

# Survey Management System (SMS)



...the one in all solution

# SMS Product Information

## Introduction

- Survey Management System (SMS) is a revised version of the successful Level Monitoring System (LMS) series of survey software.
- SMS inherits the same LMS interface and ease of use with additional functions to support:
  - *3-D Traverse Network*
  - *Triangulation Network, and*
  - *Intersection Network.*
- With provision for GPS data/results and emphasis on survey data management, SMS is a logical platform for efficient processing and use of survey information, Fig. 1.

# SMS Product Information

... Introduction Contd.

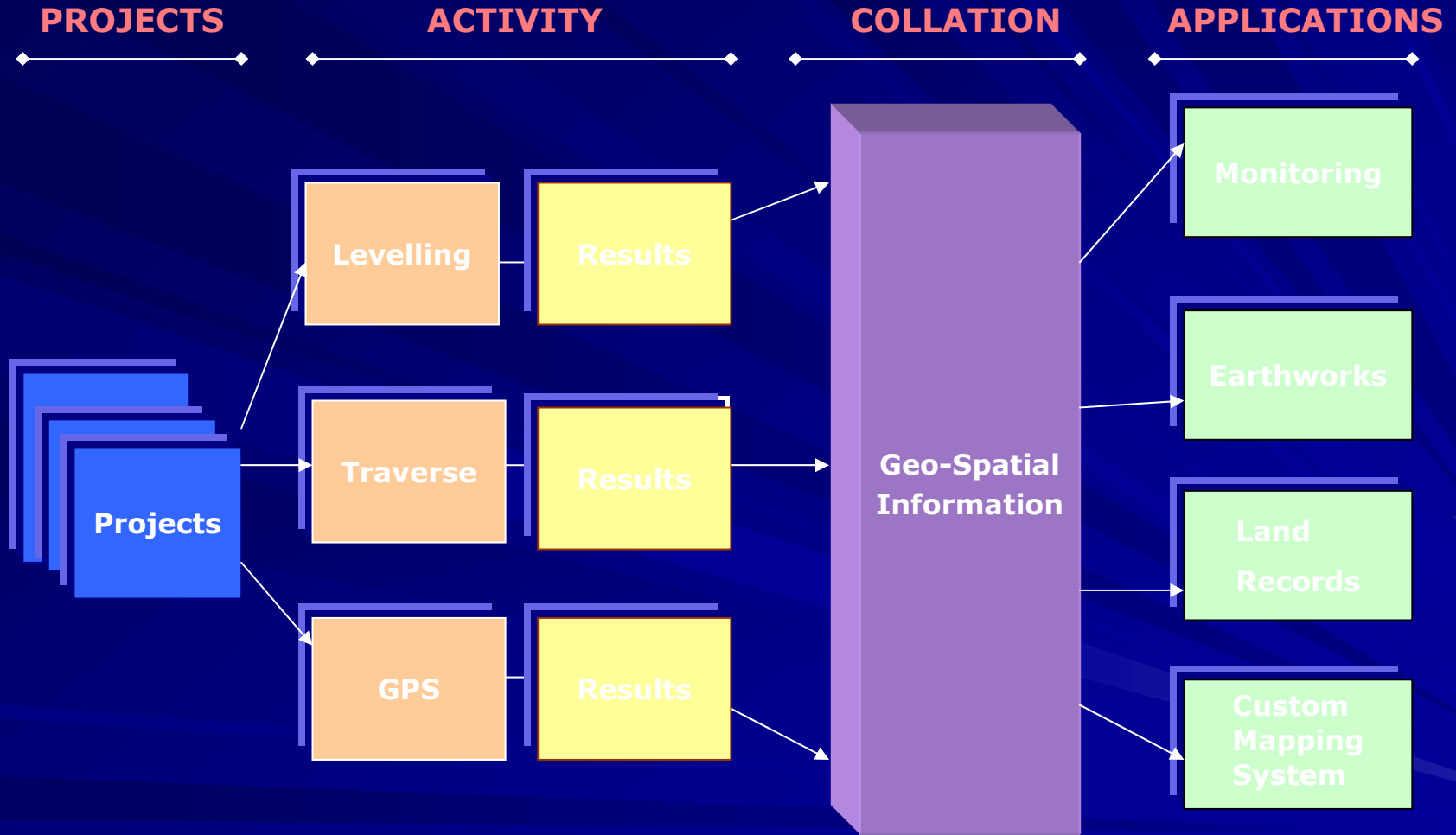


Fig. 1

# SMS Product Information

## Database

- At the core of Survey Management System is an integrated database system with facilities for job classification and field activity.
- Standardized menu structure with uniform survey interface, Fig. 2.

The screenshot shows a software window titled "Job Index Database". The interface is divided into several sections:

- Job Information:** Fields for "Job Number" (containing "OWNTA"), "Location", "Title Of Job", and "Date of Job".
- Class:** A section with three icons: a blue square with a white plus sign, a pink flower-like shape, and a green bar chart.
- Activity:** A section with three icons: a yellow and black striped rectangle, a red circle with a black cross, and a purple funnel.
- Client Name/Information:** A large text area containing "Sample Pipe Line Traverse".
- Navigation Buttons:** A row of buttons labeled "New", "Save", "Revert", "Next", "Previous", "Delete", and "OK" (with a green checkmark icon).
- Status:** "6 of 6" is displayed at the bottom center.

Fig. 2

# SMS Product Information

*...Database contd.*

- Under each project, there are survey schemes that may be independent but under a common datum database.
- Overall, the capacity of the database is in millions of records.
- Database capacity is limited only by available computer memory.

# SMS Product Information

## Control Datum

- Datum is specified or edited through a control database for each project.
- It contains a list of points in each datum that could be used in the course of a job execution.
- Also, in line with the trends in geo-informatics, SMS provides the capability to include photographic attributes in station descriptions supported by integrated image and graphic editor, Fig. 3.

# SMS Product Information

... Control Datum Contd.

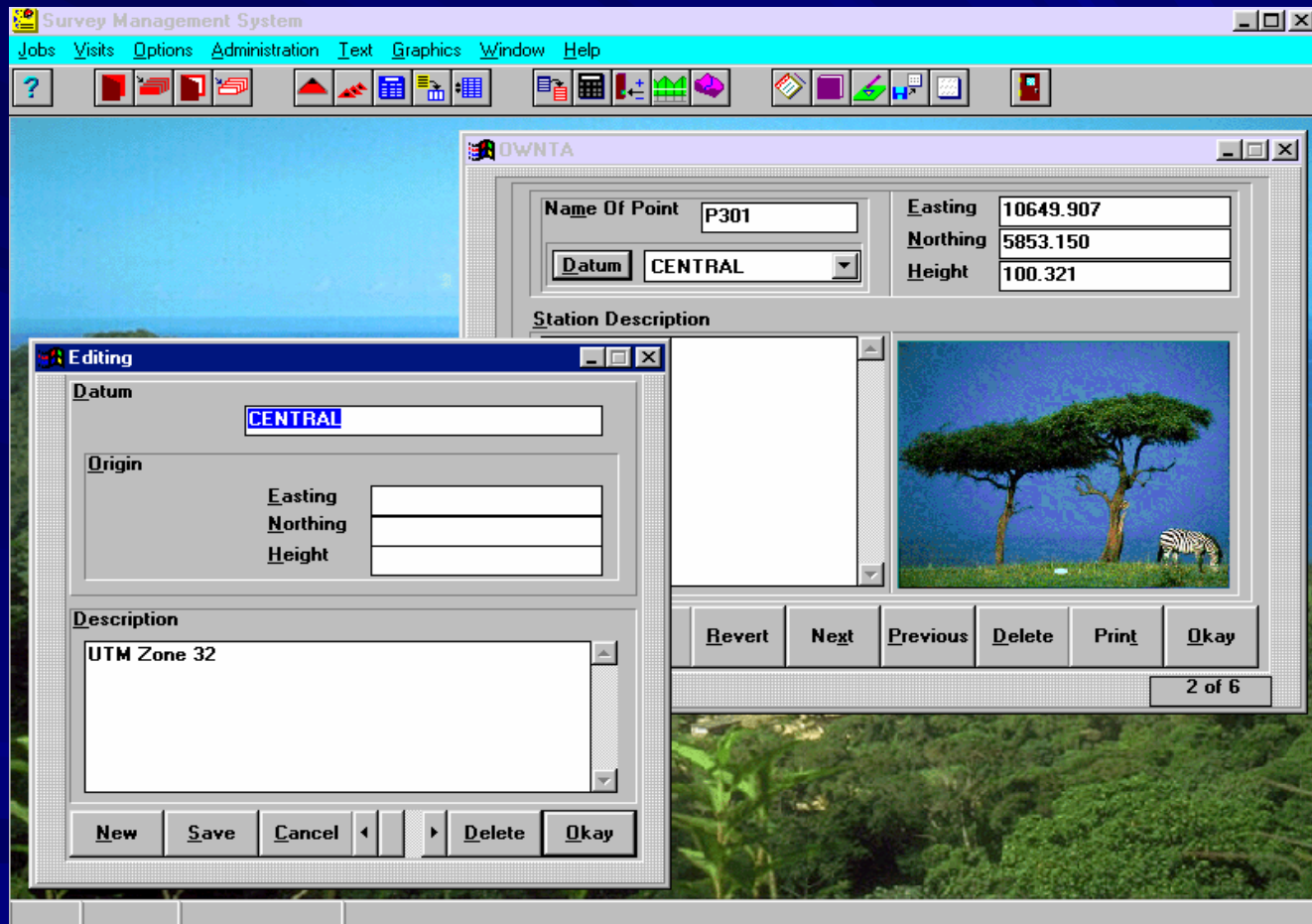


Fig. 3

# SMS Product Information

... *Control Datum Contd.*

- Hence, in your projects part of your station descriptions can be easily acquired using digital cameras presented in a neat form to eliminate errors that may arise from ambiguity.
- During computations, SMS database provides information to classify fixed and free points in the network. ■



# SMS Product Information

## Data Interface

- Input and output from SMS is guided by the need for common connectivity.
- There is a comprehensive data interface to all major brand of data recorders/collectors and survey instruments, such as Digital Levels and Total Stations, etc., Fig. 4, to accommodate input preferences from a wide range of instruments to custom formats.
- Update is continuous and you can share data through ASCII file import/export for use in other packages.

# SMS Product Information

... Data Interface Contd.

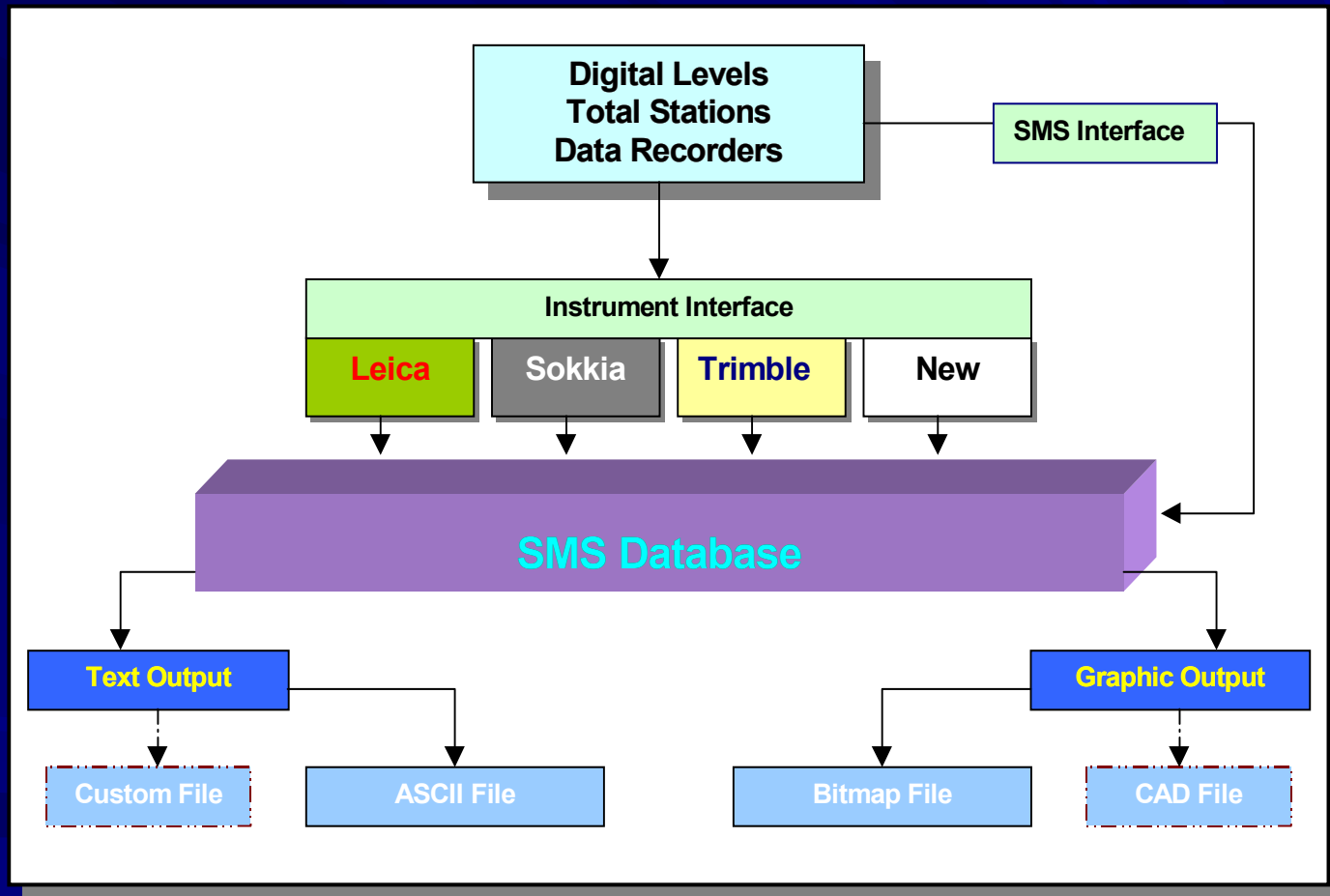


Fig. 4

# SMS Product Information

## Data Collection

- SMS retains traditional survey methods in a digital environment.
- The traditional field book, Fig. 5-1, is preserved as an interface into a database.

The screenshot shows a software window titled "WARRI / EFFURUM" with a standard Windows-style title bar. The main area contains a data table with four columns: "Station", "BackSight", "ForeSight", and "Height Diff". The data is as follows:

Station	BackSight	ForeSight	Height Diff
P5002	1.2911		
P5003		1.2531	0.03800
P5003	1.3055		
P5004		1.1963	0.10920
P5004	1.2796		
P5005		1.1866	0.09300
			0.13770

Below the table is a large empty text input field. At the bottom of the window is a control bar with buttons for "New", "Save", "Revert", "Delete", "ISight", a page navigation control (left arrow, a shaded box, right arrow), a page number "4", and an "Okay" button.

Fig. 5-1

# SMS Product Information

... *Data Collection Contd.*

- Data input process amounts to electronic hand booking of results into the traditional field book where further input and/or manual editing may be carried out. Repeats are processed automatically during the data input process.

OWNTA / GAS PIPELINE

Header

Stn Name: P303

Instr. Height: 1.215

Ref Stn Name: P301

Circle: Select Type 1

Comments

Data Abstracts

Observations

Traverse

Tacheometry

Point	Hz Angle	Elevation
P301	00°00'00"	+00°10'52"
P375	181°16'43"	+00°07'59"

Counter: 1 of 15

New Save Delete Revert Next Previous OK

Fig. 5-2

# SMS Product Information

*... Data Collection Contd.*

- Traverse field books, Fig. 5-2, provide automatic data abstracts of rounds and detail points as well as diagrams of directions at each station. It also filter and ensure that processed observations are acceptable and within the margins of instrument error.
- To ensure maximum productivity, there are no constraints in data collection. ■
- A survey can start from any point in any order and end at any point. Even data classification or feature coding may not be necessary.
- Custom options include modules to direct and control instrument observations through PC-based data recorders.

# SMS Product Information

## Processing and Computing

- SMS's data processing compiles a list of observations prior to computations.
- This process reconciles traverse abstracts, reduces double levelling to mean values and merges data from other field books.



# SMS Product Information

...Processing and Computing Contd.

The screenshot displays the Survey Management System interface. The main window is titled 'OWNTA / DEPOT' and contains a table titled 'RUNS IN THE NETWORK'. A secondary window titled 'INSTANCES IN THE NETWORK' is overlaid on top. The 'RUNS IN THE NETWORK' table lists 8 runs with columns for 'Nos', 'From Node', 'To Node', 'Instr Stns', and 'Coord Diff/ENH'. The 'Instr Stns' column for run 4 is expanded to show a list of nodes: P303, P375, P377, and P379. The 'INSTANCES IN THE NETWORK' table lists 8 instances with columns for 'Nos', 'Station', 'Ref Stn', 'Radiation', 'Fwd Stn', and 'Prov Coords/ENH'. The 'Station' column for instance 1 is expanded to show '[P303]'. Buttons for 'Print', 'File', 'Nodes', and 'OK' are visible in both windows.

Nos	From Node	To Node	Instr Stns	Coord Diff/ENH
1	P378	P1	1	-110.701
2	P1	P303	2	-31.748
3	P303	P381	4	176.245
4	P381	P383	4	25.291
5	P381	P384	P303 P375 P377 P379	19.998
6	P384	P383		19.998
7	P384	P378		
8	P1	P378		

Nos	Station	Ref Stn	Radiation	Fwd Stn	Prov Coords/ENH
1	[P303]	1	2	1	1997.008
2	[P301]	1	0	0	2000.000
3	P1	1	3	1	2028.804
4	P376	0	0	2	1992.919
5	P378	1	3	1	2139.505
6	P381	1	3	1	2173.253
7	P383	0	0	2	2198.544
8	P384	1	3	1	2193.251

Fig. 6-1

# SMS Product Information

*...Processing and Computing Contd.*

- In general, the following information is available:
  - Sorted data list of observations.
  - List of Fixed Points in the network.
  - A numerical description of the network. This is in the form of survey runs and directions, and the number/list of intermediate stations, Fig. 6-1. It provides an important check on the surveyor's own network diagram.
  - Further diagnostic is provided by the closing errors in 3-D. It includes linear accuracy within each traverse loop and error analysis, Fig 6-2.
- These SMS processes enable surveyors and engineers to isolate errors in observations and validate the integrity of the network so that computations can begin.



# SMS Product Information

...Processing and Computing Contd.

The screenshot displays the Survey Management System (SMS) interface. The main window, titled "DWNTA / DEPOT", shows a table of "LOOPS/ MISCLOSURES[m]". The table has five columns: Loop, Easting, Northing, Height, and Accuracy. Three loops are listed with their respective values. To the right of the table are buttons for "Print", "File", and a small bar chart icon.

Loop	Easting	Northing	Height	Accuracy
0	0.021	0.015	-0.098	1/1466
1	0.048	0.002	0.067	1/12276
2	-0.026	-0.007	-0.002	1/11058

An inset window titled "Loop 0" is open, showing "RUNS IN THE LOOP". It contains a table with four columns: From -> To, E-Diff, N-Diff, and H-Diff. The first three rows are populated with data, and the first row is highlighted. To the right of the table are buttons for "Print", "File", and "OK" (with a green checkmark icon). Below these buttons is a "Scroller" with up and down arrow buttons.

From -> To	E-Diff	N-Diff	H-Diff
P381	25.291	-66.081	-0.272
P383	-5.272	-2.895	-0.228
P384	-19.998	68.991	0.402

Fig. 6-2

# SMS Product Information

...Processing and Computing Contd.

- Computation is by method of Least Squares adjustments.
- SMS Least Squares adjustment involves iteration until corrections are insignificant followed by reduction of detail or intermediate points. The results, Fig. 6-3, are available for review.

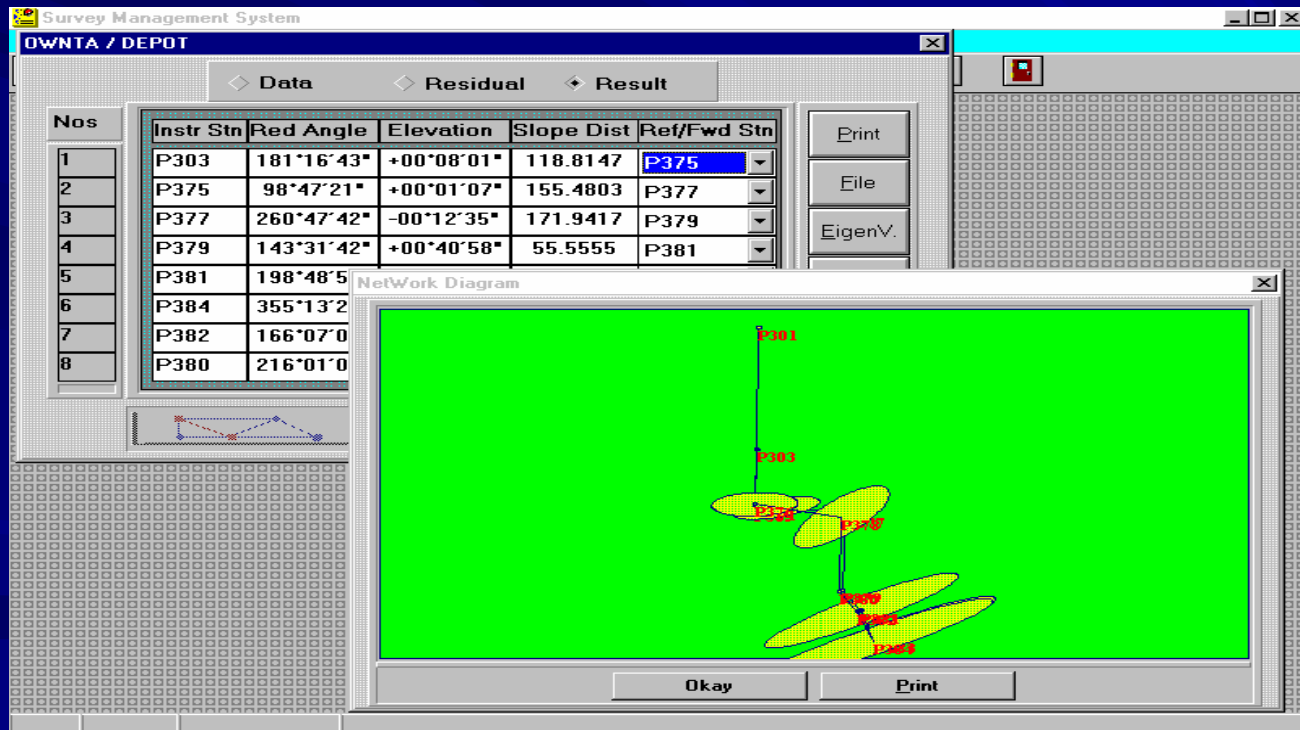


Fig. 6-3

# SMS Product Information

## Geodesy

- Geodetic transformations are provided within the SMS environment, Fig. 6-4.
- Positions on the reference spheroid would be known once the 3-D traverse computations are complete.

The screenshot displays the SMS Geodesy software interface for a job titled 'NIGER'. The interface is organized into several sections:

- Job Ref.:** NIGER
- Topo Centric LHS:** A table with columns for Station, X, Y, and Z. The Station is P23, X is 100000.000, Y is 150550.579, and Z is 300.575.
- Geographical System:** A table with columns for Station, Latitude, Longitude, and HNormal. The Station is P23, Latitude is 006°56'45".788-N, Longitude is 004°56'55".678-E, and HNormal is 195.567.
- Target:** A dropdown menu showing 'UTM Projection' and 'Spheroid'.
- Spheroid:** A table with columns for a and 1/f. The values are a = 6378.137-km and 1/f = 298.257.
- Information:** A large empty text area.
- TM Projection:** A table with columns for C.M., S.F., Lat., Easting, and Northing. The values are C.M. = 009°-E, S.F. = 0.9996, Lat. = 000°-N, Easting = -500-km, and Northing = 000-km.

At the bottom of the interface, there are two rows of buttons: 'Topo', 'Geo', 'TM', '3 of 4', 'Spheroid', 'Transform', 'Inverse' in the first row; and 'New', 'Save', 'Revert', 'Next', 'Previous', 'Delete', 'Okay' in the second row.

Fig. 6-4

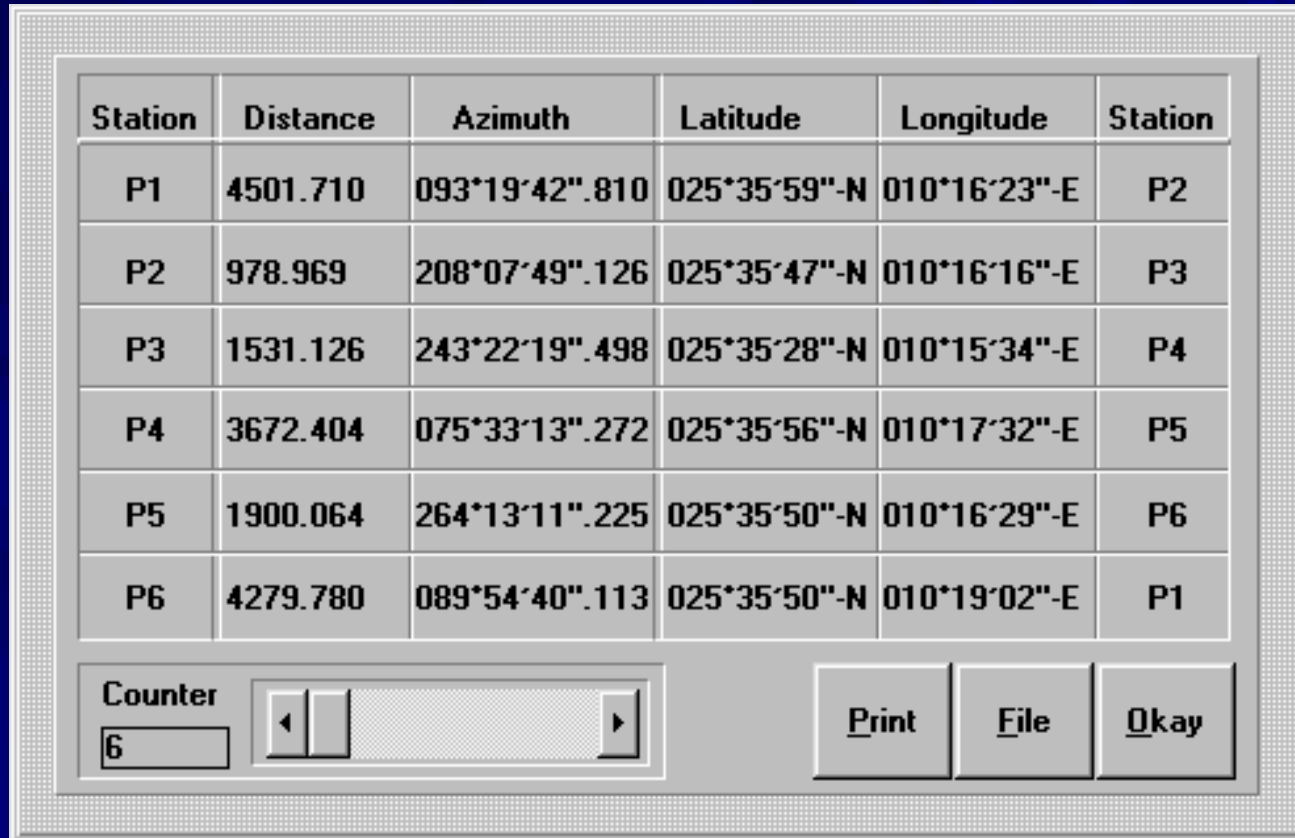
# SMS Product Information

*...Geodesy contd*

- Cartesian datum may be either Topocentric LHS with origin at the topographic surface or Geocentric RHS with origin at the centre of the spheroid.
- Other options include transformations to or from local variants of UTM projection and change of geodetic datum.
- Inverse computations on the spheroid are also available from any list of known position.
- SMS provides the geodetic azimuth and chord distances between positions, Fig. 6-5.

# SMS Product Information

...Geodesy contd.



The screenshot shows a software window with a table of geodesy data. The table has six columns: Station, Distance, Azimuth, Latitude, Longitude, and Station. The data is as follows:

Station	Distance	Azimuth	Latitude	Longitude	Station
P1	4501.710	093°19'42".810	025°35'59"-N	010°16'23"-E	P2
P2	978.969	208°07'49".126	025°35'47"-N	010°16'16"-E	P3
P3	1531.126	243°22'19".498	025°35'28"-N	010°15'34"-E	P4
P4	3672.404	075°33'13".272	025°35'56"-N	010°17'32"-E	P5
P5	1900.064	264°13'11".225	025°35'50"-N	010°16'29"-E	P6
P6	4279.780	089°54'40".113	025°35'50"-N	010°19'02"-E	P1

Below the table, there is a 'Counter' section with a text box containing the number '6' and a horizontal slider with left and right arrow buttons. To the right of the counter are three buttons labeled 'Print', 'File', and 'Okay'.

Fig. 6-5

- Therefore, surveyed positions are determined at any required datum.

# SMS Product Information

## SMS Applications

- The focus of SMS is in the use of survey information. With automated data collection and processing, the surveyors and engineers are enabled to concentrate on information management.
- Typical SMS applications include:
  - Topographical Surveys
  - Network Levelling
  - Rail and highway Construction
  - Utilities Survey for Positioning Pipelines and Conduits
  - Monitoring Structural Deformation
    - Monitoring Cracks
    - Determining transverse bending in bridges
  - Geology and Soil Mechanics such as
    - ground creep
    - large-scale sinkage
    - analyzing the consequences of earthquakes
    - etc.

# SMS Product Information

## Deformation Monitoring

- As part of Facilities Management, Monitoring plays a key role in civil engineering and environmental management.
- SMS provides precise survey results suitable for applications in subsidence and settlement monitoring.
- SMS allows management to cope with higher frequencies of surveying activities with the same level of manpower.
- SMS is unique in providing excellent and comprehensive tools for monitoring Structural Deformation.
- SMS can be customized so that cycle selection and designation of base, previous and current visits (Epoch) is automated, with options that include random comparisons.
- The survey party performs the survey and the SMS software compute the movements, generate charts and provide trend analysis.
- System is flexible and will accommodate 3-D input such as GPS/Traverse.
- Results are instantly available upon completion of field activity, Fig. 7-1.
- With the surveyor's familiar interface, the use of the software is easy, allowing users with limited knowledge of computers to achieve instant computerization.

# SMS Product Information

...Applications - Monitoring Contd.

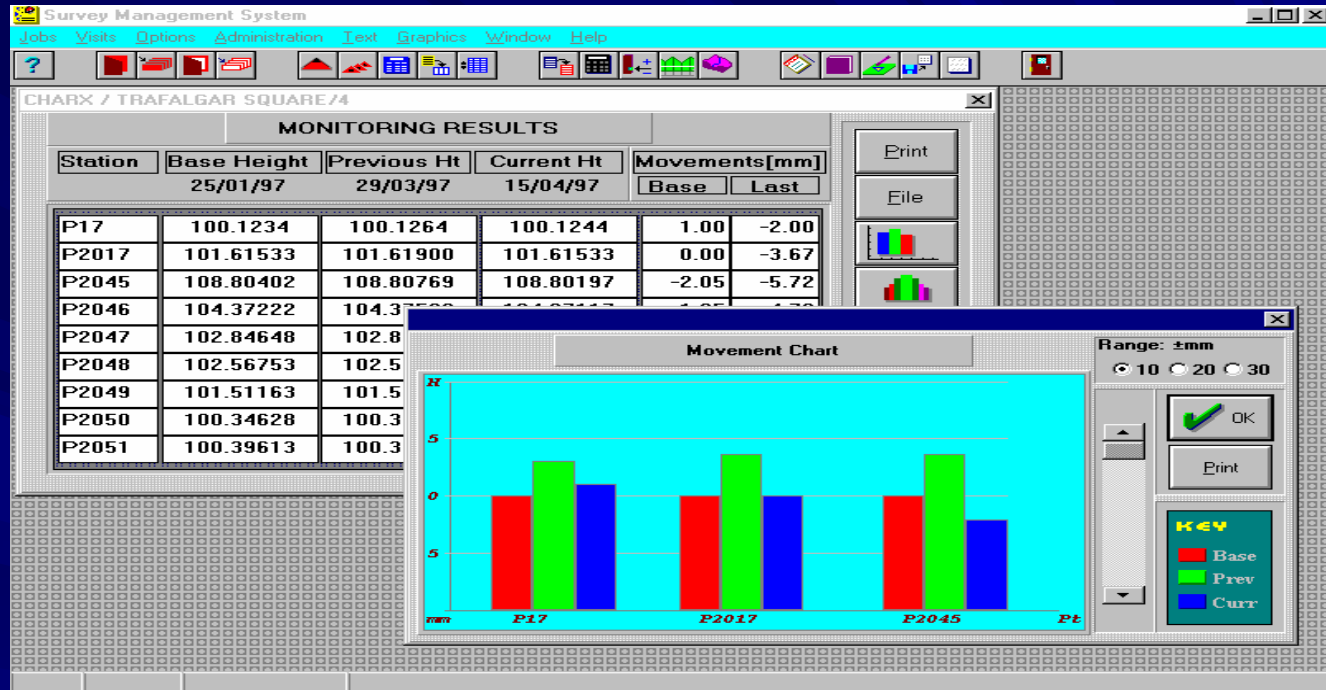


Fig. 7-1

- Trend Analysis charts the history of movements from any chosen base reference.
- The result is presented in tables and high quality 3-D graphical images viewed on the screen or sent to the printer.
- SMS is a complete all-in-one suite such that the use of external graphic packages is not necessary, Fig. 7-2.
- The survey results may be generated in cross-sections if desired.



# SMS Product Information

...Applications - Monitoring Contd.

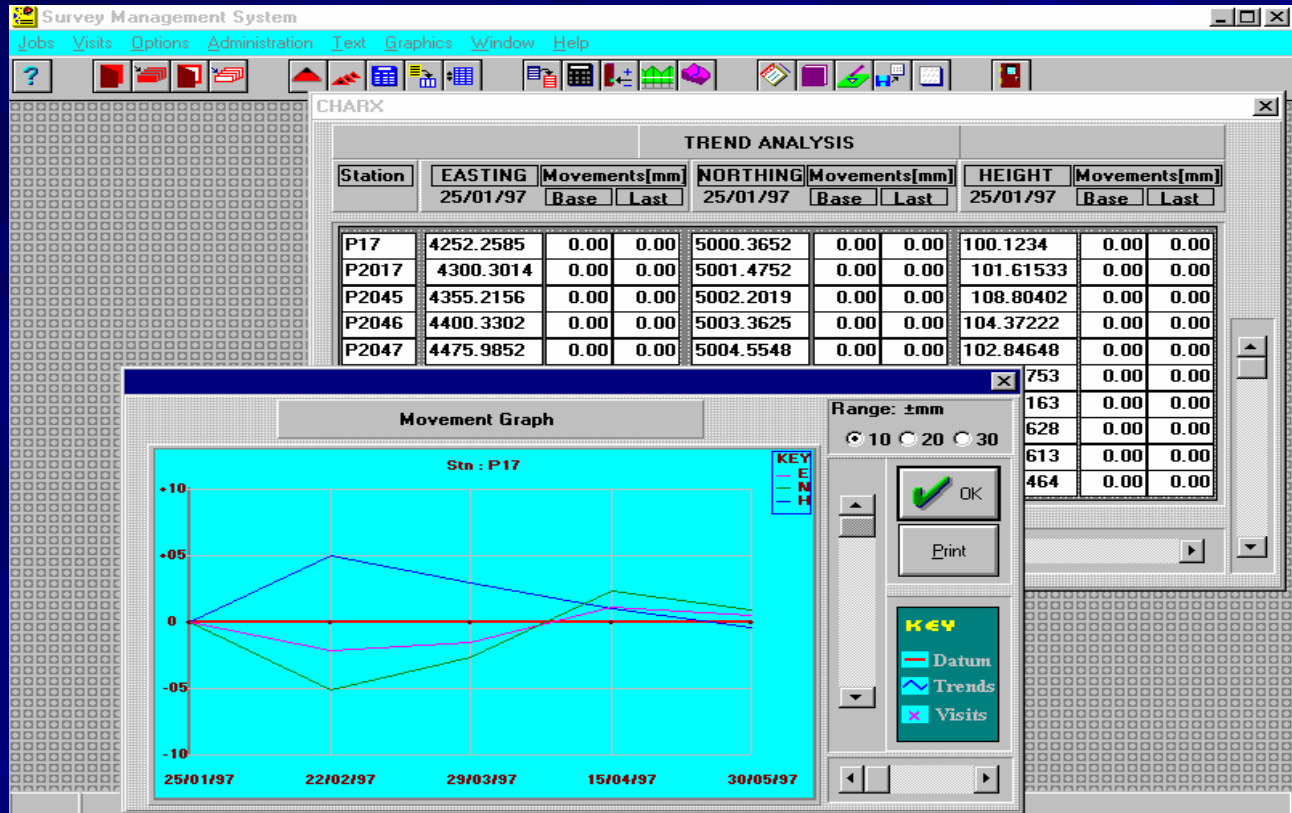


Fig. 7-2

- SMS highlight movements from user-specified tolerance to a depth of seven cycles, Fig. 7-3.

# SMS Product Information

...Applications - Monitoring Contd.

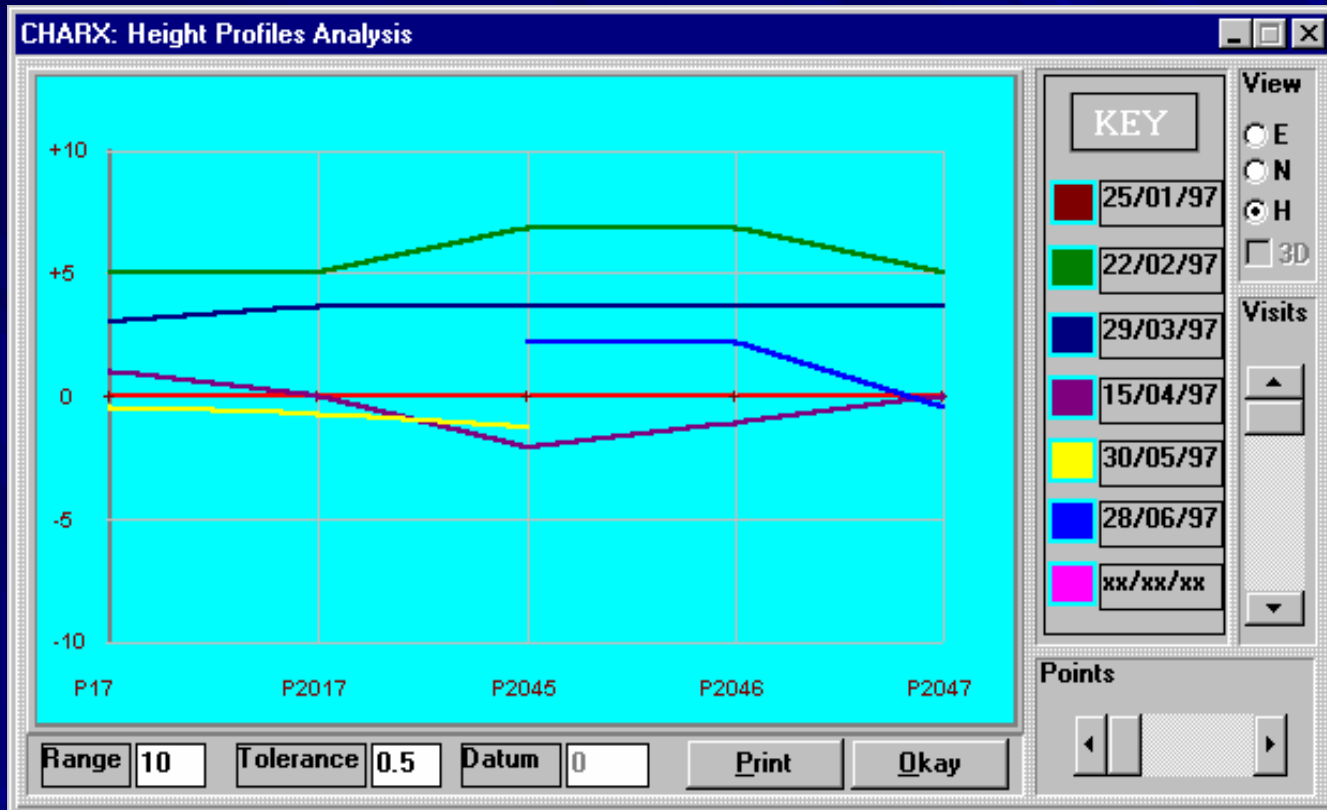


Fig. 7-3

- SMS tabulated and graphical results may be delivered to a Printer or saved to a disk in ASCII or SMS file format.

# SMS Product Information

## Earthwork Information

- Volume computation is a major requirement in civil and construction engineering.
- SMS provides excellent facilities to utilize level information for the following projects in Civil Engineering:
  - *Road Works*
  - *Dredge Quantity*



# SMS Product Information

## Road Works

- Longitudinal profile is available in every level run using a digital level where staff readings and distances are measurable.
- There is a dedicated database for this activity, Fig. 8-1.

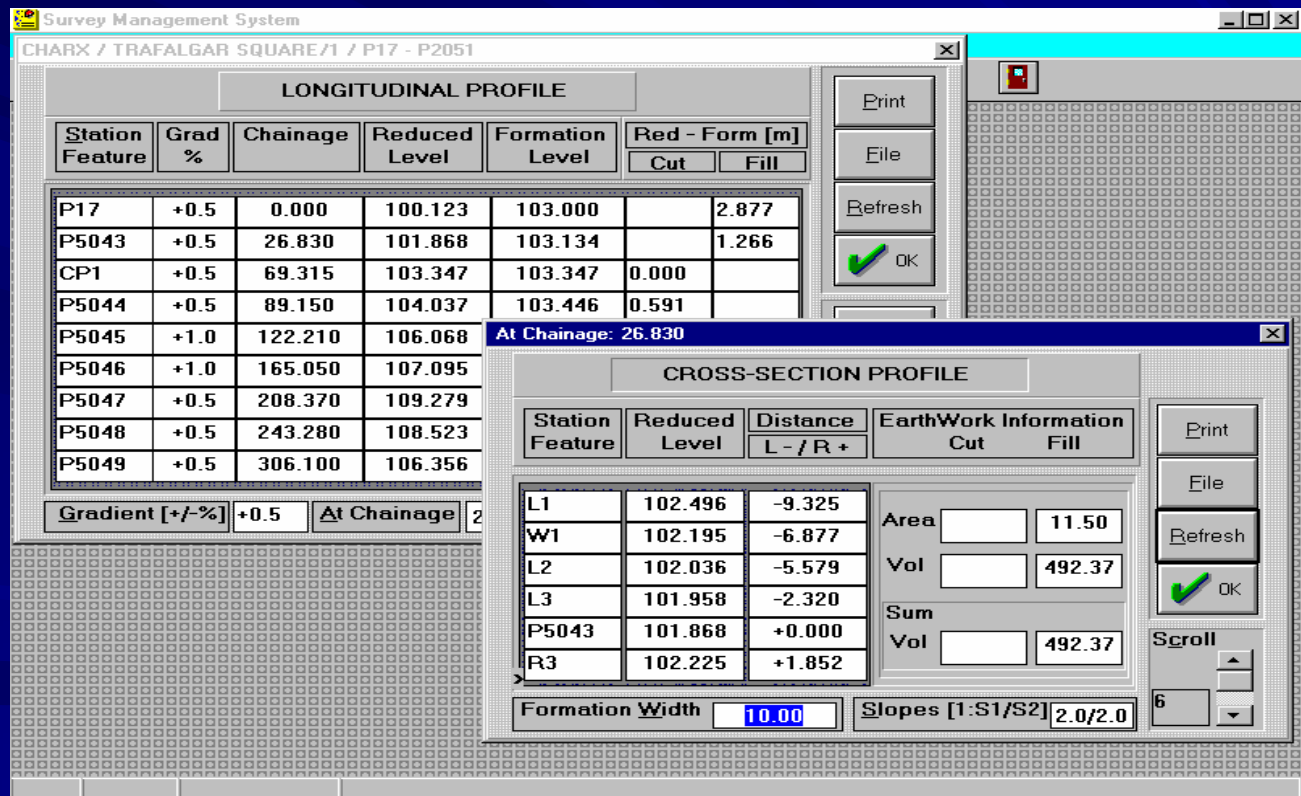


Fig. 8-1

# SMS Product Information

...Applications – Road Works Contd.

- Based on the survey model, SMS provides for input of gradients as well as formation level.
- Cross-sections and volumes may be determined in the field.
- Graphic output, Fig. 8.2, sent to a printer is excellent.
- There are options for output to other custom file formats.

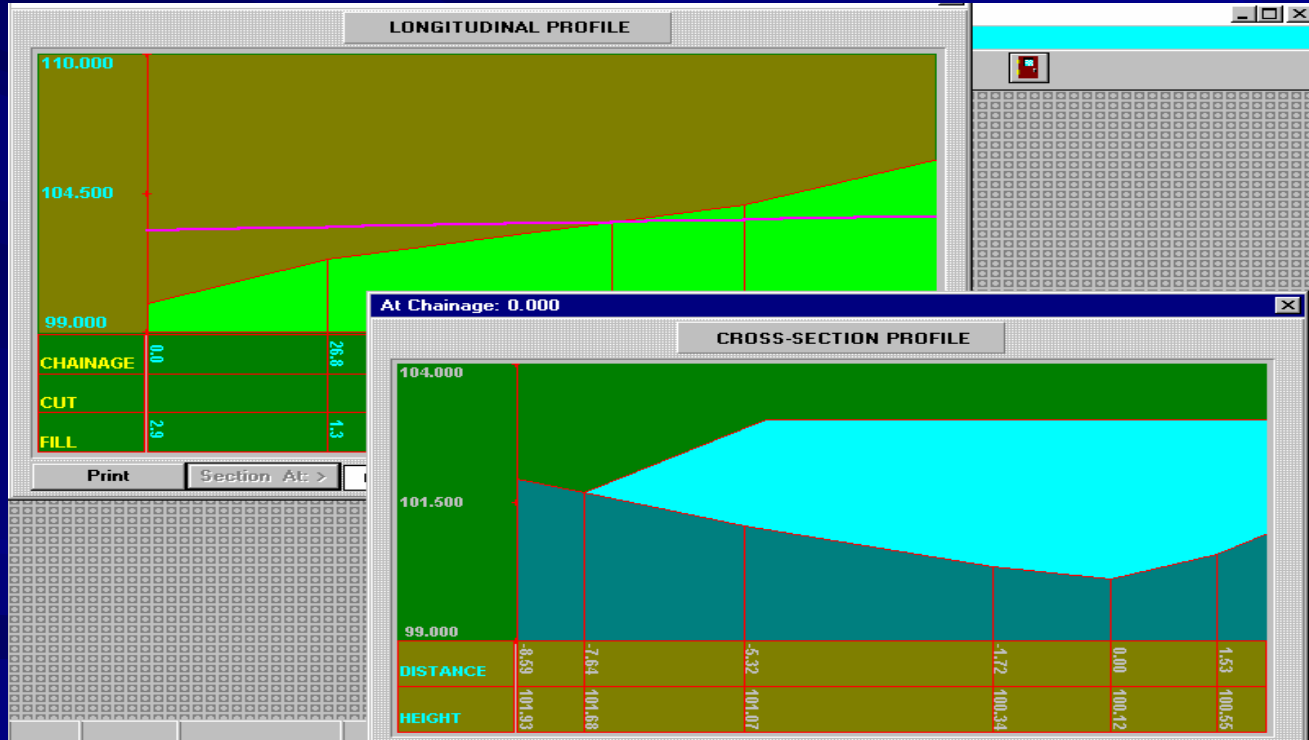


Fig. 8-2

# SMS Product Information

...Applications – Road Works Contd.

- Volumes are tabulated to assist quantity analysis.
- Design and topography may be visualized or realized in a 3-D perspective diagram, Fig. 8-3.

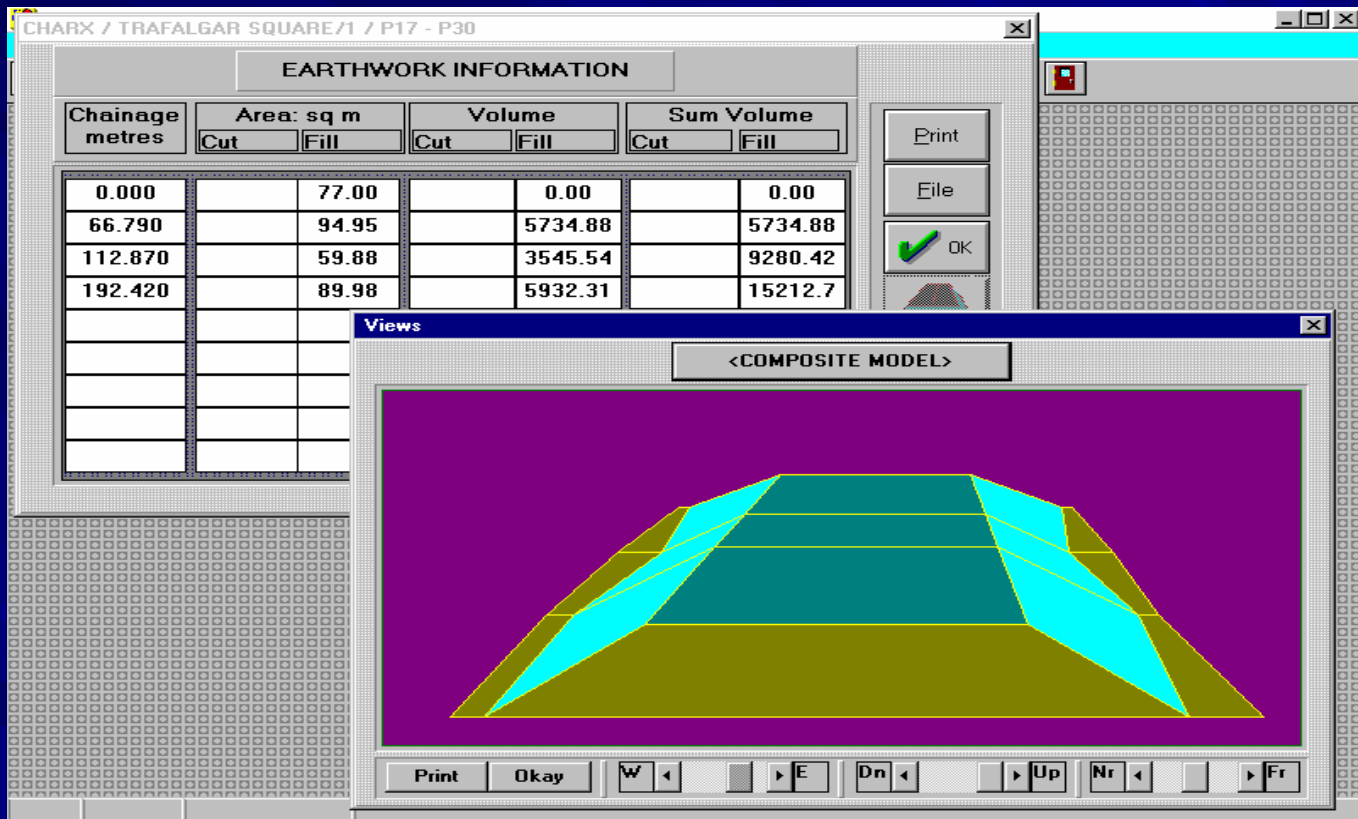
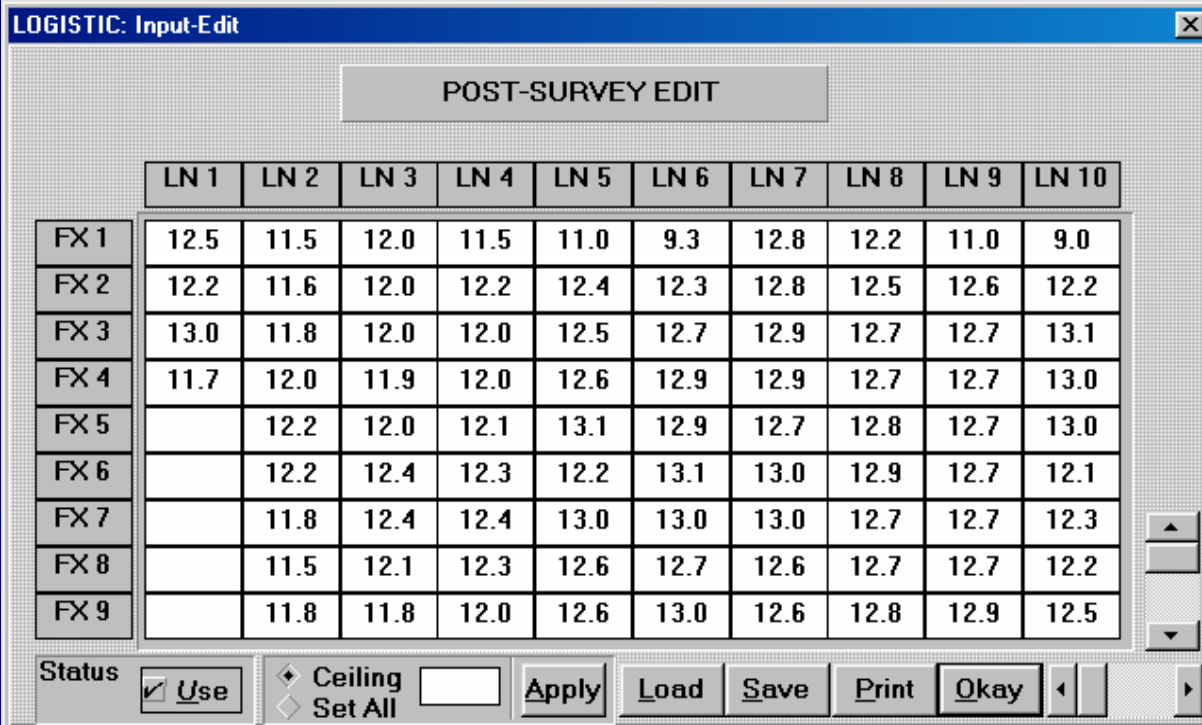


Fig. 8-3

# SMS Product Information

## Dredge Quantity

- Quantity of dredge is available from two data types:
  - Soundings.
  - Levels.
- There are two spreadsheet-like tables for data input, pre and post survey. A third table, Fig. 8-4, is for post-editor which is useful in defining depth ceiling and boundary demarcations.



The screenshot shows a software window titled "LOGISTIC: Input-Edit" with a "POST-SURVEY EDIT" button at the top. Below the button is a table with 10 columns labeled LN 1 through LN 10 and 9 rows labeled FX 1 through FX 9. The table contains numerical values representing dredge quantities. At the bottom of the window, there is a "Status" section with a checked "Use" checkbox, a "Ceiling Set All" option with an empty input field, and several control buttons: "Apply", "Load", "Save", "Print", and "Okay".

	LN 1	LN 2	LN 3	LN 4	LN 5	LN 6	LN 7	LN 8	LN 9	LN 10
FX 1	12.5	11.5	12.0	11.5	11.0	9.3	12.8	12.2	11.0	9.0
FX 2	12.2	11.6	12.0	12.2	12.4	12.3	12.8	12.5	12.6	12.2
FX 3	13.0	11.8	12.0	12.0	12.5	12.7	12.9	12.7	12.7	13.1
FX 4	11.7	12.0	11.9	12.0	12.6	12.9	12.9	12.7	12.7	13.0
FX 5		12.2	12.0	12.1	13.1	12.9	12.7	12.8	12.7	13.0
FX 6		12.2	12.4	12.3	12.2	13.1	13.0	12.9	12.7	12.1
FX 7		11.8	12.4	12.4	13.0	13.0	13.0	12.7	12.7	12.3
FX 8		11.5	12.1	12.3	12.6	12.7	12.6	12.7	12.7	12.2
FX 9		11.8	11.8	12.0	12.6	13.0	12.6	12.8	12.9	12.5

Fig. 8-4





# SMS Product Information

## *...Applications – Dredge Quantity Contd.*

- Area and volume are computed for each grid and tabulated.
- Volume computation is automatic and precise.
- There is option to specify area during computation.
- Computed volume is very accurate and depends on the quality of data and grid network.
- Moreover, SMS processes soundings as well as levels in computing dredge and sand-fill quantities.
- The resulting plans / models of the survey may be visualized on the screen or reproduced on a printer.

# SMS Product Information

## Land Information

- SMS provides Land Record as the basis of a land information system.
- The module includes 2-D Traverse, hence the integration of survey fieldwork and land records.
- Land Record System is a database with capabilities for graphical data fields and capacity to hold up to 16,000 records in a compact job file.
- The database reads output files from traverse computations.
- Input and editing may be manual and processing includes boundary descriptions such as bearings and distances.
- Land records system is unique in providing graphic plans of survey to the standards of cartography without the requirement of a CAD package.
- With the familiar surveyor's interface, the use of the system is easy, allowing surveyors with limited knowledge of computers to achieve instant automation.
- Attributes include ownership, area of parcel, graphic plan and historical information, Fig. 9-1 and Fig. 9-2.

# SMS Product Information

*...Applications – Land Information Contd.*

The screenshot displays the NSLGA software interface. The window title is "NSLGA". The main content area is divided into two sections: "Information" and "Plan".

<u>P</u> lot	MG 152/76	<u>O</u> wner	MR G. E. UGWU
<u>L</u> ocation	12 University Road Nsukka ENUGU STATE	<u>A</u> ddress	Family Compound Amahor Ede-Oballa Nsukka L.G.A.
<u>S</u> ize	1565.166 SQ M	<u>V</u> ocation	Public Service

The "Information" section contains a large empty text area. The "Plan" section shows a diagram of a plot with a red border and a light blue fill, set against a green background. The vertices of the plot are labeled with coordinates: CG18798 (top), CG18801 (left), CG18799 (right), and CG18800 (bottom).

At the bottom of the window, there is a control panel with several buttons: Data, Heder, Footer, 2 of 3, Offsets, View, Joins, New, Save, Revert, Delete, Print, and Okay.

Fig. 9-1

# SMS Applications

## Applications – Land Information Contd.

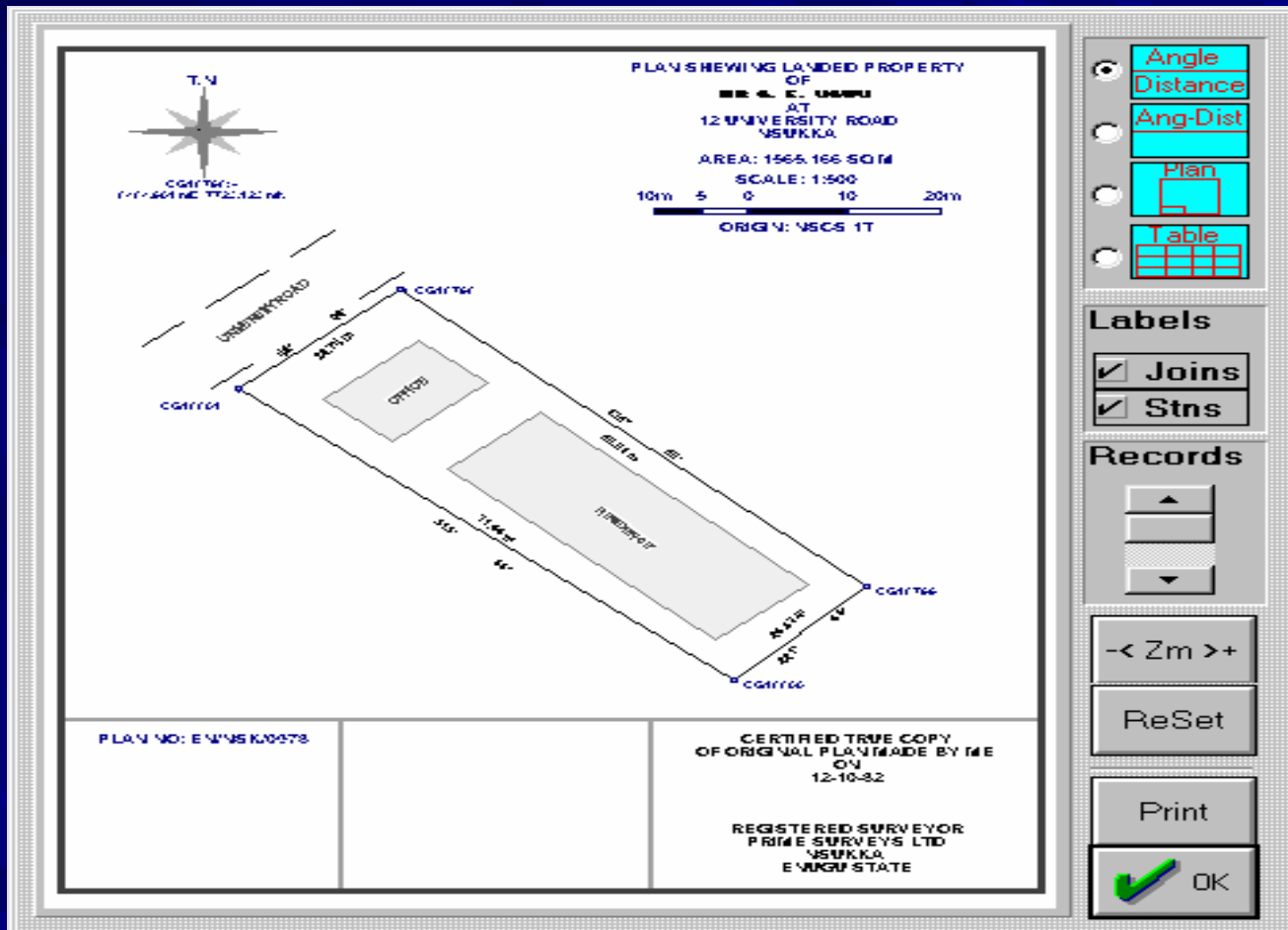


Fig. 9-2

# SMS Product Information

## Quality Assessment

- SMS adopts standard techniques to qualify the reliability of available information.
- The instrument standard error is incorporated in computations to determine the precision of a position.
- Hence, the station may be quoted at this accuracy
- Histograms are included to further assist in analysis, such as in computations, Fig. 10-1.

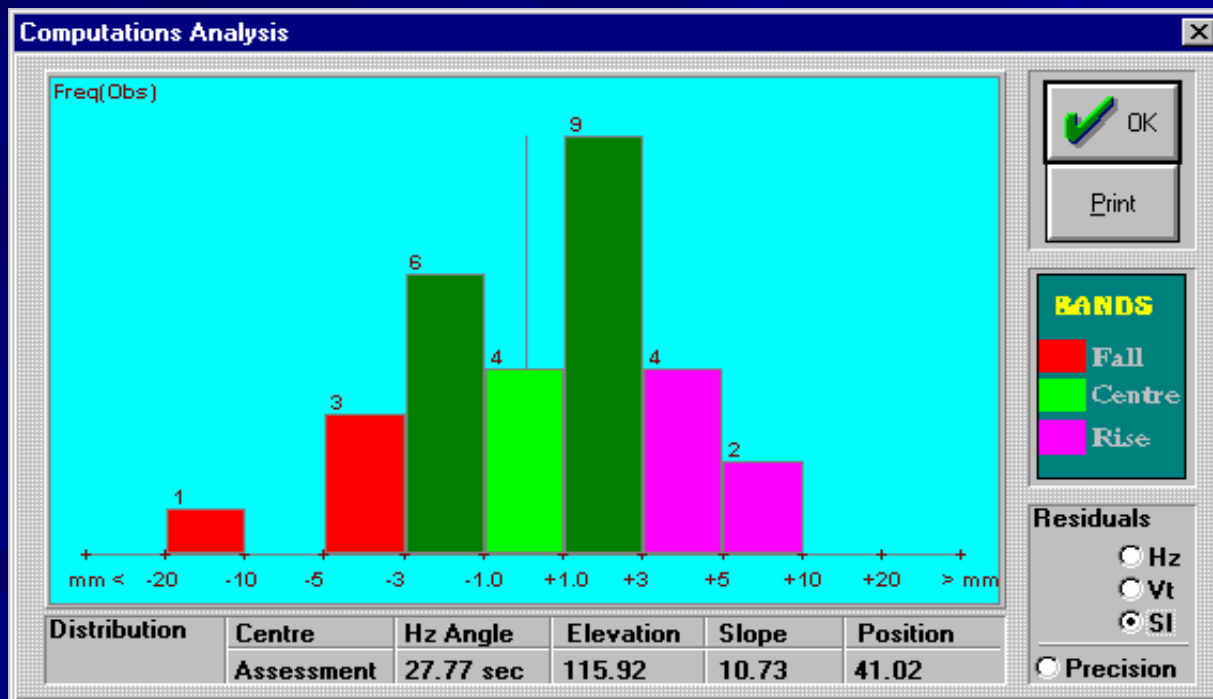


Fig. 10-1

# SMS Product Information

...Applications - Quality Assessment Contd.

- A useful parameter is assessment representing 99 percent of distribution.
- It may be used to set tolerance in the projects or qualify movements in deformation monitoring and analysis, Fig. 10-2.

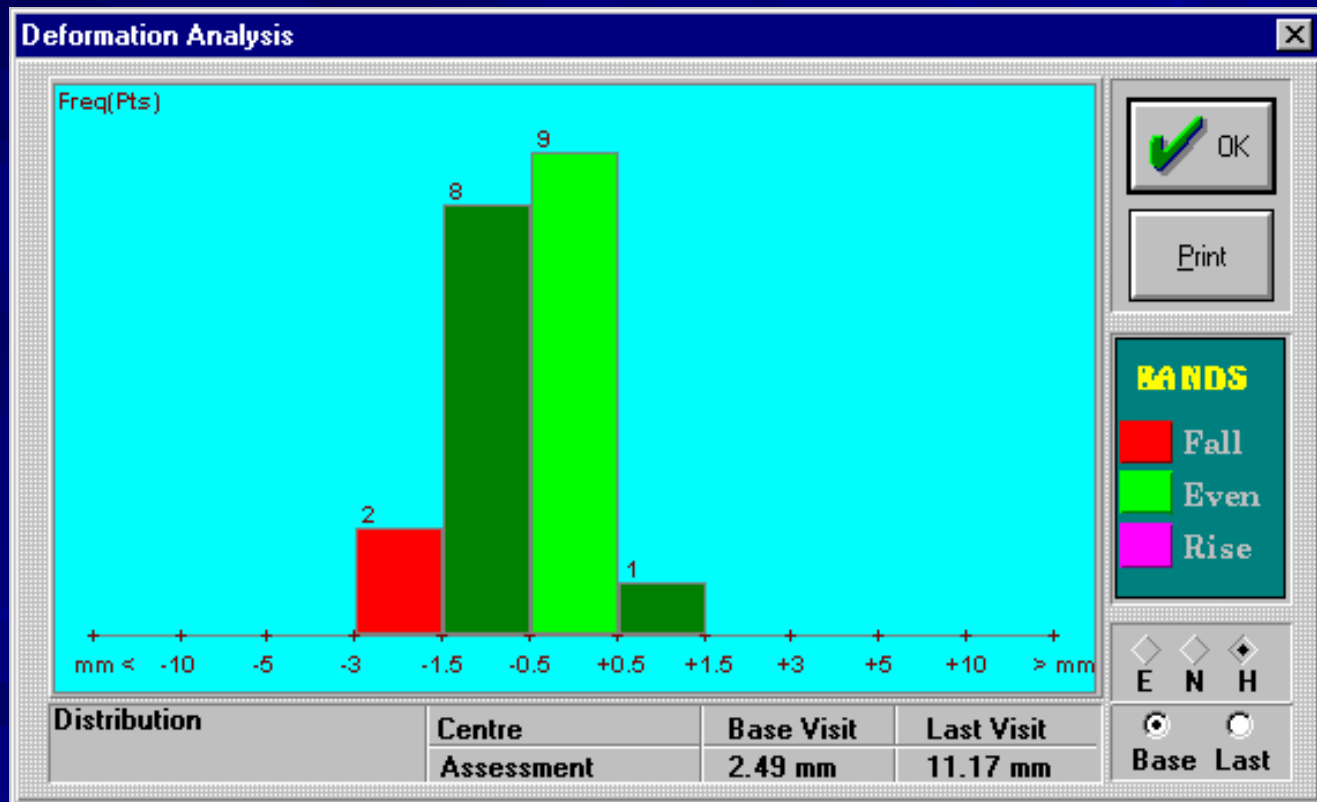


Fig. 10-2

# SMS Product Information

## Conclusion

- SMS is easy to use because it's process is sequential and logical.
- SMS uses surveyor's recognizable familiar interface.
- SMS learning curve is very low for all users including beginners.
- SMS provides the software component to survey instrumentation hardware to form a perfectly matched integrated system.
- SMS turns the once complex task of survey network adjustment/management, comparison of data sets, and trend analysis into a straight forward operation that can be easily and rapidly performed on a computer at the office or a laptop at job site.
- SMS is useful for processing and adjusting levelling networks for control and monitoring.
- SMS provides high level of productivity and cost-effective management.
- With emphasis on information, SMS is a vital tool in Geo-Informatics.
- SMS offers seamless integration, high performance and reliability that forward-looking companies rely on to increase productivity, profitability and gain competitive advantage.

# SMS Product Information

## End of Presentation

- This is the end of the product information presentation.
- SMS Software package is provided as follows:
  - 1. A complete package consisting of all five core programs, fully integrated as follows:
    - *Field Book and Data Interface*
    - *Level Network Analysis*
    - *3-D Traverse Computations and Tachometry*
    - *Subsidence and Deformation Monitoring*
    - *Level Profiles/Section/Volume Computations with Dredge/Sand-Fill Quantities.*
  - 2. A separately stand-alone package consisting of one or more of the programs listed in (1) above.
- Need additional information? Please e-mail [peca@pecaconsult.com](mailto:peca@pecaconsult.com)