FIELD INVENTORY APPROACH TO DATA CONVERSION

S. B. Mah

Underhill Geomatics Ltd.

ABSTRACT

The implementation of automated mapping and facilities management systems requires loading of accurate data into the databases. The source of these data is usually a combination of existing hardcopy and digital data; and field inventory. Converting the different sources of data into a digital format is a logistical and technical exercise. The field inventory/conversion process can be greatly simplified by using small, but powerful computer systems in the field. These systems replace the paper maps and pencils traditionally used and go beyond by removing the need to digitize the field collected data back in the office. Additionally, sophisticated software enables the electrical network connectivity to be modeled as the devices and conductor data are collected in the field. Previously, these tasks were only possible in the office environment. The use of field computer systems makes it economically feasible to collect up-to-date data instead of relying on questionable existing records during the conversion process. This paper describes such a system and how it has been used in a number of electrical distribution conversion projects.

FIELD INVENTORY APPROACH TO DATA CONVERSION

The task of creating an accurate digital record of the assets of a utility company has evolved greatly in the last 25 years. The changes that have taken place since the 1970s have been largely driven by technology. During this time frame, computers have become more powerful, smaller, and cheaper and computer software has become bigger, better, and easier to use. All this has changed how data conversion, the process of creating digital records, is performed.

Underhill Geomatics Ltd. has been involved in a number of conversion projects using both types of technology. This paper describes the benefits the new technologies offer.

Historical Methods of Electrical Distribution Data Conversion

Electrical utility companies' records for their facilities have been in the form of maps and engineering drawings showing the location and circuits, together with digital databases for managing the individual devices such as poles and transformers. The maps and drawings are a very significant part of the conversion process and this includes two parts - the land base and the electrical circuits. Conversion of the land base may be accomplished by using available existing digital maps or creating new digital maps by such methods as photogrammetry or just digitizing existing paper maps.

The conversion of the electrical records is a more complex procedure. The existing plans must be evaluated to determine their accuracy. Over time, even with updates, the paper maps may not be up-to-date. That is not to say that no records exists for the changes that have taken place, but that the changes recorded by various different departments have not been transferred to the plans. This makes compiling an accurate picture of what actually exists, a difficult process to manage and the only way to verify the results is a field check.

If an analysis of the existing documents concludes that they are not the best source of accurate data, then a field inventory is carried out. Up until about the middle 1990s, this would involve making paper copies of the best available plans showing land base and electrical circuits and sending them out to the field for checking. A person would take each plan and visit all the locations where electrical circuits exist and verify or update the information shown on the plan. Data collected includes location, feature type, and pertinent attributes such as size and material. Circuit information may also be collected by noting the actual routing of conductors.

The marked-up paper maps are then brought back into the office where the information collected is entered into computers. A digital land base will already reside in the computers and a person, using the land base for reference, will enter the poles, conductors, devices, and their attributes into the system. This person must interpret the information drawn on the maps by the field person and enter all the data correctly. This office phase will consist of several steps including the data input, plotting the results, visually inspecting the new drawings, and running computer programs to check the data digitally. Errors found are corrected and inconsistencies detected will be resolved by field revisits. A number of locations may be revisited in the

field as quality control even if no errors are found. After all corrections have been made, the digital product is delivered to the client.

Data Conversion using Field Computer Systems

The advent of modern computers has changed how field inventory and data conversion are performed. The development of computers has progressed from the mainframe technology of the past to today's portable hand-held computers that are more powerful than their mainframe predecessors. The availability of the low-cost and powerful portable computers has made it practical to combine the field inventory and data conversion tasks.

Several key features of computer have made it possible to use them in the field. These are:

- bright, high resolution screens that are readable in sunlight,
- large, fast hard disk storage,
- massive memory chips,
- low power consumption and long battery life,
- and compact packaging.

The power of these computers has made it possible to put large, sophisticated programs in the field. These programs are easy to use and require minimal user training. The users need to be knowledgeable about the work they are doing (electrical field inventory) but do not require special computer skills.

The ideal portable computer for field inventory applications is a pen-based computer, although a laptop computer can be used. This computer has no keyboard but uses a stylus instead as an input device. Powered by PenWindows operating system, it includes character recognition software for interpreting handwriting. Even then, field software can be designed to use graphics interface tools such as radio buttons, check boxes, list, menus, and other selection tools to minimize the input that needs to be typed or written.

The field inventory software that Underhill Geomatics Ltd. has developed is the result of its field inventory and data conversion experience. It has been used successfully in electrical distribution field inventory/data conversion projects and is currently used by a third party in ongoing projects.

The Field Inventory / Conversion Software

The software was implemented on the FieldNotes software platform from PenMetrics, Inc., now part of Trimble Navigation in the USA. This is a graphics based program designed for Pen Windows for inputting and displaying graphics and attribute data. It also has an application programming interface which allows software developers to implement new applications, building on existing functions such as those for file management, graphics display and menu systems. Underhill Geomatics Ltd. has done this and one of the applications is for electrical distribution field inventory and data conversion.

The software is a Windows application and the Windows graphical user interface approach results in what-you-see-is-what-you-get graphics. This is an important feature as it minimizes the training required for the software. Also, the results of the user input are accurately depicted on the computer screen immediately. See Figure 1 for a screen shot of how an example of this software looks.

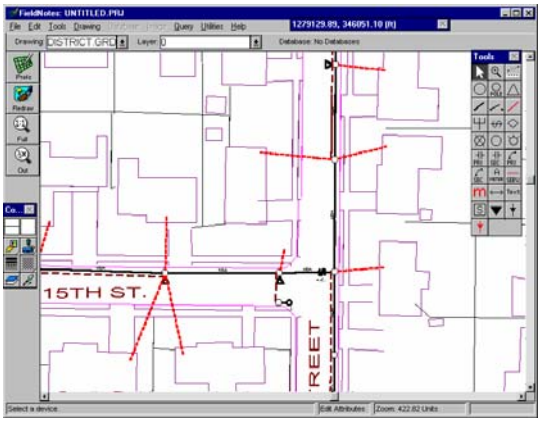

Figure 1. Screen Capture of the Program

The same software can be used for the field and the office. This simplifies the training program required for a project and enables the same personnel to be used for office and field tasks. It also means that data may be taken between the field and the office without any translation procedures.

Using the software for field inventory or conversion starts with loading the land base. This can be done by importing AutoCAD DXF or ESRI GEN files. Other formats can be custom programmed but most data is available in DXF format.

Once the land base is in place, the electrical distribution data conversion can begin. Whether this is done in the office or in the field, the procedure is similar although the logistics may vary. The basic sequence of placing the facilities is: poles, primary conductors, switches, transformers and other primary devices, secondary conductors, and services. If the facilities are placed in this logical order, the software will be able to correctly build the electrical circuits which can be use for circuit analysis.

The graphics created and seen on the screen, as the facilities are input, are the same as what will be in the final product. The circuit model, with its electrical connectivity, does not depend on the graphics presentation. There are no restrictions on graphics appearance in order to build the electrical model.

An important aspect of field inventory and data conversion is quality control. The software addresses this by helping to prevent user input errors and also to detect potential errors that may exist in the data. The use of standardized lists of attribute values by the way of buttons, drop down lists, and check boxes greatly reduce the chance for input error (See Figure 2 for an example of a typical attribute data input screen). Checks performed while devices are being placed will not allow wrong components to be joined together.

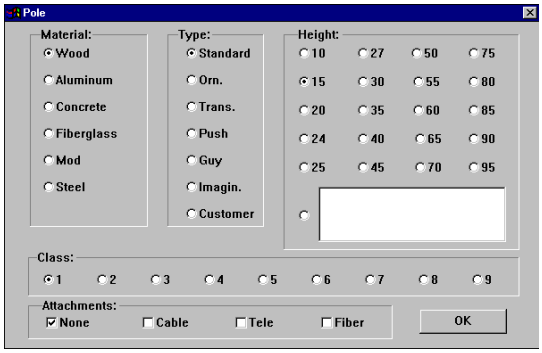

Figure 2. Pole Attribute Input Screen

For data already converted, programmatic checks can be performed. These include valid connectivity checks; for example primary devices should not be connected to secondary conductors or devices that are not connected but should be such as transformers with no primary conductor feeding it. Additionally, circuit tracing functions are available. The user selects a conductor or device and all conductors and devices connected to the selected item will be graphically highlighted. There are options for stopping at open points, tracing primary only, secondary only, or primary and secondary.

As each device or conductor is placed, it is tagged with the time and date, and also with the name of the person using the program. This information is useful for analyzing production statistics.

Comparison of Methodologies

Computerized field inventory / data conversion

Advantages:

- checks can be performed on data in the field as they are being collected. Errors can be quickly corrected.
- requires less manpower; significantly less office staff required. Input of data from written records is reduced greatly.
- ability to transmit digital files quickly to different offices
- eliminates the step of input data in the office that was marked on the drawings i n the field. This also removes another step where errors can occur.
- conversion in field makes field inventory competitive to digitizing existing plans with the advantage of up-to-date results
- reduces amount of paper required in the field

Disadvantages

- spare batteries are required, users must be diligent about making backup.

Paper based field inventory / data conversion

Advantages

- field workers do not need computer skills
- computers kept in clean office environment

Disadvantages

- no validity checks of data in field. Errors detected in the office will require field revisit. Field software would prevent some of these errors
- requires more manpower. Needs significant office staff as well as field staff.
- more time required for sending data between various locations.

EXAMPLES

The following are two examples of how the software has been used in electrical distribution field inventory projects:

Electrical Distribution Data Update

- data were exported from existing power utility's database (graphics and attribute data)
- data were loaded using a custom translator into field computers
- services were verified in the field and linked to addresses and customers. Some services were deleted and new services were added
- changes (deletions and additions) were exported through custom translator
- the utility's databases (graphics and attributes) were updated with the data.

Overhead Electrical Distribution Field Inventory

- this was full primary and secondary field inventory including everything from poles to services and ties to addresses
- land data in AutoCAD DXF format was loaded into the field computers
- typical procedure: place poles, place primary conductors, place primary devices - switches, fuses, transformer and others, place secondary and services
- electrical network built automatically as facilities are placed
- annotation may be automatically generated as facilities are placed are generated later
- quality control checks were performed in the office and field revisits were made to check data
- data exported in AutoCAD DXF format

Program Customization and Other Applications

In general, the field inventory software is customized for individual projects. In this way project specifications are addressed and the results are not compromised so that pre-existing software is used. This is also more efficient and better from a quality standpoint. Data import and export functions are usually modified or specially written to meet client requirements.

Underhill Geomatics Ltd. also has variants of this field inventory software for the following areas:

Municipal Water/Sewer
- office conversion of as-built plans

Street Lights and Signs
- field inventory of municipal traffic signage and street lighting
- uses graphic images of signs to help identification in the field

CONCLUSIONS

Low-cost, power, portable computers coupled with easy-to-use software has changed how field inventory and data conversion is performed. What used to be only possible with a large mainframe computer in an office can now be accomplished in the field with hand held computers. Because of this, the high cost of field inventory compared to office document conversion becomes less expensive when it is possible to eliminate a large component of the office costs while getting the most accurate record of what actually exists in the field. For overhead electrical distributions systems, this approach has indeed been proven to be cost effective and office data conversion is used only for underground facilities.