A MOBILE OFFICE FOR SURVEYORS.

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ABSTRACT

Various land professionals are now contributing to the build up of land and geographic information system databases. A variety of technologies are available to facilitate the collection and processing of measured data and associated information (or attribute data) into these databases. Like all land professionals, surveyors too, are aware that improved productivity can be assisted by investing in products that provide more information, faster. GPS is a relatively new tool for acquiring survey related data. Although it offers significant productivity improvements for many survey applications, there are some limitations to the technology (especially in city, urban and forested areas). This means that total stations continue to be a standard tool for surveyors. Both Total Station technology and GPS technology will coexist and, as a result, a relatively new concept, which pursues standardization both amongst various surveyors' instruments (total stations and GPS) and in the data flow through to GIS systems are being implemented. The data standardization concept combines a range of GPS systems, total stations and application software designed around a common data carrier. A standard interchange format provides a uniform link to the immense variety of software used for surveying computations, CAD, GIS and LIS.

Part of the new concept allows for a new range of field surveying instruments to collect data on-line with an in-field software solution that provides information in a form suitable for GIS systems. The penpad or laptop software solution allows data to be visualized in the field which minimizes errors and speeds the flow of data to a GIS. The mobile survey office concept guarantees that surveyors can meet the demands of the GIS industry now and in the future as well as maintain compatibility with existing methods, existing instruments and data types. Practical examples that demonstrate productivity gains are given in the paper.

INTRODUCTION

The Mobile Office concept overturns the notion that offices must be a fixed place of work in favor of locating the work process at the most efficient location.

All organizations want to improve their work efficiency. Some improvements are incremental. They speed up an existing process or introduce additional quality procedures to prevent rework. For example: desktop software has sped up many survey calculation tasks. Other improvements are more fundamental. Flows of work are radically redesigned, eliminating entire steps and offering leaps in productivity. For example: the fax machine not only replaced telex machines, they radically reduced turnaround time on business correspondence by substituting normal post for day to day correspondence. In both cases, technology improvements have contributed to work flow improvements. However, in the second case, technology substituted an entire process and enabled, not just incremental improvements to correspondence turnaround time but a complete transformation. There are many examples of technology contributing to major leaps in performance.

Mobile office solutions are certainly contributing to radical transformation of work processes and work locations.
Cellular and mobile phones have allowed people to be "accessible" at remote sites or even making travel time more efficient by permitting business discussion in automobiles. Laptop computers have allowed work to be performed at remote site locations or at home, cutting travelling time. Combining both technologies allows file transmission and retrieval to colleagues, business partners and clients. In many industries, these mobile office solutions are contributing to change. A salesperson's face to face time with customers is enhanced by cutting office work. Even orders can be transmitted direct by laptop and digital mobile phone. A meter reader can update household electricity meter readings for billing, direct on site.

Combining other technologies for input further enhance business process redesign. Warehouse personnel using a laptop computer and barcode input devices can update stock information during delivery eliminating processing paper work afterwards.

SURVEYING AND MAPPING: FIELD VERSUS OFFICE

Clearly, the source of surveying and mapping data is at the site, not the office. Land information and associated infrastucture information can only be gathered at the location directly or through a remotely sensed mechanism (e.g., aerial photography). The office therefore serves as a secondary location need after the survey site. Amongst other purposes, surveyors' offices are currently needed to post process information gathered in the field. Desktop personal computers, plotters and printers would naturally be difficult to carry around on site. However, the requirement for paper plots and plans is diminishing as more data is provided to the client in digital form. Improved computing power and digital storage contribute to the trend towards a paperless offices. Subsequently office floorspace requirements can be reconsidered. There would be less need for increasing floorspace, if much of the data processing could be carried out on site. It is well known that large construction sites use "site" offices. The convenience of being located to the daily site work makes the investment in portable buildings worthwhile. So, one can envisage the possibility of reducing the need of office (even a site office) if post processing of data into a finished product was integrated with the data collection process. For such a shift in work process location significant benefits in field equipment technology would be necessary.

TECHNOLOGY CHANGE ENABLES FINISHED PRODUCTS IN THE FIELD

Several recent advances in technology indicate that mobile office solutions have the potential to substitute office work.

Penpad computers which have the equivalent power of a desktop 486 personal computer provide a major advantage when considering mobile office solutions: size. By providing input through the screen, the computer hardware is reduced to the size of the screen.. Laptops may have proved a significant step for transporting computing power to hotels, homes and cars, but for professions such as surveying, penpads permit 486 processing power in the field. Penpads that are designed to cope with environmental conditions in the field are available now. (e.g., -20 degrees Celsius to + 50 degrees Celsius). Portability and ruggedness also contribute to the practical use of penpads as a substitute for office systems.

Whilst some software solutions for collecting surveying data on a penpad have been available for some time, only a few software solutions really offer the potential to replace desktop processing with on-line or real time processing of survey data into a finished product. The added advantage of recent penpad surveying software has been the use of PenWindows as the penpad operating system. Nearly all people using computers are trained to use Windows or are being trained to use Windows. PenWindows offers immediate familiarity to those that have used Windows which saves considerable training time in learning another type of user interface. Field surveying software for penpads which can process large quantities of data such as Digital Terrain Models into contour maps or volume calculations contribute to rethinking the need for office processing.

Improvements to communications technology complete the viability of mobile office solutions for surveyors. Whilst mobile (or cellular) phone networks already offer verbal contact with business colleagues and clients, the implementation of digital telecommunications networks (replacing analogue networks in many countries) offers the possibility of transferring data from the field via a mobile phone. A few models of mobile digital phone already cater for this requirement. (e.g., Nokia 211D). They have the dual capability of handling voice and data communications.

INTEGRATING MOBILE OFFICE SOLUTIONS WITH "SENSOR" TECHNOLOGY

Sensor technology refers to electronic instruments that can "sense" a measurement and process it into interpretable data. (e.g., EDM measurements into distances). Whilst a "sensor" includes remote sensing, in the context of this paper, it is used to refer primarily to total stations and GPS receivers.

GPS sensors that permit centimeter accuracy in real time (e.g., Leica GPS-System 300 with RT-SKI) offer many improvements to collecting survey data. Savings in man power can be significant. It is possible to use only one field operator at a roving GPS receiver. One other major improvement to survey data collection is that the operator is located at the point being measured - the point of interest. So, whilst less field personnel can be used to do the field work, their effectiveness is also increased. Observing and recording information about the point of interest is more effective when the observer is located at the point than remotely at the sensor. The efficiency gain is particularly noticeable as more information is collected about the points of interest (e.g., attributes, topology).

Presently, the total station is the surveyors "workhorse" for digital data collection. Current models of total stations have integrated considerable computation processing power on board or in a hand held data recorder. Many software routines combine measurements with real time computations (e.g., free stationing, road alignment design and stakeout). Presently, these software routines tend to support field procedure decisions rather than substitute office processing. Limitations to graphical display size, computation and storage power together with ergonomic handling and portability considerations have tended to restrict data processing to the office: "post-processing" field data. With the advent of penpad technology, ergonomic and portability limitations become less problematic. At the same time, graphical screen size and processing power are improved.

For data transfer, penpad technology is readily integrated with total station technology through RS232 cable connection and communication software. Ergonomically, the integration is not as straight forward. Devices to support penpads on tripods are available. However, this still places the total station and penpad operator at the instrument position, which is remote to the point of interest.

Recent improvements to total station technology make the use of penpads even more beneficial to finishing processing in the field. These improvements are based on three types of technology integration. Motorized drives, target recognition (or prism lock-in) and telemetry links. (e.g., Leica TPS-System 1000 with ATR1 target recognition). Like GPS, field man power can be limited to one person, and the effectiveness of the operator can be increased by locating the operator at the point of interest.

In this case the integration of penpad technology requires more design consideration than mere data logging. Since the operator is remote to the total station instrument, the instrument itself needs to be controlled through the penpad. Many of the keyboard commands available to an operator behind the instrument need to be placed within the penpad. Prompts, operational flags and status information all need to be built into the penpad software.

However, to really achieve progression towards a mobile office the operational commands for the "sensor" must be integrated with normal processing software for the office. In other words, an opportunity exists for substituting both office processing systems and the "sensor" keyboards and processors. If the claim of "substitution technology" appears too extravagant, then, at least, there is an opportunity for complimentary technology that places the operator at the point of interest and permits more "finish" in the field. "Fieldlink" is a software module for a portfolio of Windows surveying software called "LISCAD Plus". Like all the LISCAD Plus software modules, it is seamlessly integrated into the database and Windows Man Machine Interface (MMI) of LISCAD Plus. It provides a real time link to total stations, recording coordinate data simultaneously with field records, and graphical information such as line connectivity, symbol assignment, point descriptions, codes and other information. It is also possible to record data directly to layers, decide to exclude points from digital terrain models etc. Field decision support calculations such as "free stationing" and "stake-out" are included with the measuring procedures in the "Fieldlink" module. A significant design feature is the "pop-up" total station controls which simulate the total station keyboard, including controls for target recognition (e.g., lock-in and search).

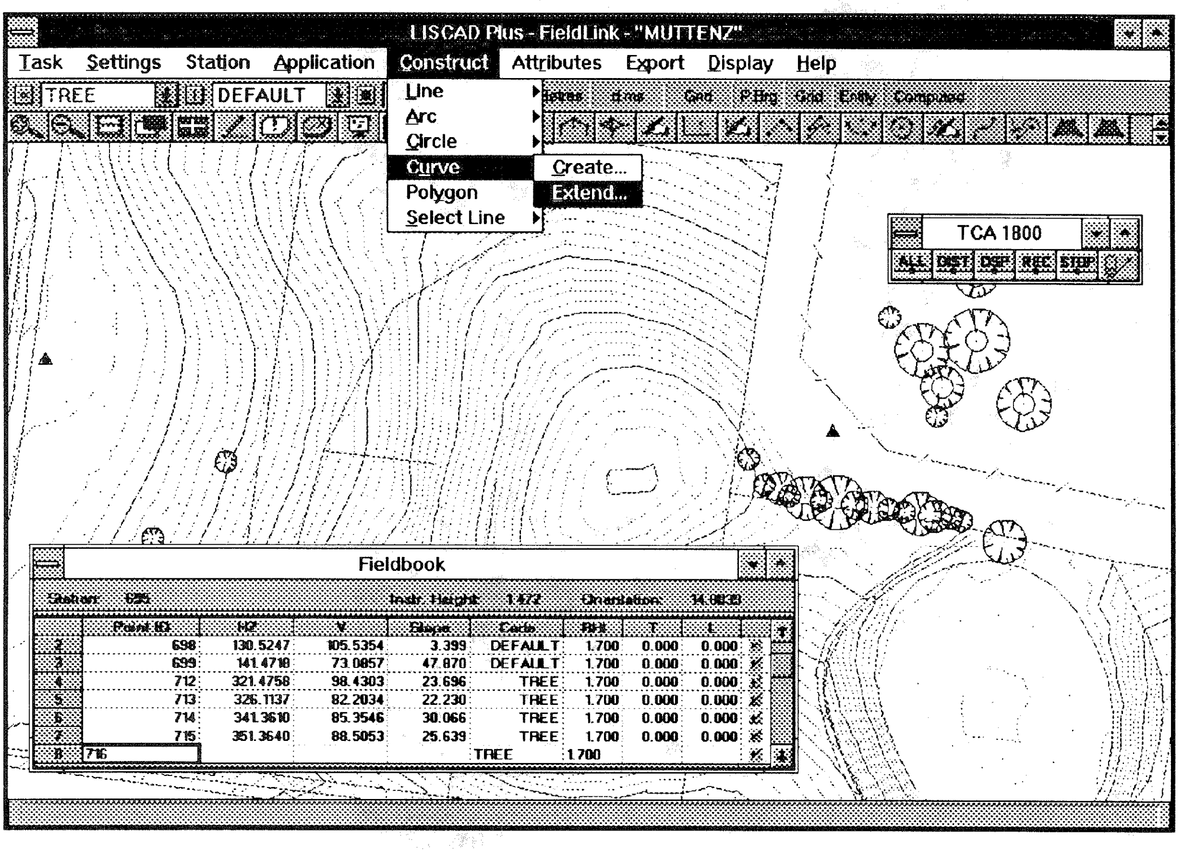

Fig. 1. Penpad surveying software screen showing fieldbook information and total station control

One field procedure that can be reconsidered as a result of on-line field data processing, is coding. Entering field codes as part of the data collection process in surveying is generally to support "post-processing". On the one hand operational or control codes are used as "flags" in a data processing sequence. (e.g., set up stations for a traverse, with appropriate operational codes for azimuth settings to control points). On the other hand, feature codes have been used for post processing software to allocate graphical elements such as symbols, line types or segregate data into layers. With graphical views of data being available straight away on a penpad, the need for "flags" for post processing diminishes. Coding as a field procedure can be reconsidered. Coding procedures should support efficient data collection "on-line" rather than for control of "post-processing".

To ensure comfort and efficiency a special penpad holder has been designed. The penpad holder conveniently positions the penpad under the chest of the operator. There is room to locate a telemetry link on the penpad mount. One hand is free to carry the prism pole, the other for using the penpad pen to control the functions of the total station and data acquisition software and other surveying calculations.

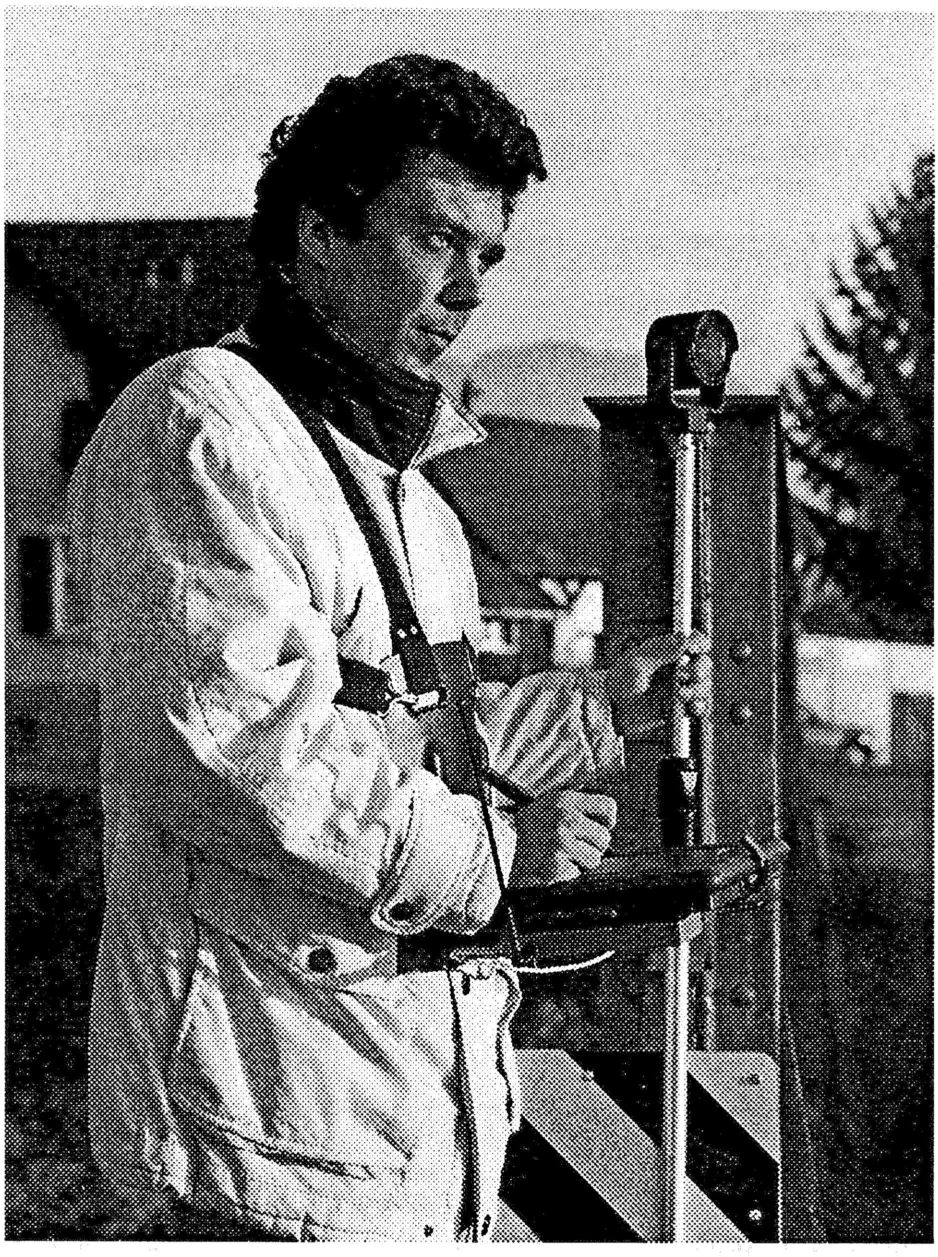

Fig. 2. Chest mounted frame for penpad. Telemetry link mounted underneath.

COST ASPECTS

Fieldworthy penpad hardware and associated surveying software costs are equivalent to desktop hardware and surveying software. On first consideration, the initial cost may seem significantly more than say a handheld data recorder. However, the penpad cost may substitute the cost of an additional office computer and software. The following simplified scenario gives a guide to potential cost savings. The amounts are relative, no particular currency is shown.

	Non Mobile Office	Mobile office
CAPITAL INVESTMENT:		
Total station:	12,000	12,000
Accessories: prism etc.	700	700
pole	300	300
Data collection handheld	2,000	
penpad		6,000
Office computer	6,000	
Surveying software	8,000	8,000
SUBTOTAL	29,000	27,000
ONE PERSON OPERATION		
Options telemetry link		4,000
target recognition		3,000
motorization		3,000
TOTAL CAPITAL OUTLAY		37,000
SAVINGS:		
MANPOWER (Per year)		
Experienced surveyor	70,000	70,000
2nd field person	35,000	35,000
OTHER COSTS & SAVINGS		
Rent partial office floor space		-2,000
Reduction in rework due to on-site finish.		Unknown
Training		2,000
TOTAL OUTLAY: FIRST YEAR	134,000	107,000
SAVINGS AFTER FIRST YEAR		**27,000**

CONCLUSION

Substantial productivity gains may be possible through the completion of all data processing on site and in a form suitable for transmission direct to the client or data bank. Whilst, the security and technical issues of the receipt of data direct from the field are not considered by this paper, the in-field possibilities offered by relatively new technology have been considered. New field equipment technology incorporating new hardware, databases, software and communication systems offer benefits similar to those of "The Mobile Office". As a result, task oriented processes in the office and in the field can be radically re-thought with a tendency to finishing products in the field.

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