu options** and **Toolbar** are used to navigate through the software.

Basically, a format file must contain the following items:

- **Header** information appearing only once at the head of the report.
- **Data Block titles** appear once over the actual surveyed data output.
- **Export Formatstrings** (the surveyed data) arranged in tab delimited columns.
- **Footer** information appearing only once at the end of the report.

However, items such as Header, Block titles or Footer are not always necessary to appear in the format file. In the Header section we can write all information concerning the Header section of the DXF file.
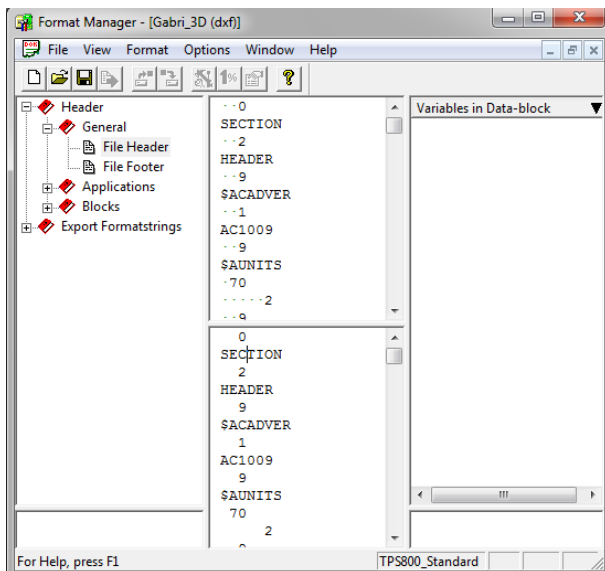

Figure 2. Sample of Header structure of the DXF file created with Format Manager

In this section the user can set the AutoCAD drawing database version number, units format for angle, units precision for angle, number of precision places displayed in angular dimensions etc.

In order to write measured data or computed data using application of te total station we have to use the Export Formatstrings which select the appropriate variables from the Variables in Data-block View to export Job information, surveyed data codes etc. in a structured ASCII text file.

Export Formatstrings, exports information about the stored TPS Measurement (distance, angles, EDM Type, corrections, offset information, accuracy, station information) and information about the calculated point (point id, rectangular coordinates, coding information, accuracy, annotations). A block is exported for each TPS measurement. A Format String may contain text and variables. At least one application must be assigned to every defined Exportstring. It will be used to generate all data output by the assigned application.

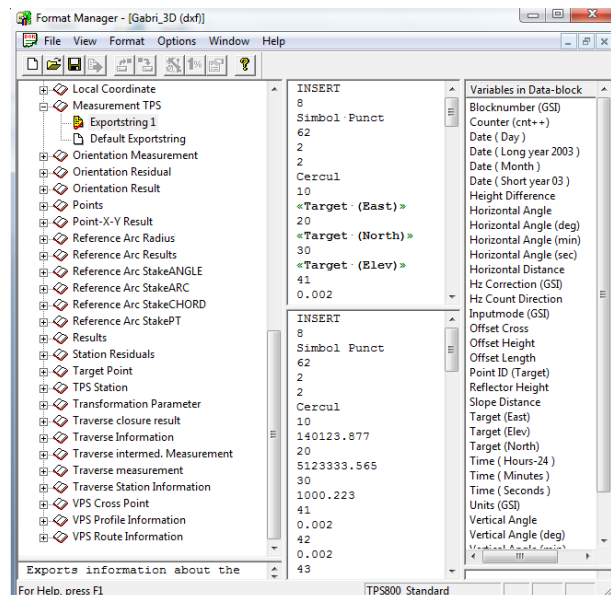Eventually, the EOF item must be present at the end of file.

Figure 3. Writing the TPS measurements as DXF structure

Creating the interface on this way, allow us to obtain the desire format that later can be use by CAD file, a format that meet our personal needs. Once the format is ready, it must be saving as FRT file and later upload into the total station using LeicaGeoOffice.

We must take into consideration that writing a program that creates a DXF file can be more difficult than one that reads a DXF file, because you must maintain consistency within the drawing in order for AutoCAD to find the file acceptable. However, AutoCAD lets us to omit many items in a DXF file and still obtain a usable drawing.

Some particularity of the DXF file can use our work in finishing the structure of the DXF file. They are mention as follow:

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- the entire HEADER section can be omitted if you don't set header variables.
- any of the tables in the TABLES section can be omitted if you don't need to make entries, and the entire TABLES section can be dropped if nothing in it is required.
- if you define any linetypes in the LTYPE table, this table must appear before the LAYER table.
- if no block definitions are used in the drawing, the BLOCKS section can be omitted.
- if present, the BLOCKS section must appear before the ENTITIES section.
- within the ENTITIES section, you can reference layer names even though you haven't defined them in the LAYER table. Such layers are automatically created with color 7 and the CONTINUOUS linetype.

4. CONCLUSIONS

A topographic map is primarily concerned with the topographic description of a place, including the use of contour lines showing elevation. Terrain or relief can be shown in a variety of ways. At present, one of the most widespread and advanced methods used to form topographic maps is to use computer software to generate digital elevation models which show shaded relief.

Achieving the measurement by using modern technologies and later, by processing the measurements with specialized and adequate software, allowed a better view through the modern approaching of the land surface by using modern and adequate digital equipments in the field stage but also in the office stage.

Although, the total stations have predefined formats for downloading some data, it is important that the user can create their own format depending on its needs.

The paper shows only the possibility of transferring the data from total station, LEICA TCR 800 into a desired format of the user. Subsequently, the transferred data can be post processed in order to obtain the final shape of the project.

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