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NEW TECHNOLOGIES IN MAKING ORIENTEERING MAPS

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Abstract

Orienteering maps are special type of maps, which are mostly made by non-professionals. The technology of making these maps (fieldwork, drawing) has considerably changed in the last 20 years.

Base maps can be made by digital photogrammetry or airborne laser scanning technology, but the methods of creating state topographic maps (which are used as base maps of orienteering maps) have also changed in the past few years. The accuracy of these maps has also increased to help the users.

In the fieldworking, we can use GPS devices (sometimes with real-time differential corrections) for measuring points and lines. GPS devices are available for more than 20 years, but only in the last few years they became used in fieldworking as regular techniques.

For faster, but not very accurate distance measurements, we can use ordinary laser distance finders.

The orienteering maps are drawn by computer software. In some countries, these were the first types of maps which were created only by computer methods.

Orienteering maps are good indicators of how the new cartographic techniques are easily applicable for non-professionals or how widely they are used as everyday techniques.

This paper summarizes the milestones of the development of these techniques to understand how we can make these methods and devices more user-friendly and simpler.

Orienteering maps are one of the very few types of maps that have the same legend all over the world. Theoretically, there are no national deviations – although practically there can be some, but these are not relevant and/or they are only used at local events. Every country inspires their mapmakers to use the international orienteering map specifications not to make disadvantages for the national competitors.

Orienteering maps are special products, because the mapmakers have to be familiar not only with the map specifications, but also with the rules and traditions of the sport in order to make them suitable for orienteering sport. To be a cartographer only does not guarantee that we can make excellent or even suitable orienteering maps. It is more important to be an experienced orienteer.

Generally, the mapmakers of orienteering maps are not professional cartographers. To help their work or even to make their work possible, they have to use basemaps, which can be normal topographic maps or special photogrammetric plots.

Basemaps for orienteering maps

Even if we have good access to up-to-date basemaps, mapmaking for orienteering requires a lot of real fieldwork (made by orienteers), much more than in any other ordinary (topographic-like) maps. Depending on the quality of the available basemaps, the mapmakers regularly spend 20-30 hours on every square kilometre (foot-o maps). The quality of the basemaps affects considerably the time mappers spend on the terrain. We can calculate the most effective method: spend more money on good base maps or spend more time with fieldworking, but sometimes the time factor is also very important.

State topographic maps can be basemaps of orienteering maps if the scale is appropriate. In many countries, the largest possible scale of state topographic maps is too small, so in these countries the orienteers are looking for alternative solutions.

The general scale of normal (foot-orienteering maps) is 1:15 000, which is usually enlarged to 1:10 000. The smallest possible scale of base maps that can be appropriate for orienteering mapping is 1:10 000 or even better if it is 1:5000. In many countries, these scales are not available for all parts of the country (especially not for forest areas, which are the common scenes of orienteering events).

For other orienteering disciplines (ski and mountain-bike) a little bit smaller scales (1:20 000) can be also appropriate, because the perfect accuracy of each feature is not so much

important. The competitors in ski-orienteeing and mountain-bike orienteeing events can only use the path/track system, so the accuracy of other elements is not so much relevant (they may not be represented at all if they are not visible from the paths/tracks). In less complex terrains, even 1:20 000 scale state topographic maps can be used as base maps of these disciplines.

Trail-orienteeing uses the map specification of the shortest form of foot-orienteeing, called sprint orienteeing. This form of foot-orienteeing events was invented to be as media-friendly as possible: we use mostly urban or park areas. The courses are very short (12-15 minutes), and the number of features is much more than in normal forest areas. To represent such complex areas and make legible maps for very fast events, we need larger scales (1:5000 or 1:4000) and a little bit different legend (more symbols in plane shape and less point symbols). For sprint maps, the base maps can be cadastral maps (1:1000-1:5000 scales) or very large scale state topographic maps (1:5000). Because these terrains are mostly urban or park areas, we have a good chance that these areas have already been surveyed at very large topographic and cadastral map scales.

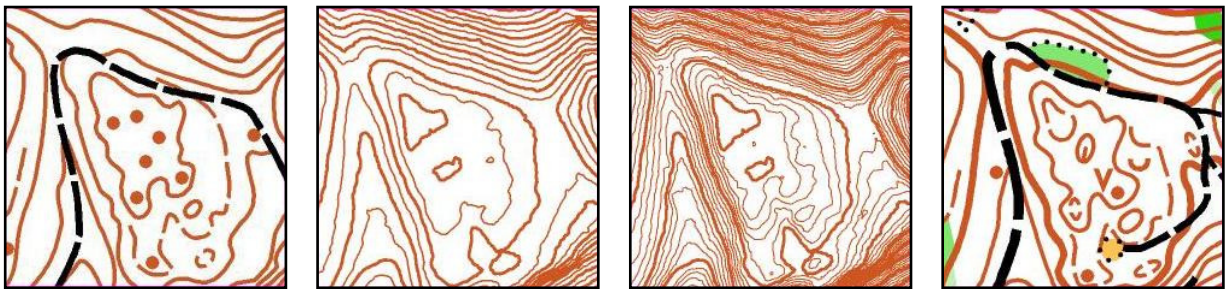
In some countries, where state topographic and cadastral maps are not available at suitable scales, the orienteers are looking for alternatives. Air photos or orthophotos are commonly accessible in these countries and special services are offered for making stereo photogrammetric plots with detailed contour lines (in Scandinavia, some firms are specialised on creating basemaps for orienteeing).

Sometimes, the combination of air photos (or orthophotos) and topographic maps can be an alternative: get contour lines from state topographic maps and all other data from the air photos.

Airborne laser scanning is a remote sensing technique that measures the round-trip time of emitted laser pulses to determine the topography of the Earth's surface (an active sensor measures the distance from the sensor to the ground from which the laser beam is reflected). Airborne laser scanning is a rapidly growing technology, which has initially been conceived for topographic mapping.

The distance data alone cannot give the ground position. Aircraft position is calculated with high accuracy using a combination GPS data both on the aircraft and on the ground. Aircraft acceleration and three-axial attitude data are measured by a special unit. Furthermore, direction data of laser beam are measured in the sensor onboard. These data are combined to calculate the three-dimensional position on the ground.

One advantage of airborne laser scanning compared to classical photography is that laser scanners are not dependent on the sun as a source of illumination (good air photos for orienteering maps can only be taken in certain weather and light conditions), the interpretation of laser scanner data is not hampered by shadows caused by clouds or neighbouring objects. If we use a precise digital terrain model, we can get more detailed relief information even in the case of dense vegetation. The technology can provide information not only about the illuminated top layers of the forest canopy, but signals from the surface can also be processed. Airborne laser scanning is a promising technology for gathering topographic data, especially in forested areas in a short time. This technology could be ideal for orienteering maps, but actually the technique is not wide-spread enough (not easily available in every country) or sometimes it is simply too expensive for orienteering map projects.



Photogrammetric plot *Airborne laser scanning (2.5 m DTM)* *Airborne laser scanning (1 m DTM)* *Orienteering map*

Comparison of various basemaps and the final orienteering maps (GLOOR, T.-HOHL, T., 2005)

Advantages of laser airborne scanning for orienteering maps:

- Saving of time in the terrain because of its availability without interruption and its preciseness (used in few countries only at the moment).
- Time-consuming work to find suitable photogrammetric pictures is not any more necessary.
- Significant reduced costs compared to photogrammetric base maps (if the raw data are already available).
- Combination with orthophotos is easy.

The only disadvantage of laser airborne scanning is that detailed contour relief of raw data could easily lead to an overcrowded and poorly generalized map image.

GPS in orienteering mapping

GPS devices are more commonly used during fieldworking. Using these devices makes a special problem in every country. Orienteering maps are not regularly “georeferenced”, which means that only very few of these maps were fit to known projections and/or datum. Theoretically, the orienteering maps used the same projection/datum as the original base maps, but as the time went on and the old maps were updated, new areas were added, and more and more minor distortions were incorporated into the maps. Practically, if we try to use GPS measurements and fit them into the orienteering map, we have to “georeference” the orienteering map first. The “unreferenced” orienteering maps were suitable for the events, because the inaccuracies were distributed on the whole area of the map, and these failures do not affected the navigation of the competitors who use only the orienteering map and compass on the terrain. Absolute positional accuracy is of little significance compared to the relative accuracy and proper representation of the terrain shape and features. Coordinates are not indicated in orienteering maps, and GPS does not have a role in classic orienteering (according to the competition rules, external help during the events is prohibited for the competitors).

“Georeferencing” is a time-consuming process, and it requires some technical knowledge. So orienteers need experts to help the “georeferencing”, but they do not have too many and they cannot afford this process. Even in the most developed countries, this process is going on very slowly, because the quality of old-fashioned orienteering maps is still good enough for orienteers and the use of GPS devices do not reach the critical value yet.

The number of orienteering mapmakers does not increase. They may have less and less time for fieldworking . Using GPS may help them to make their work more efficient.

What are the main advantages of using GPS?

- They are definitely more accurate than traditional mapmaking techniques (pace counting, bearing).
- Absolute positions are very helpful to improve mapping and to save minimum 25% off the fieldwork time.
- It is easy to see the basemap errors and uncertainties.
- Sharing mapping work with non-mappers: we can ask “simple” orienteers to collaborate in measuring; they may help to complete the basemaps. It is especially

useful on terrains which are frequently used for training, where the orienteering activities are continuous and orienteers visit all parts of the terrain.

Differential GPS correction gives advantages (more precise measurements), but requires more skills (devices) and probably more investment. GPS can be more widespread in the near future, when GPS chips will be built in mobile phones (which may help to reduce the price of more advanced GPS devices) and new systems (like Galileo) will be operated. For orienteering mapping, the real-time differential correction is not essential, but post-processing can be useful. Nevertheless, the general accuracy of semi-professional GPS devices is already good enough for orienteering mapping if we are familiar with the system.

Professional orienteering mapmakers have a different approach to the GPS technology:

- A GPS device is used in an early stage of the fieldwork; however, if we have a good base-map, it is not that important whether we use GPS or not.
- A semi-professional GPS receiver is used in the initial stage of mapping. The mapmaker covers the terrain with the GPS receiver, recording everything that looks worthy, adding extra data: paths, walls, all kinds of point and line features. Differential corrections are used as post-processing, and the data can be imported into the drawing programme. This enhanced map will be used as a basemap of the fieldworking.
- On-line differential correction is used on the terrain with the orienteering map drawing software on a wearable PC with a sunlight-readable screen. The main disadvantage of this hardware is not only the price, but the lack of long time lightweight power supply (mappers regularly spend 8-10 hours on the terrain).

Mapmakers can use other special devices on the terrain, like a laser range finder, a clinometer, but using these devices are not wide-spread and these devices do not effect the process of mapmaking dramatically. Using these devices may increase the accuracy of terrain measurements or may shorten the time of measurement. For example, using laser range finders can shorten the process of distance measurement: the mapmaker does not have to walk the distance as in normal processes (pace counting or GPS measurement). These devices must be small enough, easily usable on the terrain even in difficult weather conditions.

GPS is also used in the most important orienteering events to track the route of competitors during the races. On-line or (nearly) real-time solutions are already possible, but the technology is too expensive and too complicated for every-day use.

Drawing orienteering maps

The very limited number of symbols in orienteering maps made it relatively easy to create formerly-hand-drawn orienteering maps by computer. The first vector based general graphic software and the first GIS software was released at the end of 80's. These software products were not able to produce orienteering maps – or it was extremely difficult for non-professionals to draw all symbols of the orienteering map legend; some orienteers who have worked in these areas have drawn few orienteering maps with these software).

Orienteering maps are special, because the text features are not essential elements of the map. These elements can be supplementary, but they do not really increase the usability of the maps for the competitors. This fact made it relatively profitable to create a special orienteering map drawing software. The Swiss Hans Steinegger released the first version of his OCAD software in 1988-89, and nowadays about the 95-98% of orienteering maps are drawn by this software all over the World (few orienteering maps are drawn in general graphic software Adobe Illustrator). OCAD is now map production software sold in more than 60 countries and it is not anymore used only for drawing orienteering maps. The professional version is able to create other types of maps and is able to handle GIS files. The user-friendly environment of the OCAD software makes the map drawing relatively easy even for beginners, who are not familiar with any type of computer software. In some countries, orienteering maps were the first type of maps which were created only by computer methods.

Orienteering maps are good indicators how the new cartographic techniques are easily applicable for non-professionals or how widely they are used as everyday techniques. The map production technique has dramatically changed since the beginning of 90's. Orienteering maps were hand-drawn products, but within some years, in every country, the orienteering maps were drawn by computer. Since the middle of 90's, nearly every country created (drew) all orienteering maps by computer.

The next milestone of drawing the orienteering maps is not so remarkable. The development of colour printing technologies, the price reduction of good quality colour

laser printers made the colour printing technology more affordable. The number of offset printed maps is continuously decreasing and the number of non-offset printed maps is increasing. The main factor of this change is not simply financial, but the opportunity to make the very late updates in the maps and/or control the whole printing process by the mapmaker.

It is clear that the quality of spot colour offset printed maps are the standard and that the non-professional colour printers are not able to reach this quality (thin contour lines are not sharp enough with colour laser or inkjet printers). Sometimes the two methods are combined: namely, the maps are offset-printed, but the competition courses are overprinted by colour printers (which makes the map sizes standardized to A4 or A3 sizes). The continuous development of colour printing technologies will continue and the quality of digital printed maps can approximate the quality of spot colour offset printed maps. The Map Commission of the International Orienteering Federation is continuously monitoring the development of colour printing technologies (see <http://lazarus.elte.hu/mc/> for more details).

Summary

New techniques are useful only when we can improve the quality of our products or we can make the mapmaking process faster or more efficient. The generalization of orienteering maps is extremely important to make competition maps as legible as possible in running speed. It is a danger of these new technologies to add more and more details to the map if we can enrich the basemaps with these details to inspire the mapmakers to transfer these features from the basemap to the final orienteering map.

The complex application of available techniques can be the best approach: depending on the terrains and the available basemaps, the mapmakers have to collect all available information and use the most relevant ones. The technologies themselves, however, are not enough: the generalization process of orienteering maps cannot be automatized, and without orienteering practice this work cannot be done at the proper level. It is no matter what kind of future techniques will be invented, making orienteering maps will maintain the classic job of fieldworking.

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