ISOM 201x (final draft)

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Introduction

It is the aim of the International Specification for Orienteering Maps (ISOM) to provide a map specification which can accommodate the many different types of terrain around the world that are suitable for orienteering. These specifications should be read in conjunction with the rules for International Orienteering Federation (IOF) orienteering events. For IOF events, deviations from the map specifications are permissible only with the sanction of the IOF. Other orienteering disciplines (mountain bike orienteering and ski orienteering) and formats (sprint) have separate map specification, but the ISOM is the basis for the other specifications.

The development of orienteering maps reflects the needs of the sport and the technology available to produce them. In the very early days, at the end of the 19th Century, state topographical maps at very small scales (e.g. 1:100.000) were often used. These were gradually produced at larger scales and additional detail was added. Aerial photographs and colour printing improved the accuracy and legibility of maps. This lead to the production of special purpose orienteering maps in the 1950s. In the early days of international orienteering, the contents and symbols of orienteering maps varied from place to place. To ensure fair international competitions, standardisation was necessary, and this triggered the creation of the ISOM. The first official version was published in 1969. In ISOM1972, green was introduced to show runnability, and orienteering maps started to look very much like they do today. Fortunately, the ISOM has been very well received and most national federations have applied the ISOM also for maps used in local events. The ISOM now specifies about one hundred different symbols.

Digital cartography entered the stage in the 1990s. Up to that time, maps had been drawn with pen and ink or scribed onto film. These were then copied to printing plates, one for each colour, from

which the maps were printed. Digital cartography has enabled greater precision in drawing and easier modification of maps. Unfortunately, it has also helped mappers to overload maps with too much detail.

Other technological developments have also influenced orienteering mapping. Photogrammetry and, more recently airborne laser scanning (or LiDAR - light detection and ranging) has provided better base maps. Satellite navigation systems (GNSS) can be used to provide precise locations during fieldwork. Printing technology is evolving and digital four-colour printing has provided new challenges for orienteering map printing. New types of paper (including waterproof paper) affect the printing process.

The previous ISOM version was published in 2000. Since then there have been some technological developments and there have also been some developments in the event programme. These developments have been taken into consideration when revising the ISOM. However, the basic requirements have not changed. Map legibility is still the most important aspect of an orienteering map. In the process of producing a readable map, generalisation is the keyword. This means that the mapper always must deal with selection, simplification, displacement and exaggeration.

Clever generalisation is necessary in order to ensure that maps are readable and suitable for orienteering competitions. The orienteering map is read whilst running fast through the terrain, and the perceptive capabilities of the human eye and brain have their limits.

Conventions

Several words are used to signify the requirements in this specification:

- *Must / Shall / Required* mean that the definition is an absolute requirement.
- *Must not / Shall not / May not* mean that the definition is an absolute prohibition.
- *Should / Recommended* mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- *Should not / Not recommended* mean that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour / action described with this label.
- *May / Optional* mean that an item is truly optional.

General Requirements

Orienteering and the map

Orienteering is a sport in which the competitor (orienteer) completes a course of legs between control points in the shortest possible time, by navigating aided only by map and compass. As in all forms of sport, it is necessary to ensure that the conditions of competition are the same for all competitors.

From the competitor's point of view, a legible and accurate map is necessary for a qualified choice of route and it enables them to navigate along the route chosen to suit their navigational skills and physical abilities. However, skill in route choice and map reading loses all meaning if the map is not a good representation of the ground - if it is of poor legibility, inaccurate or out-of-date. In the ideal case no competitor should gain an advantage or suffer a disadvantage because of faults on the map. For an international event the map must be up-to-date in all parts which could affect the end result of the competition. If it is not up-to-date it must be improved.

The steepness, elevation and shape of the landforms is essential information and is shown using contours. Identifying anything which impedes progress is crucial to the orienteer: cliffs, water,

dense vegetation. The path and track network shows where the going and navigation is easiest. A detailed classification of the degrees of hindrance or good going helps the competitor to make the right decisions.

The aim of the course planner is a course where the deciding factor in the results will be navigational skill. This can be achieved only if the map is clear and legible under competition conditions and sufficiently accurate, complete and reliable. Controls are important building blocks of a course. Choice of sites, placing of the markers, checking their positions, and locating controls in competition, all put definite demands on the map. The better the map the course planner has, the greater the chance he has of setting good, fair courses, whether for the elite orienteer or for the novice.

For the mapper, the task is knowing which features to map and how to represent them. A continuing involvement in the sport is important for a basic understanding of the requirements for the orienteering map: its content, the need for accuracy, the level of detail and above all the need for legibility.

Content

An orienteering map is a topographic map of a convenient size. It shall serve navigation through the terrain by representing a selection of prominent features and it shall serve route choice by showing variations in runnability (impact on speed) and visibility. The map shall contain sufficient information for the competing orienteer while at the same time being legible at running speed and under varying weather and light conditions. This is accomplished by using a carefully designed set of symbols and colours and by emphasising generalisation.

Consistent use of colour is important to ease map reading: Blue is used for features that have to do with water; Yellow is used for open areas; Green is used for vegetation features; Brown is used for landforms; Purple is used for course information; Black and grey are used for everything else, including rock and cliffs, paths and roads, and most man-made objects.

The map shall only contain features which are obvious on the ground to a competitor at speed. It should show things which could influence map reading or route choice: landforms, rock features, ground surface, hindrance to progress through the vegetation (runnability), main land usage, hydrography, settlements and individual buildings, the path and track network, other lines of communication and features useful from the point of view of navigation. However, the most important thing is to maintain the clarity and legibility of the map through skilful generalisation.

The shape of the ground is the most important aspect of an orienteering map. The correct use of contours (including index contours) to show a three dimensional picture of the ground shape and height difference cannot be overemphasised.

An orienteer's speed and choice of route through the terrain is affected by many factors. Information on all of these factors must therefore be included on the map by classifying paths and tracks, by indicating whether marshes, water features, rock faces and vegetation are passable, by showing the characteristics of the ground surface and the presence of dense vegetation and open areas.

Clear boundaries between different types of ground surface and different types of vegetation provide valuable reference points for the map reader. It is important that the map shows these.

The map must contain magnetic north lines that shall be parallel to the sides of the map. It may additionally contain some place names and peripheral text to help the competitor orientate the map to north. Such text shall be orientated to north. Text within the map shall be placed to avoid obscuring important features and the style of lettering should be simple. Arrowheads may be used to show magnetic north.

Runnability

The runnability depends on the nature of the terrain (density of trees/scrub and undergrowth, i.e.

bracken, brambles, nettles, as well as marshes, stony ground etc.). Runnability is divided into five categories of speed.

If speed through flat and open runnable forest is 4 min/km, the following applies:

No	Percentage	Description	Examples	Approx. speed min/km
1	100-120%	Easy running	lawns, paved areas, paths	faster than 4:00 min/km
2	80-100%	Normal running speed	rough open land, forest	faster than 5:00 min/km
3	60-80%	Slow running	stony ground, undergrowth, dense vegetation	5:00-6:40 min/km
4	40-60%	Difficult to run = fast walking	very stony ground, undergrowth, dense vegetation	6:40-10:00 min/km
5	Up to 40%	Very difficult to run = walking / fight	extremely stony ground, very dense vegetation	slower than 10:00 min/km

A combination of green and stony ground means that the runnability will be worse than for each of them in isolation. The steepness of the terrain may also influences runnability (the steeper the terrain, the less runnable).

Barriers and forbidden areas

In orienteering terrain, there may be features that are forbidden to pass or effectively impassable. Such features need to be clearly identifiable on the map, and therefore need separate symbols. There are several symbols for impassable / forbidden to pass features (vegetation, water bodies / marshes, cliffs, fences walls, buildings, ...). For fairness reasons, features that are mapped using these symbols have to be forbidden to cross / pass, so that the competitors shall not have to consider taking chances when deciding their route choice.

Map reading

The cartographer must always take into consideration the special conditions for orienteering map reading. Firstly, running makes reading a map more difficult. Secondly, orienteering usually takes place in forests, and in all kinds of weather. The light in forests with dense canopies is dimmed even in the middle of the day, and there are numerous other factors that impact map reading, such as rain, dirt and damages to the map or plastic bag caused by rough handling Therefore, it is obvious that legibility is of utmost importance for orienteering maps. Minimum graphical dimensions need to be respected and unnecessary detail must be avoided.

Generalisation and legibility

Good orienteering terrain contains a large number and a great variety of features. Those which are most essential for the competitor must be selected and presented on the orienteering map. To achieve this, in such a way that the map is legible and easy to interpret, generalisation must be employed. There are two phases of generalisation: selective generalisation and graphical generalisation.

Selective generalisation is the decision as to which detail and features should be presented on the map. Two important considerations contribute to this decision: the importance of the feature from the competitor's point of view and its influence on the legibility of the map. These two considerations will sometimes be incompatible but the demand for legibility must never be relaxed in order to present an excess of small detail and features on the map. Therefore it will be necessary at the survey stage to adopt minimum sizes for many types of detail. These minimum sizes may

vary somewhat from one map to another according to the amount of detail in question. However, consistency is one of the most important qualities of the orienteering map.

Graphical generalisation can greatly affect the clarity of the map. Simplification, displacement and exaggeration are used to this end.

Legibility requires that the size of symbols, line thicknesses and spacing between lines be based on the perception of normal sight in daylight. In devising symbols, all factors except the distance between neighbouring symbols have been considered.

The size of the smallest feature which will appear on the map depends partly on the graphic qualities of the symbol (shape, format and colour) and partly on the position of neighbouring symbols. With immediately neighbouring features which take up more space on the map than on the ground, it is essential that the correct relationships between these and other nearby features are also maintained.

For orienteering maps, the shape of the terrain is the most important thing to communicate. Dangerous features, such as high cliffs, must be easy to see on the map. Anything that is forbidden to cross or impedes progress is essential information: long cliffs, water, dense thickets. The road, path and track network is important, since it shows where the going and navigation is easiest. Most point features are less importance than line and area features.

Generalisation guidelines for orienteering maps are available in a separate document.

Accuracy

The general rule should be that competitors shall not perceive any inaccuracy in the map. The accuracy of the map as a whole depends upon the accuracy of measurement (position, height and shape) and the accuracy of drawing. Accuracy of position on an orienteering map must be consistent with that obtained by compass and pacing. A feature must be positioned with sufficient accuracy to ensure that competitor using compass and pacing will perceive no discrepancy between map and ground. In general if the distance between neighbouring features deviates less than 5% this will satisfy accuracy requirements.

Absolute height accuracy is of little significance on an orienteering map. On the other hand, it is important that the map shows as correctly as possible the relative height difference between neighbouring features.

Accurate representation of shape is of great importance for the orienteer, because a correct, detailed and sometimes exaggerated picture of the landform is an essential precondition for map reading. However, the inclusion of a lot of small detail must not disguise the overall shapes. This means that form line usage must be limited to an absolute minimum (e.g. form lines with a shape that can be deduced from the neighbouring contours shall not appear on the map) and insignificant contour detail must be removed. Drawing accuracy is of primary importance to any map user because it is closely connected with the reliability of the final map.

Absolute accuracy is important if an orienteering map is to be used with positioning systems or together with geographical datasets from other sources. In such cases it must also be possible to transform the map to a well known geographical reference system. Readability is much more important than absolute accuracy. Relocation of map features is encouraged if it makes the map better readable.

Georeferencing

To georeference a map means to locate it in terms of map projections and/or coordinate systems. Georeferencing is useful when geographical data from different sources (e.g. orienteering map, digital elevation model, aerial photos, GNSS positions) need to be combined. It is therefore strongly recommended to produce georeferenced orienteering maps. However, before printing the map, it shall first be rotated to make the magnetic north lines parallel to the edges of the map.

Map scale

The base scale for an orienteering map is 1:15000. The scale 1:15000 is used for all long distance competitions. For shorter competitions, enlarged maps with a scale of 1:10000 may be used. For older age groups (age classes 45 and above) where reading fine lines and small symbols may cause problems due to deteriorating vision, enlarged maps are recommended for all formats. Enlargements to the scale 1:10000 is recommended for the youngest age groups (12 years and below) where the capacity of reading complex maps is not fully developed.

Generalisation shall follow the requirements for the scale 1:15000 in all cases. Terrain that cannot be legibly presented at a scale of 1:15000 is not suitable for international orienteering events, but may be suitable for international sprint orienteering events.

Map enlargements

When a map is enlarged, all lines, symbols and screens shall be enlarged proportionally (for the map scale 1:10000 this means to 150%). This also applies to the overprint symbols.

- Large maps are difficult to handle. Maps larger than A3 should be avoided. A map should not be larger than is necessary for the orienteering competition. Large maps should be cut to fit the course (however, they should not be smaller than A5). Information about scale, contour interval and north direction shallbe available also on cut maps.
- The competition rules regulate the use of enlargements for IOF events.

Contour interval

The ability to easily assess the steepness of the terrain is vital in orienteering. It is therefore very important that the contour interval for orienteering maps is standardised.

The contour interval for orienteering maps is 5 metres. In flat terrain where the slope is less than 5% (or the contours would be more than 7 mm apart) all over the area, 2.5 metre contours may be used. It is not permissible to use different contour intervals on the same map.

The presence of a form line between contours makes the terrain appear nearly twice as steep. It is therefore very important that form lines are used sparingly. Form lines shall only be used to represent important landforms that can not be shown using contours. Instead of using form lines, contours should be shifted slightly up or down to better represent the important landforms.

Dimensions of map symbols

For line and area symbols certain minimum dimensions must be observed. These are based on both printing technology and the need for legibility. Dimensions in this specification are given at the printed scale of 1:15000.

On the ground (real world) minimum dimensions

Features that are represented on an orienteering map shall be prominent and easily identifiable by the orienteer whilst running. Minimum on the ground dimensions are provided for many of the symbols in this specification and these must be respected. Minimum dimensions do not mean that all features larger than that need to be represented on the map. For complex terrain, it will often be necessary to operate with larger minimum dimensions to achieve a legible map.

Prominent features with small terrain footprints are exaggerated on the map (for instance by using a point symbol) to make them identifiable. When a feature is exaggerated on the map, neighbouring features may need to be displaced to ensure readability and correct relative positions.

Footprint of symbols

There has to be minimum dimensions for line and area symbols on a map. These are termed

graphical minimum dimensions. The footprint of a symbol is the area the symbol would cover if it was projected onto the terrain.

For a line symbol, the graphical minimum dimension concerns its length on the map. If a line is too short on the map, it ceases to look like a line, and can be mistaken for a point symbol. Also, styled line symbols must not be made so short that the symbol becomes unrecognisable. If there is room on the map and the line feature is prominent and significant, it could be mapped even if it is shorter than the footprint of the minimum size line. However, it must be exaggerated in size on the map to meet the graphical minimum length. A bent line may have to be drawn longer than the minimum length in order to make it recognisable.

For an area symbol, the graphical minimum dimension concerns the area covered by the symbol on the map. If the area is too small, it will be difficult to differentiate it from point symbols, it becomes 'noise' to the map user or the structure of the symbol will become unrecognisable. If there is room on the map and the area feature is prominent and significant it can be mapped even if it is smaller than the footprint of the minimum size area. However, it must be exaggerated to meet the minimum graphical dimensions. It is also important that area symbols are not too narrow.

Graphical minimum dimensions

TODO: ***Illustrations*** and text needs to be checked and revised according to what is decided for the symbols. (minimum sizes of area symbols (widths, areas), minimum gaps between symbols, ...)
Where graphical minimum dimensions are given for individual symbols, these take precendence. For other symbols the following graphical minimum dimensions apply.

The graphical minimum dimensions apply to the base scale of 1:15000. This means that for larger scale maps, the minimum dimensions will be proportionally larger (1.5 times larger for the 1:10000 map scale). For instance for a cliff, the minimum length is 0.6 mm. This means that the minimum length for a cliff in the 1:10000 map scale will be 0.9 mm.

To be able to identify the individual symbols, minimum gaps are important. The following are strong recommendations:

- Between point symbols of the same colour: 0.15 mm ***(illustration: dot knolls and boulders)***
- Between line symbols of the same colour (black or brown): 0.15 mm (illustration: paths, earth walls, erosion gully, cliff)
- Between line symbols of the same colour (blue): 0.25 mm (water courses)
- Between symbols representing impassable / forbidden features: 0.3 mm (building and forbidden area, building and impassable wall, building and building, impassable cliff and impassable cliff, ...)

Minimum lengths and areas are given for many symbol. Providing minimum dimensions for areas is difficult as the shape varies. Very thin parts of areas must be exaggerated. Minimum widths for area symbols (if not specified for the symbol):

100% blue, green, yellow:: 0.25mm

Colour screens: 0.4 mm

All measures are for 1:15000. For larger scales the enlargement shall be proportional (0.6 mm means 0.9 for the map scale 1:10000).

For legibility reasons, overlapping between symbols of different colours should also be avoided (except for contours, where for instance cliffs should at least partly overlap a contour or form line).

Colour vision impairment

Colour vision impairment is the decreased ability to perceive differences between some colours that others can distinguish. That can effect orienteering map reading. 5-8% men and 0.5% women have some kind of colour related visual disorder. Orienteers with colour impairments may confuse the following colours:

- magenta and green (control in dark green areas - very hard to see)
- yellow and green (hard to distinguish between open and thick forested areas)
- brown and green (problems with brown symbols in green areas)

When choosing colours for the ISOM the above was considered. The chosen set of colours is a compromise.

Some point symbol shapes used for special features (such as the x, the circle and the triangle) are available in more than one colour. To help orienteers with colour vision impairment, only one of these should be used for colour combinations that are challenging for those with colour vision impairment.

Printing suggestions for the colour vision impaired

Use rougher dot screens or a dense, thin hatch pattern for the green screens (406, 408) to differentiate between greens and yellows.

Use a rougher dot screen or a hatch pattern for the green in the forbidden area (olive green)

Symbols

Definitions of features to be mapped and specifications of map symbols are given in the following sections. Symbols are classified into 7 categories:

- Landforms (brown)
- Rock and boulders (black)
- Water and marsh (blue)
- Vegetation (green or yellow)
- Man-made features (mostly black)
- Technical symbols (black or blue)
- Course symbols (purple)

Dimensions are specified at the base scale 1:15000. All drawings are at double scale (1:7500) for clarity only.

Notation for the illustrations:

	gap or infill between two lines or symbol outlines
	distance from centre to centre or length of line
	outside measure
	diameter
	symbol is orientated to north
	point symbol
	line symbol
	area symbol

Most of the symbols in this specification shall be orientated to north. That a symbol is to be orientated to north is indicated with an arrow pointing upward beside the symbol. When a symbol shall be orientated to north, it means that it shall be orientated to magnetic north and hence relative to the edges of the paper and the magnetic north lines.

Detailed graphical definitions for some of the symbols are provided in the section: Precise definitions of symbols.

Passable / Impassable

Some symbols are defined as impassable and hence forbidden to pass for fairness reasons. That a feature is mapped using a symbol that is not impassable does not mean that it will be passable for all orienteers. It should, however, be passable by the average elite orienteer under normal conditions.