

A Hands Free Approach to Automated-Cartography: Case Study of Land Records

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Abstract—Automated Cartography is the norm and platform for most organizations. It used to be a term expressed relative to manual process that is now of age. Yet in the new digital platform, intensive desk and office activity can most often always be the case and so the need for automation in true sense of the word. This paper examines the concepts and prototype for a hands-free approach where interaction between software and data produces on screen and in print, improved, standard and professional drawings, a case study of land records in cadastral surveying.

Keywords—Digital Mapping, Land Records, Bowditch Adjustment, GPS, Frames, Objects.

I. INTRODUCTION

Digital Mapping [1,2] may be defined as a process by numerical methods. By this definition, a manual procedure in mappings described by sequences and algorithms which translate into computer programs that execute, to achieve same result. In the early days of inception, the practice involved vector machines, calligraphic plotters and video screens. It required a large financial set out. Since then, technology has moved on at a pace such that very high resolution raster devices are now available and at affordable rates.



Fig. 1 Digital Mapping

Furthermore, the ascent of graphic operating systems meant that the option of computer based mapping is now available in a desktop, Fig. 1. Hence it became the norm, the widespread adoption of this technology.



Fig. 2 Cartography

Cartography is best described as both art and science with respect to map making, and is the main feature in the domain of map production. It has come of age and the catch word is Auto Carto [3], a synonym with computer process. However, it has to be added that the use of this terminology is qualified with respect to characterization. This is because of the degree of automation. Over the years, it has progressively improved but the art component and limits of conventional programming techniques means that there are bounds yet to overcome. Further progress though, is possible as traditional methods of programming give way to Knowledge Representation techniques in Art.Intelligence[4].

II. ADMINISTRATION

A proper evaluation of the role and process of cartography is best accomplished in the context of management model. They depend on organisations ranging from large national mapping agencies to small private firms. However, the focus in this discussion is in respect of application to cadastre, and land records.

A. Traditional Model

The traditional management is rooted in previous administrations dating back to several years. While there have been evolutions over the periods, in its most basic form it may comprise of the following:

- Computing Office
- Records
- Map Production
- Field Unit

The relationship between these units is illustrated in Fig. 3. Though there are variations, in general surveyors submit their field books and preliminary calculations to Computing Office, where they are checked and computed. Thereafter, if satisfactory, the basic plan is prepared and sent to map production unit, while computations and field book go into survey records.

The Computing Office may in future retrieve coordinate information from records to continue or assist undertaking of new surveys. There is also some feedback from Computing Office to request for resurvey, to supply coordinates and so on. Survey data could also be required by field units, direct from records. Similarly, maps completed by Map Production go into records. In time, maps could be retrieved in order to carry out revisions and scale change.

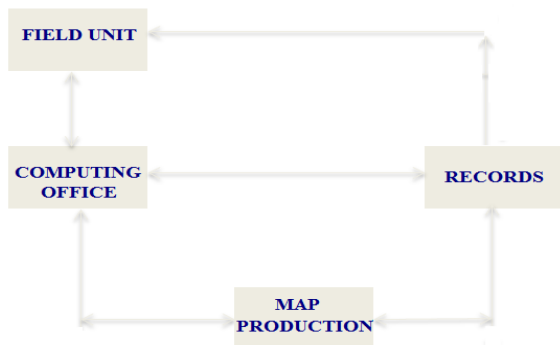


Fig.3 Survey Administration

This basic structure exists in many organisations, what has tended to change is the means of administration. The availability of modern electronic hardware with associated software has merged the functions of subsections in many establishments. For instance, most survey firms use Total Stations with on board memory units, obviating the need for traditional field books.

Surveyors download the observational data from the recorders to computer in order to perform the necessary computations using reduction software. The reduced data may then be used to produce a draft plot of the survey automatically, followed by any required editing. Not surprisingly, in such circumstances, there is no need for a draughtsman. A survey plan that would normally take a month to check, compute and produce can be completed in a matter of hours, or computer processing time.

B. Electronic Model

The electronic model represents e-administration and replicates the form of tradition by as much as possible in such a way that learning curve is minimal.

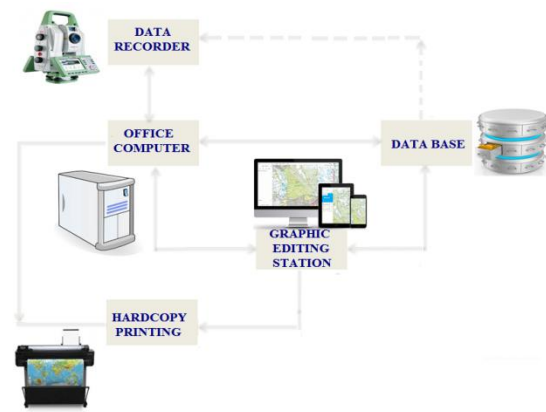


Fig. 4 e-Administration

A critical asset in any management is storage mechanism. In this context, where on cethere were physical records, in its place would be a data base. In general therefore, against the background of an organisation with many field parties, the data base functions like a record department. It operates with rest of software modules so that an administrative structure similar to descriptions in Fig. 3 is realisable in software, Fig. 4. While centralised storage is desirable, a flexible approach lends to improvements in data back up and security, hence the use of peripheral devices such as flash drives, DVD etc.

III.COMPUTERISATION

Survey practice by trained and registered surveyors is the corner stone of the cadastral system. Typically large layouts are acquired by the government or community for development. This in turn leads to plot allocation to individuals or groups for subsequent ownership. In the process, it entails a survey for title deeds and land records. The model of this practice may now be examined with respect to knowledge representation and computerisation [5,6].

A. Frames

A typical survey office is basic, where the emphasis is field activity and preparation of title plans. By and large Figs. 3-4 are representations in a microcosm. And in Fig 5 is a map of survey practice.

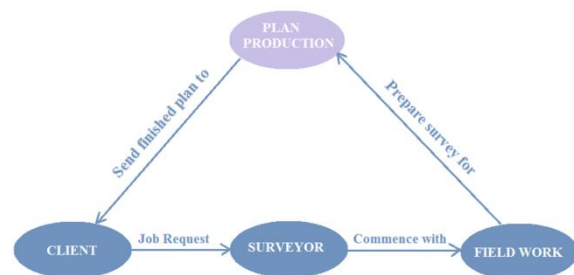


Fig. 5 Management cycle in Survey Practice

1. Client:

Client is one of the four entities in the abstraction on Survey Practice, Fig. 5. With respect to computerisation, these nodes translate into frames and then programmable objects [7],[8,9] for the purpose of automated plan production.

Client Frame

Data1	Client Name
Data2	Address of Property
Data3	Area of Property
Data4	:
	:
Method	:

Table 1

The client frame is illustrated above and comprises of slots, Data1, Data2 etc. It provides therefore for all such information that should appear in the title. The Method is a routine that operates on the data, such as placement in the graphic frame.

2. Surveyor:

The surveyor frame is similar to that of client but contains information regarding the surveyor and registration.

Surveyor Frame

Data1	Company Name
Data2	Address of Practice
Data3	Registration
Data4	:
	:
Method	:

Table 2

3. Field Work:

The Field Work Frame represents the survey field activity that ends up with computations and land parcel descriptions.

Field Work

Data1	Reference Coordinates
Data2	Connection Measurements
Data3	Parcel Survey Measurements
Data4	:
Data5	Parcel Coordinates
Method	:
Method	Computation

Table 3

As such, the frame is as represented above. Note the data slots. The most important activity is the interaction of the method Computation with data sets to generate Data5, parcel coordinates and boundary description, comprising of bearings and distances.

4. Plan Production:

Plan Production is essentially a graphic frame, operating as a platform representing the intersection of three frames in the cycle, Fig. 6.

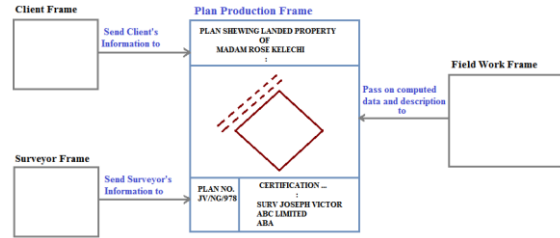


Fig. 6 Frame Intersection

The key methods operate accordingly as would a draughtsman to prepare the plot on screen and in print to professional standard.

B. Object Model

The translation of frames to equivalent objects is now described.

1. Land Records:

```
PLandRecordObj = ^TLandRecordObj;
TLandRecordObj = object(TObject)
  DataBase,Joins,Segments,Labels1,
  Labels2,Labels3,Labels4: PCollection;
  Polygons: PPolyCollection;
  LandIndexRecord: TLandRecord;
  Header:THeaderRecord; { Client Details }
  Footer:TFooterRecord; { Surveyor Details }
  constructor Init;
  destructor Done; virtual;
  constructor Load(var S: TStream);
  procedure Store(var S: TStream);
end;
```

Land Records is the key management and storage mechanism. In this regard, Client and Surveyor frames transform into records and are enclosed in the object model ofLandRecordsObj, a data type. Client information is part of the header compartment in the graphic plot, while the Surveyor and firm occupy the footer segment, and so are designated as such in the data type.

2. Computation:

```
PBowditchDlg = ^TBowditchDlg;
TBowditchDlg = object(TDlgWindow)
:
  Table: PBowTable;
  CurrPageObj:PBowPage; StnObj:PStnInfoObj;
  InstrObj,ROObj,LROObj:Pointer;
  RO1Est,RO1Nth,RO1Stn,FWD1Est,FWD1Nth,FWD1Stn,
  RODms,REFDist:array[0..12]of char; RODist:string;
:
  procedureInitializeData;
  procedureLoadTables;
  procedureBearingComps;
  procedureCoordComps;
```

```

:
procedureCtrlData(varMsg: TMessage);
virtualid_First + 556;
procedureDataInput(varMsg: TMessage);
virtualid_First + 557;
procedureAzmthInput(varMsg: TMessage);
virtualid_First + 558;
procedureComptData(varMsg: TMessage);
virtualid_First + 559;
procedureFile_OutPut(varMsg: TMessage);
virtualid_First + 560;
procedurePrint_OutPut(varMsg: TMessage);
virtualid_First + 565;
:
end;

```

Computation is performed by Bowditch Table. Defined as Table:PBowTable in the first line of object declaration, it is a frame for field work and operates inside a dialog window, PBowditchDlg. There are pages, CurrPageObj, for connection or additional surveys within the network as defined in Data2/3 in Table 3. Also reference coordinates are defined in the object as RO, FWD etc.

The procedure CompData in the Object corresponds to the method Computations in Table 3. Once activated, the procedures, BearingComps and CoordCompsrun consecutively to generate coordinate information for Data5 in Table 3, as would in a Traverse computation by Bowditch method [10,11]. File_OutPut routine then allows this data to be exported for plan production, Fig. 6.

3. Plotting:

```

PCADObj = ^TCADObj;
TCADObj = Object(TObject)
OldBrush,Brush:HBrush; Pen:HPen; MemDC:HDC;
:
NewPen,OldPen:HPen; NewFont,OldFont:HFont;
IDXObj:PLANDRecordObj;
:
constructorInit(HRef:HWnd);
:
procedureDrawFeatures(DC: HDC);
procedureDrawPolygons(DC: HDC);
procedureLabelOption(DC:HDC; P:Byte);
procedureDrawTitleNo(DC:HDC);
:
procedureDrawHeader(DC:HDC);
procedureDrawNetWork(DC:HDC);
procedureDrawFooter(DC:HDC);
:
procedure Draw;
:
destructor Done; virtual;
end;

```

Plotting is handled by a drawing object, for computer aided drafting, TCADObj. After initialisation, plotting starts with a call to Draw. Thenceforth, drawing routines go into operation. DrawNetWork carries out the plotting of the land parcel. Any features described or coded as offsets are also drawn. It completes with ownership details and certifications of the registered surveyor, provided by DrawHeader and DrawFooter routines.

IV. PROTOTYPE

The program prototype is Land Information Management, a module in SMS [12]. As would normally be expected, the centre of management is the Land Records. Thus, the program loads with this interface as the control centre, Fig. 8.

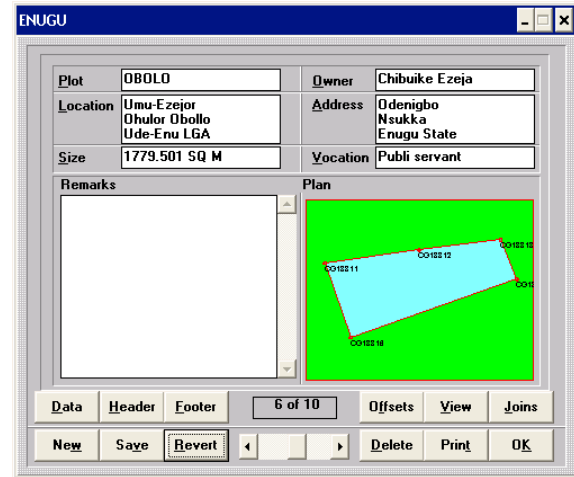


Fig. 8 Land Records

A. Data

The options in the interface can be situated with respect to discussions on frames and objects. Data is a representation of fieldwork and computations. It provides for input of boundary coordinates. Preferably, besides the manual options, it is better to import results from Bowditch Table, Fig. 9, or GPS.

Stn	Back Bearing Obs Angle Fwd Bearing	Corr.	Red. Bearing	Distance	Prov Eastings +/- dE Eastings	Prov Northings +/- dN Northings	Stn
OB0LO			157°17'16"	50.670	1000.000	1000.000	OB0LO
OB0811	337°17'16" 108°20'30"		85°37'46"	27.005	1026.926 0.001	1002.058 0.000	OB0811
OB0812	265°37'46" 165°54'35"	-00°01"	85°37'45"		1026.927 0.002	1002.058 0.000	OB0812
OB0813	71°32'21" 251°32'21"	-00°02"	71°32'19"	11.130	1037.486 1069.994	1005.583 1009.858	OB0813
OB0814	190°58'10" 82°30'31"	-00°03"	82°30'28"	32.790	0.004 1069.998	0.001 1009.859	OB0814

Fig. 9 Bowditch Table

B. Header/Footer

Header and Footer are associated with records as defined in the frames, and this option brings up a dialog box as in Fig. 10.

Title	PLAN SHEWING LANDED PROPERTY
Line 2	OF
Line 3	MR CHIBUIKE EZEJA
Line 4	AT
Line 5	OHULOR
Line 6	OBOLLO UDE-ENU LGA
Line 7	ENUGU STATE

Plan No	UWE/ENSK/650
Scale	1:500
Origin	CG18811
North	T.N

Fig. 10a

Title	CERTIFIED TRUE COPY
Line 2	OF ORIGINAL PLAN MADE BY ME
Line 3	ON
Line 4	15-10-2010
Line 5	

Signed	SURV UWAKWE EZE
Status	REGISTERED SURVEYOR
Coy/Org	EZE SURVEY ASSOCIATES
Address	ENUGU EZIKE ROAD
Address2	OBOLLO AFOR

Fig 10b

C. Production

Fig. 11 Screen Plot

This option is activated by the View command. As described in Fig. 6, it is the culmination of the interaction between the three frames. There is no editing involved in generating this screen plot. Nor

is a graphic package required. Labels are uniformly and automatically placed. However, provision exists in Zoom mode to adjust label positions. Similarly features, roads and buildings can be added from Offsets, but again preferably by coded descriptions.

One major advantage is the minimal size of land records database. Graphic drawing, rather than being stored, is generated dynamically from the input records. Print option delivers client's copy, Fig 12.

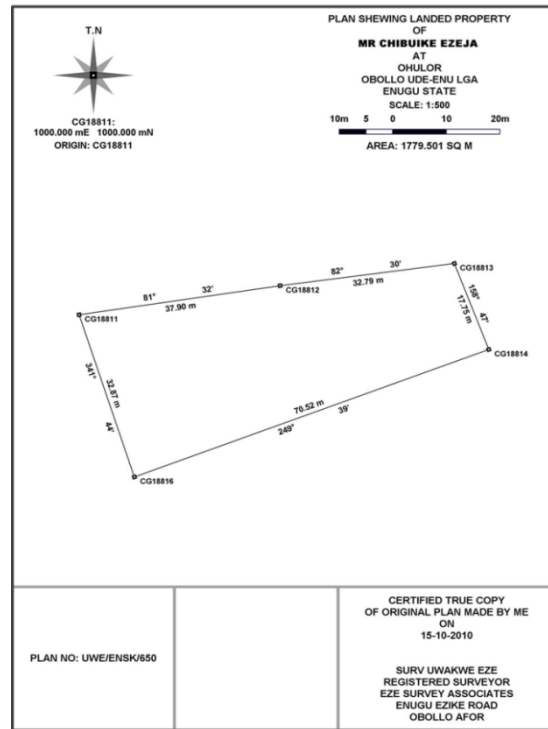


Fig. 12 Print Copy

V. CONCLUSIONS

The prototype of this model, LIM, has found use in many survey organizations, from offices of Surveyor-Generals to registered surveyors in legal practice. In common with users, there are options in prominent names in computer drafting and mapping systems. Thus, adopting this model is in recognition of its novelty. The future would lie therefore in customization through in house developments and programmable adaptation of available systems.

Whereas the system is successful, it is however with respect to specific domains of application. Expansion of facilities is best achieved by retaining the model and perfection in progressive developments. In this respect, further options are envisaged in feature representation, connection surveys and layouts.

The model is a further appreciation of Auto Carto, and enhances its full realization in Survey Practice.

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