Digital Azimuth Integrated Telemetry (DAIT) - proposal for a new survey system (theoretical)

This disseratation proposes a new system for topographical survey of orienteering maps to improve speed and precision, removing the costs of map production .

This new system not only reduces time but also ability level and personal experience needed, for a major circulation of mappers.

The actual problems of circulating maps, at least in Italy, are attributable to the high costs of production because there are few professional mappers and they justifiably charge more in respect of the maps requested in high quantities:

- Time available
- Graphic ability (above all, manual design, but also in minor part on PC)
- Observations (evaluation of distance, directions, contours, accessability through vegetation etc.)

The computer skills (use of PC or Ocad) actually required of a mapper cannot considered of high level as they can be found in anyone having a little familiarity with a PC and with digital design and anyway they can be easily acquired with little effort.

Another factor which increases the cost of production are the basic maps which are sometimes of poor quality (above all in Italy), and this increases the importance of the elements indicated above, required from the professional map maker, which therefore increases the economic requirements (poor source maps = more time +more ability =higher charges)

It is clear to everyone that the growth of our sport crosses paths with map production.

For example, my region has much woods of beautiful quality a few kilometres from the location of my club, but we never found the finances to produce maps of it.

The research in Orienteering must therefore consider ways of reducing the cost of map production.

The idea, theoretically, should be a system of map survey which provides :

- zero map requirement or at the most a map of low quality (for basic reference eg. asphalted roads, fields etc) with much reduced cost
- no need for great experience and great observation experience of the surveyor
- the possibility to digitise the survey directly in the bush during the survey (skipping the passage from drawing of the countryside to PC)
- raising the precision of the survey of distances, directions, land formations and heights / land formations (contours)

I would like now, therefore, to leave the basis of theory, for a new system of surveying which approaches as close as possible, the ideal model. In this way, someone with a minimum of dexterity and little time at their disposal is enabled to create maps of quality. Any club may therefore have 1 – 2 map makers in their team who may survey maps at the lowest cost and in little time (free time, holidays etc)

The elements contained in this new survey system are :-

Gli elementi costituenti di questo nuovo sistema di rilevo sono:

- ***Laser Telemetry*** : measuring distance, inclinations, azimuth and by means of calculated internally supplying precise height of a point and precise distances ; such an instrument is interfaceable directly with :-
- ***Palm computer (PDA) or Tablet PC***
- programme for design of orienteering maps ***OCAD modified*** (version for palm PC which utilise such an instrument instead of the PC version for using a Tablet PC)

We define such a system as Digital Azimuth Integrated Telemetry (DAIT) and the OCAD version is dedicated as OCAD DAIT.

Description of the Instrument

Laser Telemtry (Telemeter) ?

The Laser Telemeter interfaceable with palm or table PC is an instrument of recent origin which permits the positioning of a subject and the acquisition with a simple " click " of the distance and the slope , precise to the centimetre (!) and tenth of a degree (!!); a further device can survey the degrees North (Azimuth) with a precision of 1° North. To calculate inland it can also precisely measure the height and planimetric distance (horizontally) . This data can be viewed on a display and may be sent to a palm/ tablet PC through a serial cable RS232 (with adaptor) or through a USB port or Wireless port (bluetooth [1])

Actually I have found two models commercially available, with these charactersitics. The first is the Laserace 300 (fig. 1) and the second is the Laser Atlanta Advantage (fig. 2)

Model descriptions:

Fig. 1 LaserAce 300

Fig. 2 Laser Atlanta Adavantage

The first (Laserace 300) is like binoculars through which you look and aim at the subject, receiving a pulse you click and acquire the data.

The second is a kind of pistol which you point in the direction of the subject and press a trigger to acquire the data.

The first instrument offers more precise stability when hand-held, is lighter and therefore ergonomically better than the second.

Here are the characteristics of the two instruments

LASERACE 300	LASER ATLANTA ADVANTAGE
Type GaAs Laser Diode 905nm Eye Safe Class 1 CENELEC EN60825-1/FDA Range Passive up to 300m. Reflectors to 5km Range Accuracy Typically 10cm Range Resolution 1cm Measurement Time 0.3 sec **INCLINOMETER** Type Accelerometer Range -90º to + 90º Accuracy 0.3º at 0º Resolution 0.1º **COMPASS** Type Digital 3 Axis Fluxgate Range 0º to 360º Accuracy Typically better than 1º Resolution 0.1º Construction Reinforced Polycarbonate Weight 50g **TECHNICAL DATA** Construction Reinforced Polycarbonate Dimensions (L x W x H) 175 x 106.5 x 56mm Power 3V DC 350mA (Standby 20mA) / 2 x AA cells internally Weight 600g Custom LCD Display Backlit Alignment Telescope Red Dot Scope / optional telescope **Data I/O RS232 4800 or 9600 Baud** MDL Tel: UK +44 (0)1224 246700 Tel: USA +1 281 646 0050 email: info@laserace.com www.laserace.com	Type: Semiconductor pulsed laser 904um Eye Safety: FDA Class 1 (21CFR1040) Accuracy: ± 15cm / 0.50ft (3 sigma) Resolution: 1cm / 0.10ft Range: 600m / 2,000ft (passive) Meas. Time: 0.33 sec (0.4sec acquisition)NGEFINDER **INCLINOMETER** Type: Dual Axis Liquid Range: ± 50° (from level) Accuracy: ± 0.4° Resolution: 0.1° Repeatability: ± 0.3° **COMPASS**OMPASS Type: Triaxial Magnetometer Range: 0° to 359.9° Accuracy: ± 1° (when level) Resolution: 0.1° Repeatability: ± 0.3° **TECHNICAL DATA** Size: 21.5cm x 11.5cm x 19.0cm [LxWxH] Weight: 2.2kg Display: LCD, 4-line x 20 characters Keyboard: Membrane keypad PCMCIA: Slot for Type II SRAM Sighting Optics: Heads Up Display Battery Type: NiCad Current: 200 mA to 400 mA Battery Life: 2 - 3 hours / battery Warranty: 1 year (limited)CAL **Data I/O: RS232** Data Interface: NMEA Baud rates: 300 to 48,000 (selectable) Protocols: ASCII, XMODEM Power: 6VDC **Laser Atlanta Optics, Inc.** 2827 Peterson Place Norcross, GA 30071 TEL: (770) 446-3866 FAX: (770) 840-0462 sales@laser atlanta.com www.laser atlanta.com

Another model of telemeter is the Hike 300 which has integrated in the instrument a palm computer (PDA) HP Ipaq, a GPS and a Digital camera. These are its principal specific technical details.

Hike 300

Fig 3. Hike 300 Telemeter with palm PDA, GPS and Digital camera
Fig. 3 Hike 300 telemetro con palmare PDA, GPS e fotocamera digitale.

Survey Lab
P.O. box 6529
Wellington – New Zealand
Ph + 64 4 382 8064
Fax + 64 4 382 8205
info@surveylab.co.nz
www.surveylab.co.nz

Type: 905um (invisible infrared)
Eye Safety: Class 1 (21CFR1040-10)
Accuracy: ± 50cm
Range2-100 mt
INCLINOMETER
Range: ± 60°
Accuracy: 0,4° (from 0° to 30°); 1° (from 30° to 60°)
COMPASSOMPASS
Range: 0° to 359.9°
Accuracy: ± 1°RMS (level); 3°RMS (platform tilt 0°-30°); 4° RMS (platform tilt 30°-60°);
Resolution: 0.1°
TECHNICAL DATA
Size: 26.0cm x 11.0cm x 7.0cm [LxWxH]
Weight: 1,050kg
Display: Transflective TFT 65.000 colours 320x240 dpi
PDA
Processor: Intel Xscale 400Mhz
Ram 128 Mb SDRAM
Non-Volatile memory: system 48 Mb flash rom; storage256, 512 or 1024 Mb
Operating system: Microsoft Pocket PC 2003
Electrical
Battery Type: internal rechargeable LiPolimer
Battery Life: 8 hours / battery
Charging time: 3 hours max
Data I/O
USB 1.1
Bluetooth
Wi-Fi
GPS
12 channel parallel
frequency: L1C/A code and carrier phase
position accuracy: < 5mt (CEP) (single point; < 1 mt (CEP) (DGPS)
DGPS Real Time: RTCM-SC104
WAAS and EGNOS supported

Fig. 4 example of a palm computer PDA

Palm Computer PDA

The palm computer also called PDA is a lightweight instrument (max. 200g) pocketsize (max dimensions approx. 130x90x18mm) with a colour display (up to 65000 !), touch screen (you change the display with a stylus like instead of a mouse) with a screen 3.5 "- 3.8" across the diagonal and resolution of 240x320 up to 480x640 pixel (according to the model). The screen is very small but enlargement functions should make easy operation equally possible.
The most recent Palms provide for great autonomy in terms of rechargeable batteries (up to 12 hours) or allow battery substitution. The operating systems are different (but not unique, according to the model) actually mostly using Microsoft Windows Pocket PC within which the current version of OCAD may not be used. It's possible, however, that OCAD may be modifed for use in such environements.

The memory of these pocket computers varies from a minimum of 32 Mb up to 64/128 Mb ROM and 64/128 Mb RAM, with the possibility of expansion with various types of memory cards (SM/MMC/CF).
The most recent models are beginning to support Bluetooth or other technology which permit transmission of wireless data.
The prices run from Euro 300 up to Euro 900 according to the model.

Tablet PC

In reality, a portable computer (from 1 to 2.6 Kg) with all the effects, but the lightest model is composed of a touch screen with approx. A4 dimensions (from 10.4" to 14.1" with resolution of 1024x768 pixel). Some models also have a folding keyboard, with others you may connect the display to a workstation which also includes peripheral drives (keyboard, DVD player etc) The autonomy of the battery is rather limited but inter-change is possible. The operating system of such computers is Microsoft XP Tablet Edition which would supports the reading of OCAD version 8. Also with such models it is possible to integrate Bluetooth technology for the wireless connection of peripherals (including Telemeter).

Fig 5. A Tablet PC with integrated folding keyboard

Characteristics of an average Tablet PC
Intel Processor from 900MHz up to 1.7 GHz
Hard Disk from 20 to 60 Mb
Memory 512 Mb
Ports for USB, VGA, PC Card, slot SD, Bluetooth, 802.11b, IrDA, Wi-fi
Display video : nVidia GeForce, Chipset Intel 855GM 32/64 Mb,
maximum dimensions: 310x270x30
weight from 1 Kg to max 2.6 Kg
Price from – to: from 1.700 at 2.400 €

OCAD integrated with functions specific for Survey DAIT (OCAD DAIT)

The current version of OCAD v.8 does not support the technique (see following) of surveying polar co-ordinates [1] in an automatic mode, nor will it work in the Microsoft Windows Mobile Pocket PC system (the most widely available system on palm PDA). Therefore, OCAD must be supported by some other functions and instruments. To understand someone, it is better to read the following paragraphs :

- automatic interface with telemeter to acquire polar co-ordinates of points (distance, slope and azimuth) at every click of the instrument;
- particular linear symbol to trace planimetric distance of the contour integrated with the data of the " slope " available directly from the telemeter;
- rotation of the map base, after acquisition by the telemeter, of the azimuth through a rectilinear reference.

This version of modifed OCAD is called ***OCAD DAIT***

[1] Polar co-ordinates: differ from the map co-ordinates which identify a point half way between 2 perpendicular distances from the origin, the polar co-ordinates determine a point through direction and distance from a polar origin. The direction of our application should be the Azimuth and the pole a noted point on the map.

Functioning and Techniques of DAIT surveying

Surveying an object

Positioning an object (such as a boulder) is very simple and precise with DAIT. Ocad DAIT obviously must integrate a new tracing instrument for objects, that is in any case similar to the straight line tool when you click in points without drawing them with the mouse (the current version of Ocad 8 displays a line drawing window which requires the length and angle to be manually inserted).

We call this new tool ***Polar Coordinate Tracer .*** Therefore, these are the operations which the version of Ocad DAIT must support :

1. Select the polar coordinate drawing tool from the toolbar
   With the palm / tablet PC pen, click on the base map the starting position of the map-maker (eg. Path crossing[1] 1); this constitutes the start point of the tracking;
2. Select the symbol to be placed (eg. boulder) on the map from the table of symbols; Ocad DAIT expects the data from the Telemeter to position the point symbol;
3. Point the Telemeter at the object (eg. boulder) in such a way that the laser ray can fire, showing a red point at the top of it; click the acquisition button of the Telemeter ; the distance in metres[2] (precise within 10-15cm !!!) the slope and the degrees North of the direction (precision 1° !!!) is transmitted by a connection cable (or Bluetooth) to the palm / tablet PC; Ocad DAIT places the selected symbol at the relative position from the polar coordinates acquired by the Telemeter.

The precision of the data from the Telemeter is so very high that other triangulation is unnecessary ; with a single point it places the intended symbol on the map with maximum precision.

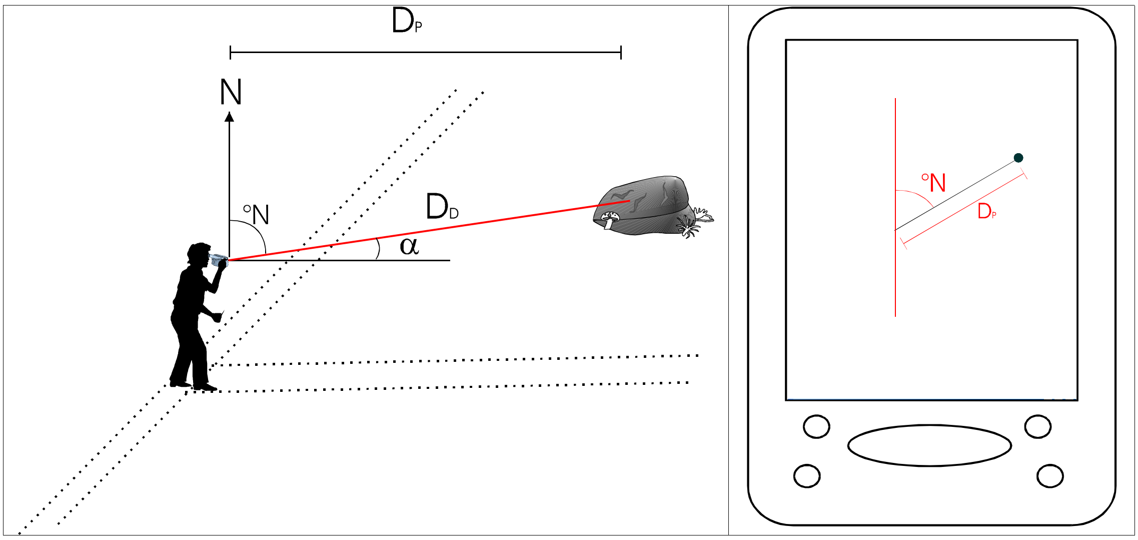


Fig. 6. Acquisition of the polar coordinates with laser Telemeter to position a object point on the map.

In the case of an invisible object to be on the map (eg a pit) it is possible to:

- point at an object very close by (eg. A tree at 1mt)
- plant a peg (eg. A telescopic pole with extremities of at least 10/15 cm x 10/15cm) at the object point or as close as possible (a pole)

In case there is insufficient visibility between the object point and the acquire point (eg. thick vegetation) it is possible to overcome this obstacle by making more points using trees or peg. In

[1] Although not advisable, it is possible to start a survey without a base map.

[2] The Telemeter directly transmits the primary data acquired from its sensors: distance, slope and azimuth of the subject; the Telemeter internally calculates the planimetric distance, otherwise Ocad DAIT must calculate itself with a simple trigonometric formula ($D_P = D_D \text{cotg}\ \alpha$) where D_P is the planimetric distance (horizontal) D_D is the distance surveyed by the Telemeter (oblique) e and α is the slope of the subject in respect of horizontal.

this case you need to utilise a linear symbol (see following paragraph " Survey of a linear element") and manually place the symbol at the end of the line which can later be cancelled.

Survey of a Linear Element

Surveying a linear object (eg. path) is likewise fast and precise with DAIT.
Obviously you trace the object considering it like a line as in traditional technology. Ocad DAIT provides a level of rounding much less accentuated in this case (each map maker chooses the basis of how much to cut the curve of the linear object[3]).

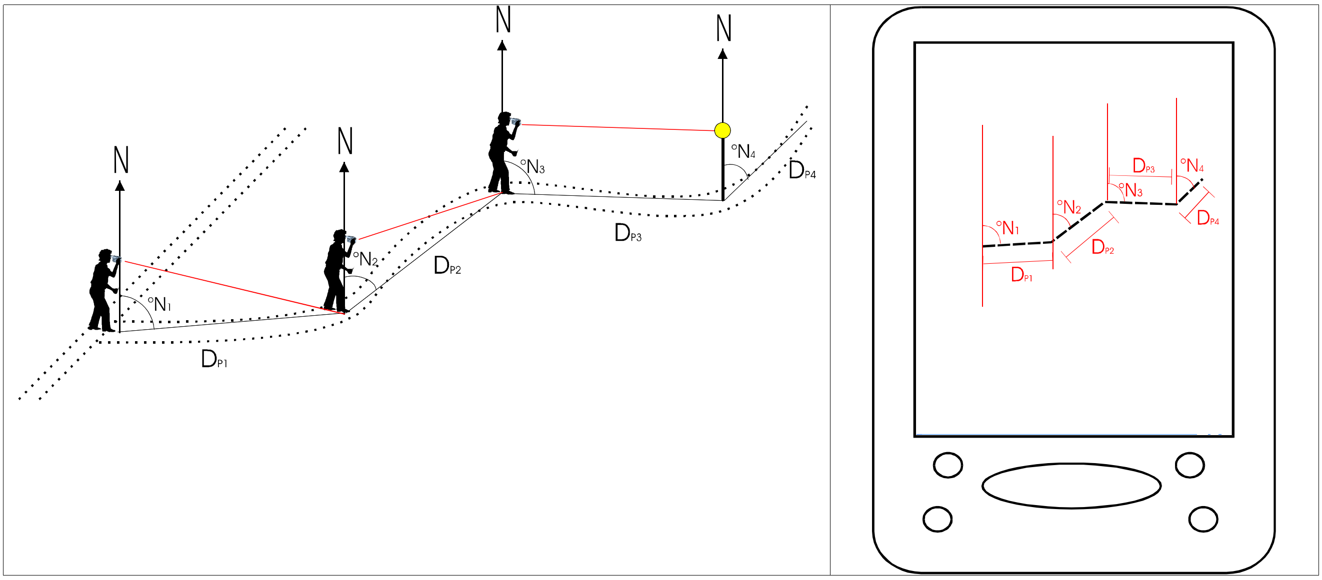


Fig. 7. Survey of a linear element using DAIT

These, therefore, are the operations which should be supported by the version Ocad DAIT :

1. selection of the polar coordinate drawing instrument from the toolbar ; such an instrument should have the characteristics of a freehand-drawing tool;
   with the palm / tablet PC pen, click on the base map/display, the position of the map maker
2. (eg. path crossing) ; this constitutes the departure pole of the line;
3. select the linear symbol (eg. path) from the table of symbols to draw on the map; Ocad DAIT expects the data from the Telemeter to position the first part of the line ; Ocad knows that the selection of a type of line from the symbols table, means the arrival of a subsequent line corresponding to the successive departure pole;
4. point the Telemeter at a point on the terrain on the axis of the linear object at an appropriate distance in a way not to cut too much the possible curvature ; visually memorise the exact point at which the red dot of the laser beam strikes the ground, click the data acquisition button on the Telemeter ; the distance in metres (precise to 10-15cm !), the slope and the degrees North of the direction (precision 1° !) is transmitted to the palm / tablet PC through the connection cable (or by Bluetooth); Ocad successively calculates the planimetric distance anologically for the placing of the object points and traces the first segment (light black line) in the direction (azimuth) supplied by the Telemeter; Ocad waits to trace a second segment;
5. repeat operation 4 until reaching the end of the linear object; Ocad DAIT should provide a signal to understand that the line is finished; such signal would be the Enter button on the palm / table PC generally placed below the display ; at the pressing of the Enter key , Ocad DAIT draws the line with the symbol selected at the start; using the polar coordinate drawing instrument like the freehand tool in the case of drawing a path, the outline will not be interrupted by the angles (unlike using the tool in the straight line mode);
   If the linear object we have drawn is in reality curvilinear (eg. path or contour) rather than a true and typical straight line (eg fence), then you need to transform the line into a Bezieres

[3] The mode of drawing of Ocad for the survey of such a line should be of the freehand type because in this way the nodes of the angle do not interrupt the outline (eg. in the case of the path symbol)

curve to allow the rounding of the angles; this is a manual function already in the current version Ocad (command Modify – To curve) but the predefined impositions of such a command over-deform the line ; It is necessary, therefore, that Ocad DAIT provides another command (Modify – To curve from polar coordinates) which puts the tangent handles much closer to some nodes and in the segment (every node must be transformed into a cusp) ; by this means the map maker can manually modify the curvature of the line tracing the tangent handles.

The point along the axis of the linear element (eg path or fence) can involve problems of precision of the point (eg lack of a precise point on the terrain); this is simply solved by :

- pointing at an object in close proximity to the end of the first rectilinear part (eg a tree at 1mt);
- planting a pole (eg telescopic peg with extremities of at least 10/15cm x 10/15cm);

Survey of Areas

To survey areas start with the linear elements following the border of the area and proceeding to fill it in. Nevertheless, with the system DAIT, it is also possible to use a *Radial Technique* from a central point, also if this is not always practical (Fig.8)

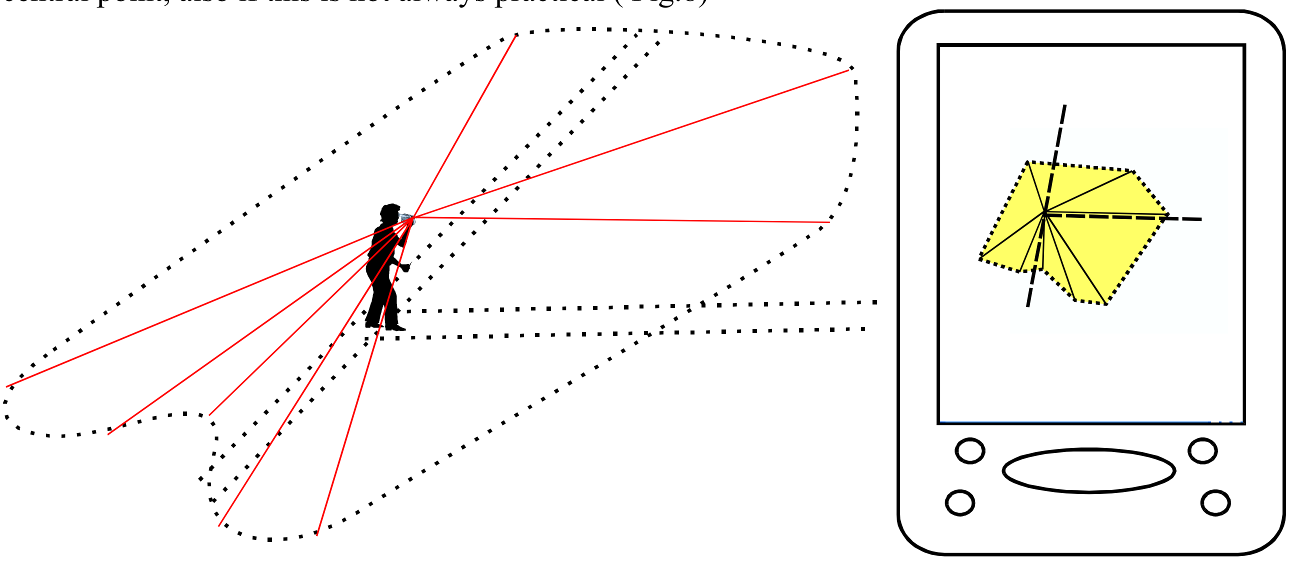


Fig. 8 One of two methods to survey of an Area with DAIT

Also in this case, Ocad DAIT must provide another tool called ***Radial Trace***. Here is the procedure:

1. Select the tool Radial Trace from the Ocad DAIT toolbar
2. with the palm / tablet PC pen, click on the base map /display the position of the map maker (eg. path crossing); this constitutes the pole of radiation of the points;
3. select the symbol of the area (eg field) to draw on the map, from the symbols table; Ocad DAIT waits the data from the Telemeter to position the first point of the border of the area; Ocad knows from the selection of the Radial Trace tool, that the point of arrival of the first point corresponds to the start of a line;
4. the Telemeter at a point to start the survey of the border of an area and click to acquire the data of distance (eg tree or otherwise an especially positioned pole); Ocad calculates the planimetric distance and places the start point of the border of the area; Ocad waits for the polar coordinates of a second point to unite it with a segment to the first point;
5. repeat the procedure acquiring more points of the border of the area until complete; at each acquisition, Ocad DAIT unites the last point with the previous one with a light black line;
6. At the end of the survey press the Enter key on the palm / tablet PC; Ocad closes the enclosed area, uniting the last point with the first and fills in the contained area with a symbol selected at the start (eg. yellow)

7. transform the line of the border into a Bezieres curve to allow the rounding of the angles with the special Ocad DAIT command (Modify – To curve from polar cordinates) as described in the paragraph tracing a linear element ; by this means the map maker may manually modify the curve of the line, tracing the tangent handles.

With the same technique / tool it is also possible to trace linear elements.
The radial techhnique is not advisable, where, from the point of radiation it is not fully possible to understand the variations in the form of the linear object which you want to survey.

Inserting the base map (if available) and its orientation

The North of the possible base map inserted in Ocad as a template to the palm / tablet PC must correspond perfectly with the North surveyed by the compass of the Telemeter. This directional alignment must be managed directly from Ocad by a command especially created for the DAIT (Template – Rotate Template with Telemeter). The following are the operations which Ocad must manage :

1. import the base map into Ocad
2. draw something with the straight line tool and a linear symbol (eg. blue line) over a rectilinear topographical element (eg. road). Such a line will have, for example ,the direction of 30° to the vertical on the display of the palm / tablet PC and Ocad takes this for granted;
3. with the chosen line, activate the command *template – rotate template with telemeter ;*Ocad prepares to acquire the degrees North of the road, from the Telemeter ; position yourself at the middle of the rectilinear road, and acquire the direction of the same ,pointing the Telemeter on the axis of the road at an appropriate distance (eg 100 mt), click the acquisition button on the Telemeter; the degrees North of the road (eg. 33°N) will be transmitted by Ocad DAIT through the connecting cable (or Bluetooth) to the palm / tablet PC (Fig. 9);
4. Ocad rotates the template in such a way that North on the Telemeter is turned perfectly vertical on the display of the palm / tablet PC. In practice, Ocad rotates the template of the difference between the effective degrees North of the road acquired from the Telemeter and the degrees North of the blue line previously traced (33-30 = 3° ; if the angle is negative = rotation is in the anti-clockwise direction);
5. cancel the blue line;
6. Verify the correct alignment selecting the symbol of the real topographical element (eg road) and draw the road with the technique previously illustrated (survey of linear elements). The symbol of the road is superimposed perfectly and parallel with that of the base map.

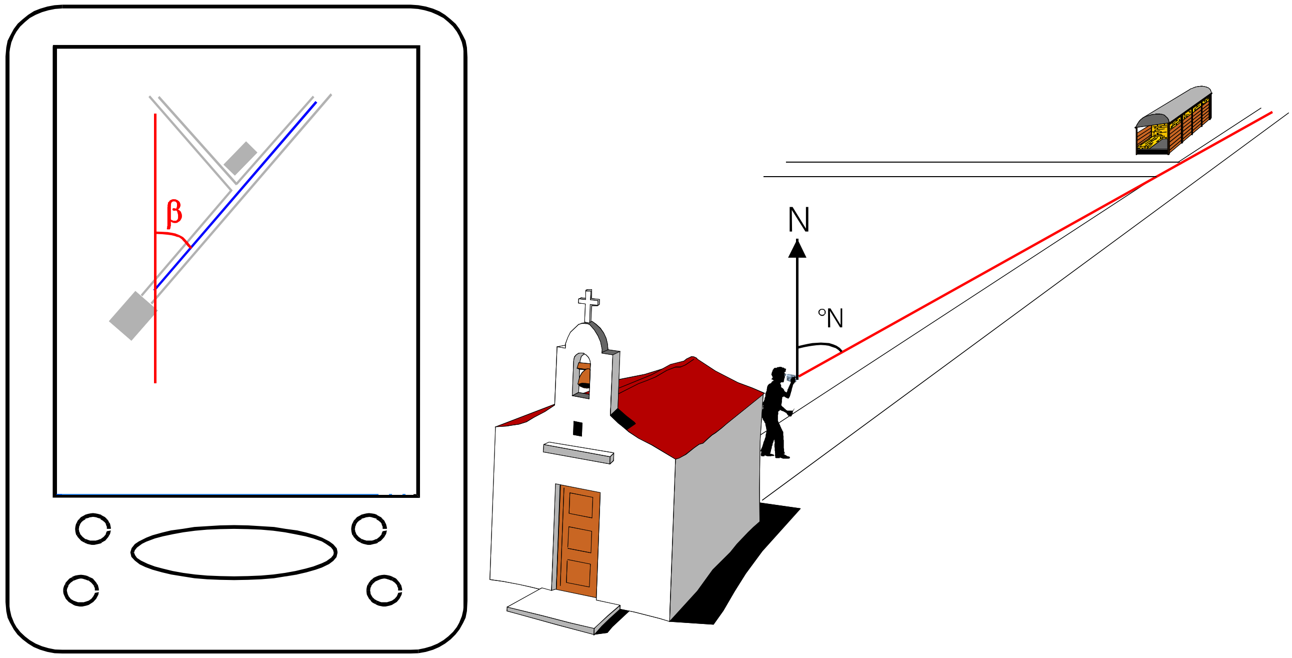


Fig. 9. Alignment of the base map with magnetic North surveyed by the Telemeter.

Survey of Contours

Tracing a Contour

Tracing a single contour with the DAIT system is rather simple and precise. In this case, however, good expert vision is required, to identify from the terrain the imaginary line of how a Contour is shaped and then it is a subjective interpretation. Nevertheless the instrumental precision of the Telemeter regarding the slope gives a hand together with another special function of Ocad DAIT (horizontally check).

In substance, proceed as if drawing a linear object. This is the procedure:

1. select the polar coordinate tracing tool from the toolbar ; with the palm / tablet PC pen click on the base map / display the position of the map maker (eg. path crossing); this constitutes the starting point of the Contour line.
2. select the Contour symbol to be drawn on the map, from the symbols table; Ocad DAIT waits for the data from the Telemeter to position the first part of the line ; Ocad knows from the selection of the type of line from the symbols table, that the line represents the departure pole for what follows ;
3. identify on the ground the stretch of the Contour that constitutes the first rectilinear part; point the Telemeter at a tree at the same height where you can see the Contour (in the absence of a tree use a pole) at an appropriate distance in a way that doesn't cut the possible curvature too much; visually memorise the exact tree which the first point is made; click the acquisition button on the Telemeter ; the distance in metres, the slope and degrees north of the direction is transmitted to the palm/tablet PC through the connecting cable (or Bluetooth); a special function of Ocad DAIT when selecting the Contour symbol shows in a window (*horizontally check*) if the slope of the point is not horizontal (+/- a certain chosen range of inclination, eg.: 3°);
4. pressing the Delete key in this window cancels the data and requires the point selection to be remade searching for the highest precision; if the horizontality of the point is within the range imposed, then Ocad DAIT calculates the planimetric distance anologically necessary for positioning the linear object and traces the first segment (light black line) in the direction (azimuth) supplied by the Telemeter ; Ocad waits to draw a second segment;
5. repeat operation 3 until adding the final point of the Contour to be drawn; push the Enter button on the palm / tablet PC; Ocad DAIT, as with the other linear objects, at the pressing of this key, draws the Contour in the form of a angular line;
6. Transform the angular line into a Bezieres curve to allow the rounding of the angles with the special Ocad DAIT command (Modify – To curve from polar coordinates) as described in the paragraph Tracing a linear element ; in this way the map maker may manually modify the line tracing the tangents handles.

Tracing Parallel Contours (planimetrically equidistant)

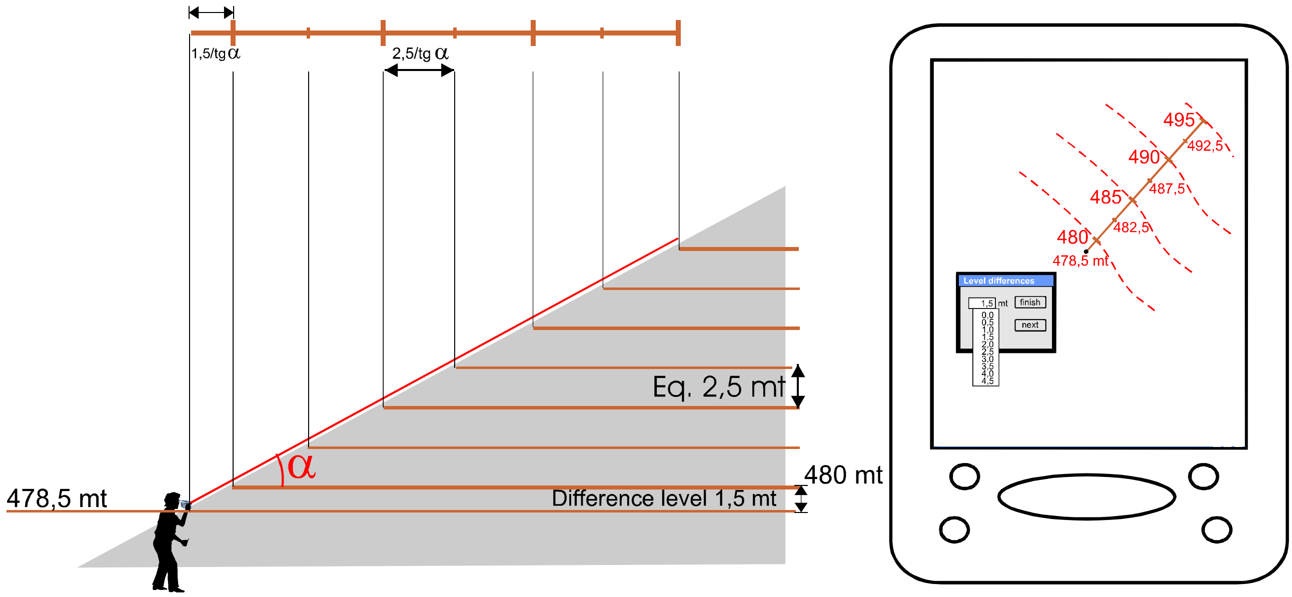


Fig. 10. The tool Draw Planimetric Contours uses the electronic CLISIMETER of the laser Telemeter to automatically draw in Ocad the distance between Contours.

This function is extremely useful if starting without a base map or one very imprecise in regard to Contours (eg. when the base map has equidistance of 10 mt or more, instead of 5 mtrs). Practically this special function of OCAD DAIT allows to draw on the map a series of equidistance contours along an uniform slope (rectilinear profile).
The tool which Ocad DAIT will add is similar to the symbol of the railway line except brown in colour and is not printable if not optional. Each dash corresponds to the passage of a normal Contour and auxilliary Contour for the subsequent dashes (therefore equidistant vertically at 2.5 mtrs) along the line of the slope[1]
The distance from one dash to another is a function of the slope as well known to each expert orienter (closer Contours = steeper slope).
We call this particular symbol *Planimetric Contour Line (pcl)* and the drawing tool *Draw Planimetric Contours.*

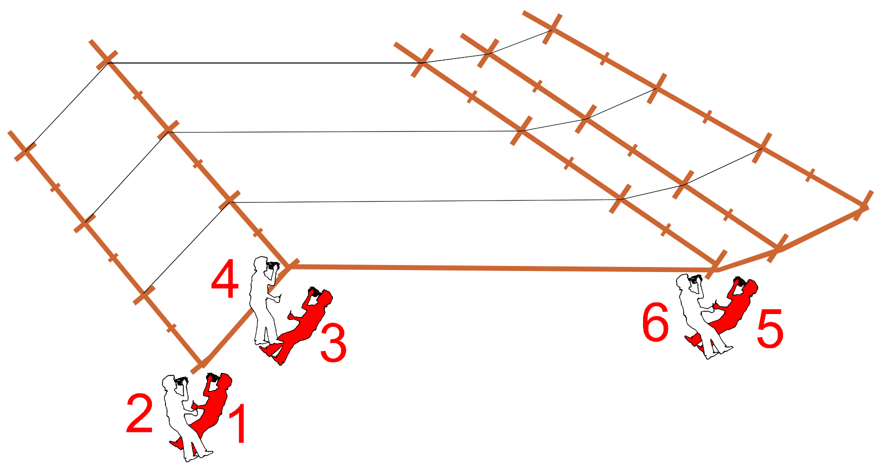
This is the procedure (Fig. 10):

1. Select the special tool *Draw Planimetric Contours* from the toolbar.Automatically, Ocad DAIT selects the special symbol described above whose characteristics will shortly be clear. It is not necessary therefore to select any symbol from the symbols table. Ocad DAIT waits for the data from the Telemeter ;
2. point the Telemeter along the slope parallel to the terrain along the greatest slope at a distance where the slope stays uniform ; as already described it is possible to point at a tree at the height of the terrain level with the height of your sight / or at a pole ;
3. Click the Telemeter button, which transmits to Ocad DAIT the data of distance, azimuth and slope (α); Ocad calculates on the basis of this information, the planimetric distance (horizontal) between the Contours (at 2.5 mt levels) this being a function of slope surveyed by the Clisimeter in the Telemeter. Practically OCAD DAIT calculates the equidistance in mm between the dashes of the special symbol (pcl); every dash corresponds at the passage of one contour (normal or auxiliary)[2] .

[1] The dashes respective to a normal Contour and those of an auxilliary are graphically different in thickness
[2] Also in this case use a simple trigonometric calculation: the planimetric equidistance (E_p) is found by the formula: E_p = 2,5 mt /tg α , where α is the slope surveyed by the Telemeter internal Clisimeter .

4. Before drawing such a symbol Ocad DAIT must open a dialogue window in which it demands the differential value of the initial start point[3]. Such a value is fundamental for the correct calculation of the passage of the Contour along the slope. An example will clarify better.
   Supposing we are at a height of 478.5 mt above sea level (surveyed from a point noted on the base map or at a precise altimeter) and want to trace the slope of a hillside (having a parallel and uniform Contour for simplicity) ; point the Telemeter and acquire the data as described above; Ocad DAIT needs to know which is the point through which there is a Contour in multiples of 5 mt (not even of 2.5 mt) other than the known height of 478.5 mt above sea level ; the multiple of the 5 mt level officially immediately above, however, is 480 mt ; therefore in the dialogue window mentioned above, digit 1.5 mt as the difference between the real measurement height point and the multiple immediately above it ;Ocad DAIT calculates, on the basis of the slope acquired from the Telemeter, not only the planimetric distance between the Contours (that is the distance of the transverse dashes) but also the distance of the first dash of the planimetric contour line (pcl) from the start point (see Fig. 10).

At first sight, such a tool may not seem very useful for those accustomed to drawing traditional Contours. In reality it has enormous potential. If you think of the example of tracing an undulating hillside also having an un-uniform slope (but however a rectilinear profile) Fig. 11 following, illustrates the point better than words.



[3] It is possible also that the dialogue window allows a series of values between 0,0 mt and 4,5 mt (with steps of 0,5 mt: 0,0 - 0,5 - 1,0 - 1,5 - 2,0 ……).

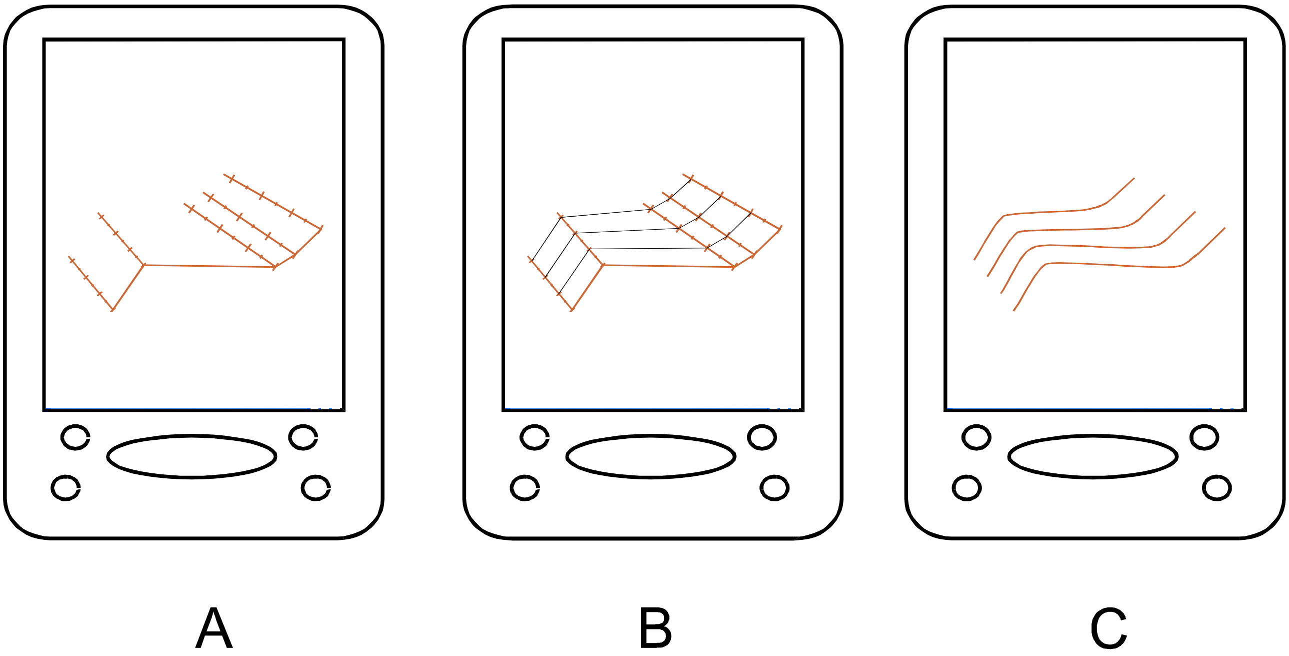


Fig. 11 Tracing the planes of a hillside with the DAIT system.

In practice you do the following :

1. point the Telemeter along the maximum slope at the beginning of a hillside and acquire the planimetric contour line (pcl) as mentioned above with the tool Draw Planimetric Contours
2. trace the first part of a Contour which constitutes the base of the hillside to survey using the tool Draw Polar Coordinates and the Contour symbol
3. at the end of the initial interval of the Contour acquire another slope using the tool Draw Planimetric Contours
4. similar to point 2, trace the second interval of the Contour constituting the base of the hillside to survey, using the tool Draw Polar Coordinates and the Contour symbol;
5. repeat the 3rd operation at the end of the second interval of Contour
6. etc, etc until the end of the hillside (Phase A);
7. Manually join the lines corresponding to the Contour symbol (using the palm stylus and the freehand drawing tool or straight line) ; this shows the trend of the Contour of the hillside (Phase B);
8. Transform into a curve and round as described previously at the end of the paragraph “Drawing a linear element” (Phase C).

A second technique to survey a hillside with a rectilinear profile, which gives understanding of the enormous potential of the system DAIT, consists of the ability to acquire more planimetric Contour lines from the same point without pointing at the maximum slope but doing more acquisitions radially (see Fig 12.)
Also in this case successively joining the stretches with more *planimetric lines cdl* you obtain a portion of the map with the Contours

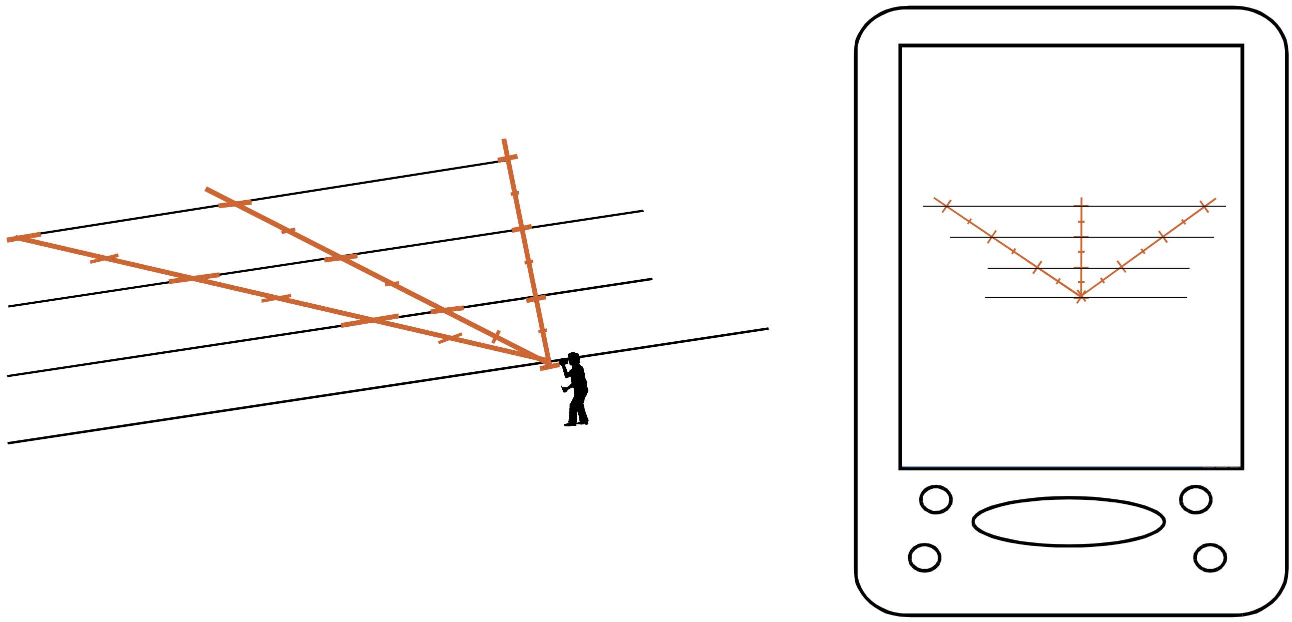


Fig. 12 Tracing the plane of a hillside with the radial method.

Nel caso il profilo della costa non fosse rettilineo è possibile tracciarlo considerandolo una spezzata dai tratti a pendenza uniforme ciascuno (vedi fig.13). Unendo questa tecnica alle precedenti è possibile tracciare le curve di livello con estrema precisione di ampie zone di coste anche non avendo alcuna carta base.
In the case of a hillside which has not rectilinear profile, it is possible to trace it considering a line of the intervals of some uniform slope (see Fig 13.) Joining this technique to the previous it is possible to draw the Contour with extreme precision of ample areas of the hillsides also without having a base map.

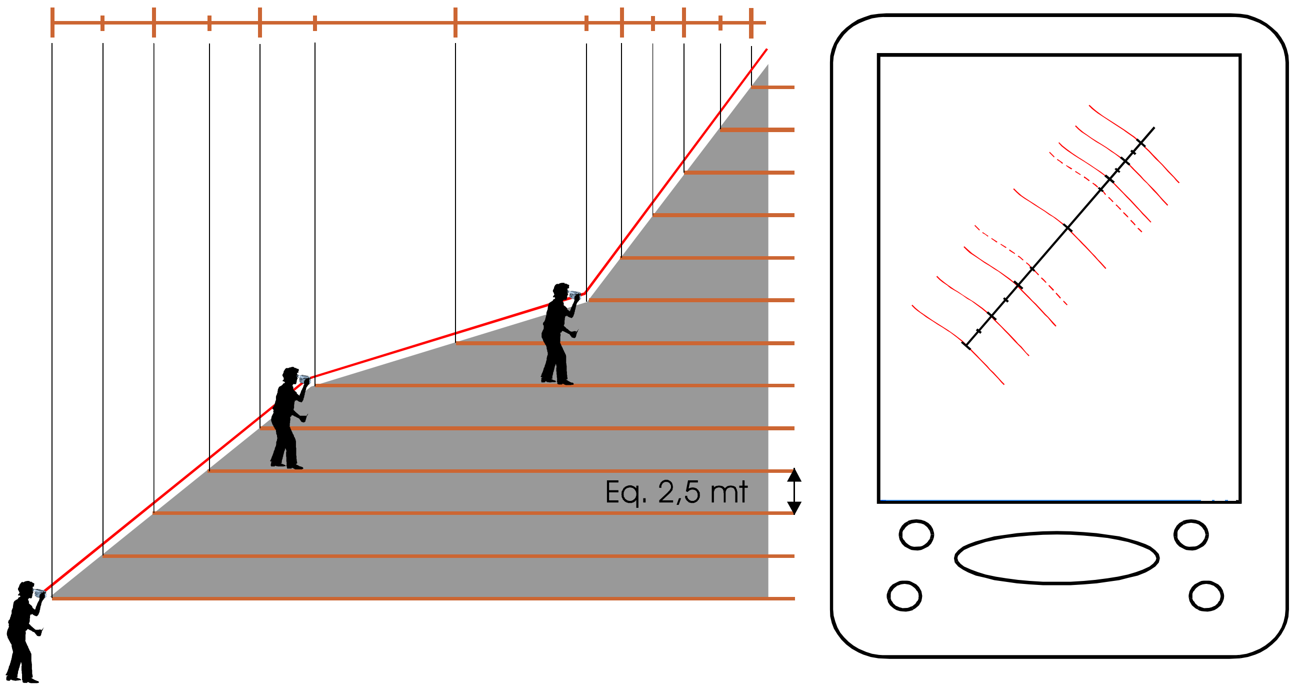


Fig. 13. drawing the planimetric Contour of a non-rectilinear hillside profile.

Drawing a valley or a nose

The drawing of a valley or a nose with the DAIT method and the tools at our disposal from the relative version of Ocad, notably simplifies the drawing of these very typical ground formations, that is valley and nose, also starting without a base map.

In substance, the technique is the following :

1. draw using the tool *Draw Planimetric Contours* the depth of the valley (or the crest of the nose) following its trend even if not rectilinear, considering it, that is, like a line (Fig. 14.); tracing consecutively more cdl planimetric lines, Ocad DAIT always considers the remaining balance of the straight line drawn, as the initial value of the balance of the successive pcl; in fact the initial dialogue window in which is requested the starting value, shows two buttons:
   - Finish (in the case of a single line) and
   - Continue (in the case of successive lines),

   To end the operation and draw the particular symbol of *Planimetric Contour Line,* press the Enter key on the palm / tablet PC ;

   Ocad DAIT draws in this way a line at the base of the valley in which transverse dashes correspond to the point of passage of curvature (vertices of inflexion) of the Contour;
2. draw the banks of the valley (or of the nose) with the same tool Draw Planimetric Contours
3. Join the dashes of the same value manually with the tool freehand or straight line with the Contour symbol (Fig. 14B.) transform into a curve and round as previously described. This creates the profile of the depression described as a Contour (Fig. 14C.)

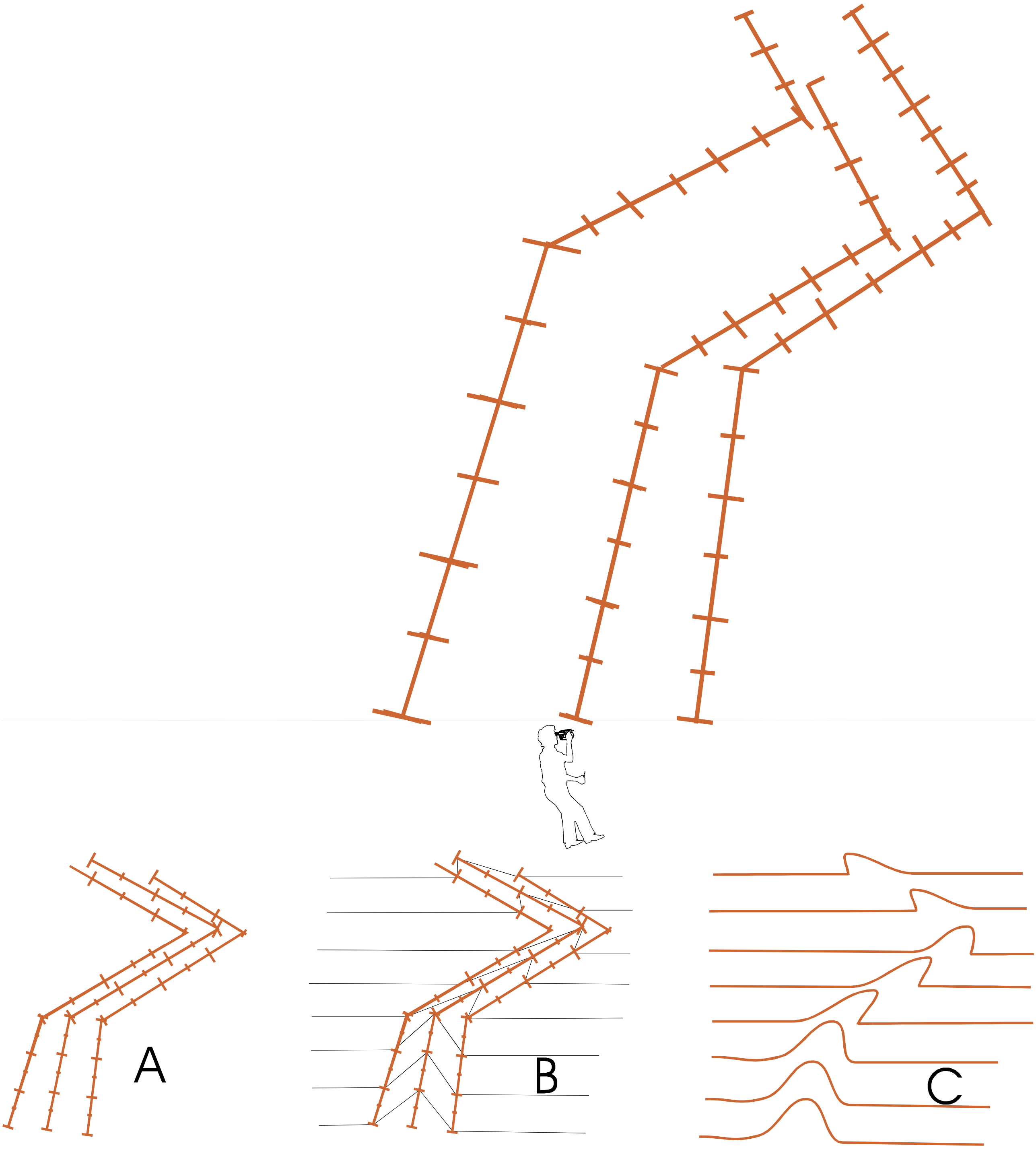


Figure 14. Drawing the plane of a valley with the system DAIT.

Conclusions

This is, theoretically what DAIT system can do. It is possible that in practice and with study, one may be able to find other techniques which could accelerate the survey time and render these surveys more precisely.

The problems to resolve for the practical realisation of the DAIT system, are the following :

1. implementation of Ocad in the environment Microsoft Windows Mobile Pocket PC and predispose it for the functions described above interfacing with the 3 types of data which the Telemeter can provide (distance, inclination and azimuth); this is the thing needed most immediately and which constitutes a big obstacle to practical experimentation; in the absence of such transformations of Ocad, it would be necessary to develop a new

programme for cartography from other companies with the above mentioned characteristics but this would only be a waste of time;
2. Research in the market of a Telemeter with the stated characteristics but at the most accessible price ; the high initial cost of the present Telemeters[1] 1 (although ammortisable over the first maps and saving time as a consequence) can in any case be absorbed by a consortium of sports societies which share the instrument, by the regional committees and/or federations which put it at the disposal of affiliated groups;
3. Experiment with everything practically, because that which should be possible in theory may not be possible in practice ; on the other hand practice may suggest new solutions and new techniques.

I believe I have launched a stone into the orienteering sea. From now on the professionals of Ocad, cartographer, electronics, computers and/or simple aficionados may translate these ideas into practice.
I urge them to overcome their natural fear of the new, which could above all, strike the ones who for years have surveyed with traditional methods. The system DAIT could give new impulse to orienteering map making for the diffusion of our sport, demolishing the costs of production and raising the precision of the maps in a way that renders less dependence on the subjectivity of the map maker. The relative simplicity and precision of the system DAIT shall allows someone with a minimum of familiarity with computers and with digital drawing, to produce good quality maps.

The Future

The future ? This is a preview of images to come.

Fig. 15. Hypothetical Future for the system DAIT:
a helmet with integrated Telemeter

A helmet with which it is enough to simply walk, look at objects and press a button.
OR BETTER STILL!! The commands, the selection of symbols and the tools made by voice recognition. All this may be very futuristic; but with the speed with which electronic technology travels, maybe not so far off.........

Roberto Biella
robiella@alice.it

[1] At least for the Telemeters which I have personally succeeded in finding in the market.