

CARTOGRAPHY

an introduction



The British Cartographic Society



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FOREWORD

WHY PRODUCE A BOOKLET?

MAPS ARE EVERYWHERE: in print, on computer screens, mobile phones, PDAs, SatNav displays, in newspapers, magazines and books. There are more maps in circulation than ever and they have never been more important. Almost everything that happens happens somewhere and location is a significant element in the vast majority of information.

Computer technology has changed the way that geographical data can be visualised, but a map usually forms an integral part of the graphic representation of the world.

But not all maps work well. Many maps don't communicate clearly because they don't use the principles of good cartographic design which have been proven to work. That's why the British Cartographic Society has taken up the challenge of improving map design by launching the Better Mapping Campaign. Its aim is to give basic information on what works well in map design and to get the world thinking about maps and their messages. We're convinced that with a little knowledge of cartography a map's message can be communicated much better.

We hope that this basic introduction to maps and mapmaking will prove interesting and useful.

Page 1

1 2 3

1 *The Dynamic World* © Global Mapping

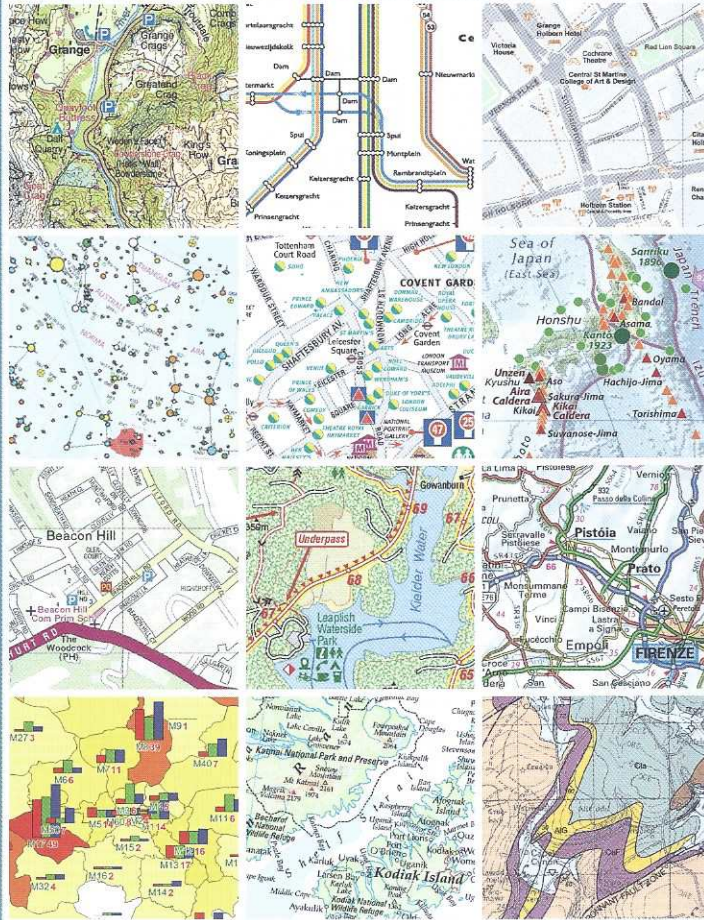
2 *Lille* © The Automobile Association

3 *Bedrock Geology* Geological map © NERC and topography © HarperCollins Publishers

INTRODUCTION

CARTOGRAPHY IS ALL about maps! It covers many aspects of maps and mapping, from their history and collection to their design and production. This booklet has been written to explain some of the basics of good mapping and convey the enthusiasm for maps that members of the British Cartographic Society all share.

If you're involved with maps, we hope that this brief guide will help you to understand them better and produce maps that look good and communicate well.



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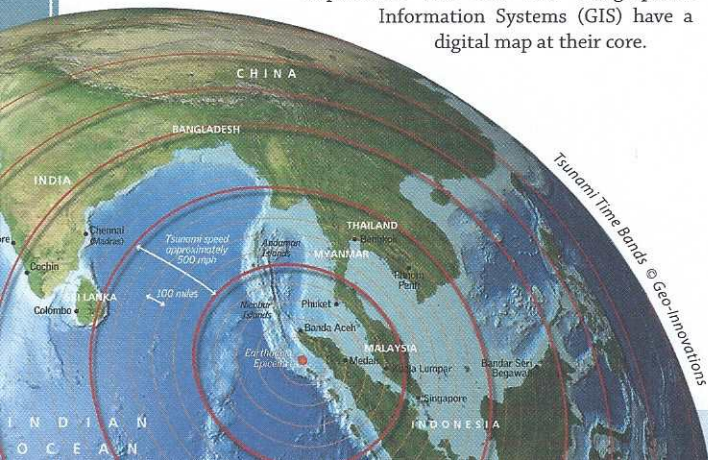
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- 4 Star Chart © Global Mapping
- 5 Central London © ML Design
- 6 The Dynamic World © Global Mapping
- 7 Street Mapping © Philip's
- 8 Reivers Cycle Route © Stirling Surveys
- 9 Road Atlas of Europe © Automobile Association
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- 11 The Times Comprehensive Atlas of the World © Collins Bartholomew
- 12 Lampeter Geological map © NERC and Ordnance Survey topography © Crown copyright

WHAT IS CARTOGRAPHY?

CARTOGRAPHY IS THE STUDY and practice of the many facets of maps and map making. Although relatively few people earn a living from producing maps, most people are involved with them as users, and growing numbers of people use on-line mapping or GIS to make their own maps. If you create maps, work with them or use them, you're closely linked to cartography.

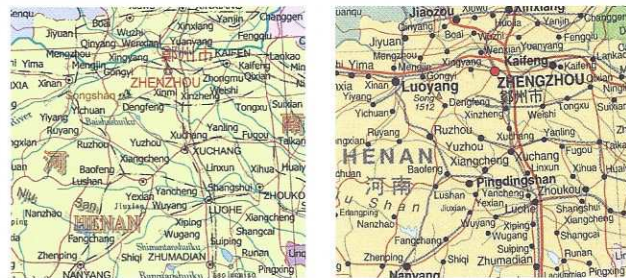
Cartography has been described as the art, science and technology of map making. But as well as the design and production of maps, cartography encompasses studying the history of maps, printing, distributing and selling them, collecting, conserving and curating them in map libraries.

The range of maps available goes well beyond the road atlases and topographic paper maps that often first spring to mind. Cartography incorporates marine, air and military charts, statistical, geological, tourist and travel maps, weather and climate maps, general and specialist atlases, cartograms, and transport network diagrams — to name but a few. Maps for computer and internet use have recently grown in importance and use, and Geographical Information Systems (GIS) have a digital map at their core.



WHY IS GOOD CARTOGRAPHY IMPORTANT?

GOOD CARTOGRAPHY IS IMPORTANT because a well-designed map communicates its message better than a badly designed one.



Poor design can be improved by applying a few basic cartographic principles

If you stop to look at the many maps you encounter every day, you'll soon realise that the quality of maps varies widely. Some maps are attractive graphics which are clear and easy to read. Some are adequate but not inspiring, while others miss the point completely and fail to communicate their message at all.

It's often hard to know exactly why one map works while another doesn't. However, as the visualisation expert Edward R Tufte put it, 'graphical excellence consists of complex ideas communicated with clarity, precision and efficiency.' Maps which don't work are often unclear, imprecise and inefficient!

There isn't a formula for making the perfect map. If there were, a computer could be programmed to design one, whereas many maps produced by computers using their default settings are truly bad. And a map is more than the sum of its symbols. It needs a bit of artistic talent, a sense of harmony, of form and colour to create a beautiful map. But don't worry, we hope some of the ideas and issues in cartography explained in this booklet will help you to design a better map.

THE EVOLUTION OF MAPPING

MAPS HAVE BEEN AROUND for 8,000 years or so — certainly longer than written words. Since the earliest known maps (around 6200 BC), the development of maps has been bound up with advances in technology.

DATA GATHERING

Take the methods of gathering mappable data, for example. The earliest geographers used sailors' and travellers' reports of the locations and distances to places to compile lists such as Ptolemy's Geography. These weren't turned into maps until centuries later. Eventually, surveyors produced maps from their own observations and travels. But it was the development of mathematics and then scientific instruments — the compass, the plane table and optical devices such as the alidade, telescope, staff, sextant and ultimately the theodolite and level — which have led to the systematic measurement of the landscape. Since the early 20th century, aerial photography and now satellite imagery have allowed the rapid survey of large areas of land.



Marine sextant

did you know...?

Around 250 BC Eratosthenes calculated the circumference of the Earth to be about 46,250 km (28,750 miles), only around 15% larger than we now know it to be.



Isle of Wight imagery
© The GeoInformation Group

THE EVOLUTION OF MAPPING

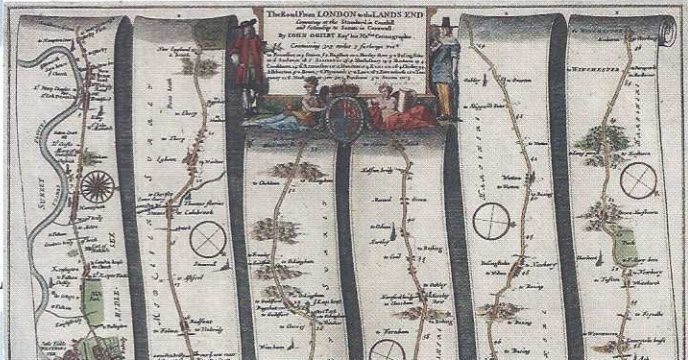


GPS surveyor:
Courtesy of Ordnance Survey

MAP DRAWING

The first maps were manually drawn using brushes, ink and parchment and so were limited in distribution. It was the invention of the printing press which allowed the wider distribution of maps. Wood engraving of early maps gave way to copper printing plates. Then lithographic and photomechanical means of making printing plates were developed, meaning that more maps could be produced consistently. Printed colour was added, while paper improvements meant that fine lines and lettering could be printed. Now maps are drawn and disseminated digitally.

Ogilby route map 1675: Courtesy of www.geog.port.ac.uk/webmap/hantsmap/

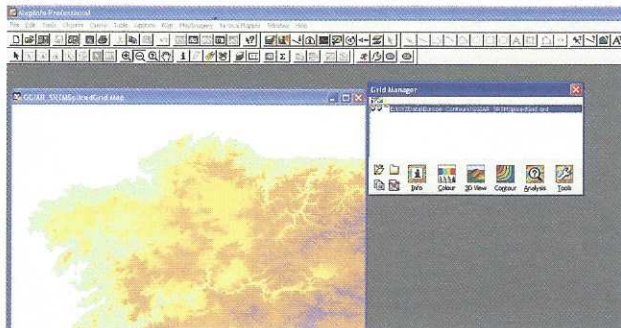


MAP DESIGN

Map design has reflected the growth of graphic design as an art form as well as the need to find better ways to show geographical data. Monochrome maps have given way to multi-coloured maps as the norm and typefaces have been developed to allow for the differentiation of features on a map. At the same time, general-purpose topographic maps have been complemented by specific-purpose thematic maps.

THE TECHNICAL REVOLUTION

The greatest revolution has been since the 1970s when computer technology has joined up the strands of data gathering, map creation, reproduction, distribution and use in a way unimaginable in the past.



Online editing © Collins Bartholomew

Mapping has developed links with image processing, visualisation and spatial analysis as well as with graphic design. Maps are now gathered, designed, printed, viewed and used digitally. GIS has a digital map at its core, and web-mapping, SatNav, and GPS-enabled mobile phones are examples of the widening ways maps are used. Moreover, the range of people making and using maps has grown enormously. Map making has become democratised — but what of the quality of those maps?

MAPS HAVE AS MANY FUNCTIONS as they have readers. Two readers may use exactly the same map for totally different purposes. However, the function common to all maps is to show selected geographical features of the world in the clearest way possible.

Some of the main categories of map function are:

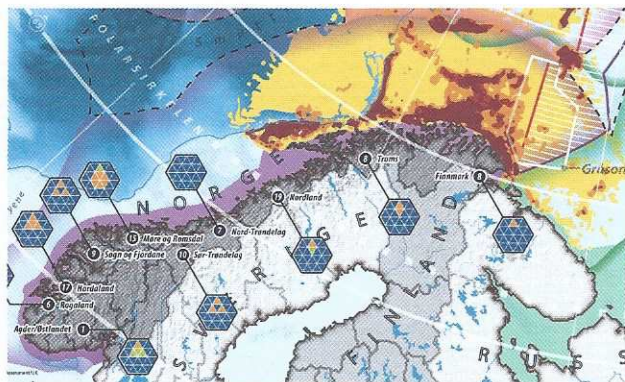
- for navigation and mobility
- for the location of places
- for analytical purposes, involving measurement
- to show statistics or trends
- to visualise a landscape
- to stimulate spatial understanding

Most people tend to think of a map primarily as being something to navigate with — a road atlas, a walker's map, or a business location map, for example. However, a huge proportion of maps are intended for other purposes, and their design reflects that.

Electronic and paper navigation charts on the bridge of cruise ship Aurora: Courtesy of UKHO



MAP FUNCTIONS



One of eight maps of the European Arctic produced to highlight important environmental, political and industrial issues in the region. © Ocean Futures

MAP TYPES

ALL MAPS HAVE IN COMMON the fact that they show features in geographical space, but vary dramatically in form and appearance. Although a map in a travel brochure may bear little resemblance to a map showing population statistics, both have in common the fact that they show location and attributes.

What counts as a map includes a wide range of graphics, presented on different media: paper or electronic delivery such as computer screen, television screen, mobile telephone, and personal navigation equipment.



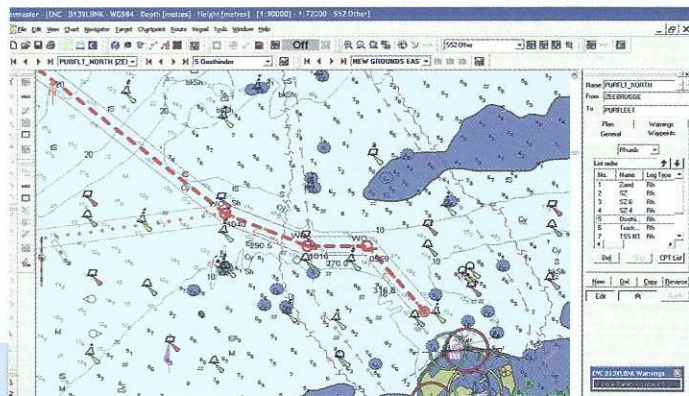
Maps on iPhone: Courtesy of Apple

Map types include topographic and thematic maps, atlases, transport maps and diagrams, photomaps (with aerial photographs or satellite images in the background), 3-D models, cartograms (which deliberately distort map shapes and areas to show statistics in a different light) and a range of maps seen only on screen: fly-throughs, SatNav maps, and Web-maps.

Route planning: Courtesy of RIN



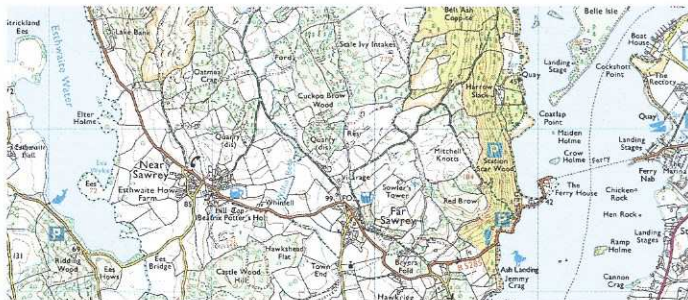
Walk 12 of Walks Around Ambleside — a map-guide from the Footprint series, designed specifically for walkers. © Stirling Surveys



MAP TYPES

TOPOGRAPHIC MAPS

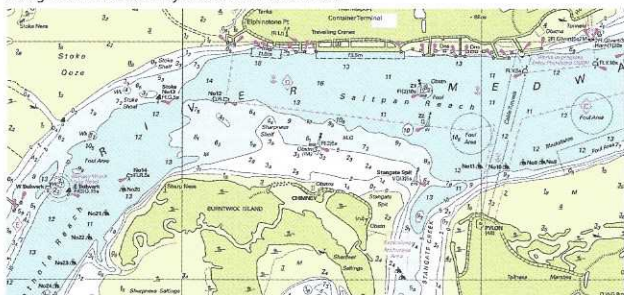
Topographic maps are general reference maps showing a range of features, both natural and human, in the landscape — Landranger™ and Explorer™ maps from Ordnance Survey® are well-known examples.



Ordnance Survey® 1:25,000 Explorer © Crown Copyright

Topographic maps also include specialist products based on accurate survey methods such as maritime and air charts ('maps made for drawing on', as they were once described), plans (large-scale, detailed maps) and cadastral maps showing property and land holdings.

Navigation chart © Imray Laurie Norie and Wilson



MAP TYPES

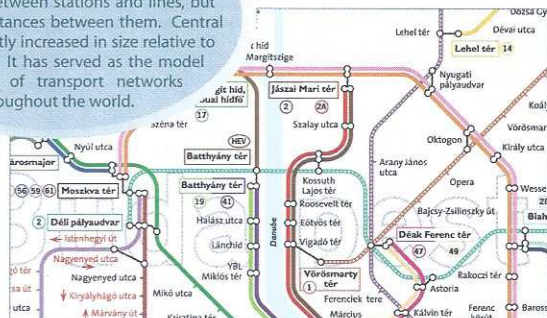
THEMATIC MAPS

Thematic maps show a specific topic or theme — population, health, or planning zones, for example — usually against a basic topographic background.

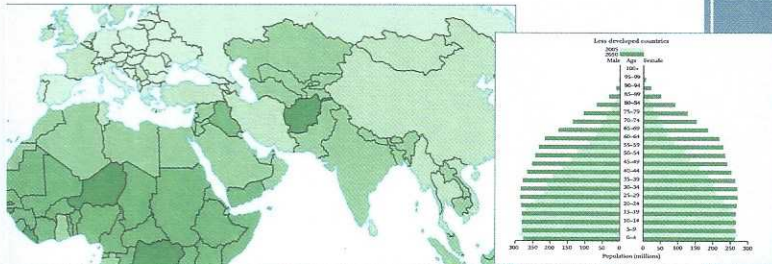
Thematic maps are especially diverse and include tourist maps, land-cover and land-use maps, planning, weather, pictorial and a range of statistical maps.

did you know...?

The London Underground diagram is a map which shows the correct relationship between stations and lines, but distorts real distances between them. Central London is greatly increased in size relative to the suburbs. It has served as the model for maps of transport networks throughout the world.



Transport mapping © Communicarta



Statistical mapping from The Times Comprehensive Atlas of the World © Collins Bartholomew

HOW MAPS ARE MADE

EVEN THOUGH MAPS VARY in type and appearance, the method of producing them is similar. Much thought goes into the planning and design of good maps as well as into their production.

DEFINING THE PRODUCT: The reason for making the map, the target audience, the budget and available technology help to define the map in terms of size, layout and appearance.

DESIGN: To produce a good map, the design process is critical. Design sketches, alternatives and rough layouts lead to a final design and a proper specification so that the map is consistent and shows information in the clearest way.

Current town names	Icembela	Berkley Oldstyle Medium	7pt 20c 100m 100y 0k fill
Current town symbols	o	1.3mm diameter 0.12mm stroke 4c 4m 32y 0k fill	
Town names	Icembela	Berkley Oldstyle Medium	7pt
River names	Jubbok Jerdan	Berkley Oldstyle Italic	8pt & 9pt
Lake names	Lake Barullus	Berkley Oldstyle Italic	8pt
Bay names	Mangula Bay	Berkley Oldstyle Italic	8pt
Sea names	Red Sea	Berkley Oldstyle Italic	Variable & kerned if necessary
Geographic feature names	Wilderness of Sit	Berkley Oldstyle Italic	Variable & kerned if necessary
Regional names	A MALEK	Berkley Oldstyle Medium	10pt & kerned if necessary
Mountain range names	Wilderness of Sit	Berkley Oldstyle Italic	Variable & kerned if necessary
Mountain peak names	Ma Yitaj	Berkley Oldstyle Italic	6.5pt
Town symbol	o	1.3mm diameter 0.12mm stroke white fill	
Approximate location town symbol	o	1.3mm diameter 0.12mm stroke 0c 80m 80y 5k fill	
Mountain symbol	▲	0.05mm stroke 0c 0m 0y 100k fill	
Possible mountain symbol	+	no stroke 0c 80m 80y 5k fill	
Route 1		0.75mm 60c 25m 0y 0k	
Route 2		0.75mm 0c 45m 70y 7k	
Route 3		0.75mm 45c 15m 75y 0k	
Route 4		0.75mm 0c 45m 70y 7k	
Trading Route		0.50mm 30c 30m 60y 20k	
Lakes line		0.15mm 100c 10m 0y 0k stroke 26c 11m 0y 0k fill	
Islands line		0.15mm 100c 10m 0y 0k	
Coastline		0.15mm 100c 10m 0y 0k	
Major river line		0.20mm 100c 10m 0y 0k	
Minor river line		0.15mm 100c 10m 0y 0k	
Coastal banding		1.00mm 18c 7m 0y 0k	

Typical design specification established at the beginning of a project

HOW MAPS ARE MADE

DATA RETRIEVAL: Some maps use new data from field surveys or aerial photographs, but many are derived from existing mapping. The features required are selected and edited, generalised if necessary, and additional information incorporated from other sources.

MAP PRODUCTION: Depending on the origin of the information, a map can begin as a careful hand-drawn compilation which is scanned and digitised, or it can be simply made up of elements selected from existing datasets. A map can be a piece of artwork, created manually or digitally. Whatever the style of map, the colours and design specifications are applied as the map is made; line weights, symbol sizes and type styles are all assigned.



Map production: Courtesy of ODC

useful tip

Even if a map is intended for electronic delivery, it is always a good idea to make paper proofs for checking. It is amazing how glaring errors which weren't apparent on-screen suddenly show up when printed!

CHECKING AND PROOFING: Maps are checked for errors, and laser proofs produced if the product is to be printed. Errors are corrected and new proofs made for final approval.

useful tip

Check that company logos, photographs, relief shading and other images are saved in CMYK mode and high resolution when maps are being printed in process colours and in RGB mode and screen resolution for electronic delivery.

FINAL OUTPUT: Maps for screen-use remain in digital form only. Paper maps are usually printed in four process colours (cyan, magenta, yellow and black or CMYK) which combine to produce the full range of colours. 'Spot' colours are sometimes introduced to match corporate colour schemes and some products are designed to be in only one or two colours.

IT'S WORTH MENTIONING what a GIS is because a lot of map information is now held in GIS format. A Geographical Information System is a computer-based means of storing both the graphic information about map objects (the points, lines and areas) with their attribute information (name, object type and other information). It's more than just a digital map because it has a linked database of information about the features shown.

GIS consist of a software programme and data. GIS software is capable of capturing, storing and analysing any spatially related data. GIS data is typically georeferenced — related to a fixed coordinate system such as the National Grid. The two main data models used are RASTER (based on a scan of a map) and VECTOR (where objects are digitised as points, lines and areas).

GIS information is structured in layers. Basic layers show topographic information: one layer may contain roads, another rivers, another contours, etc. In addition, a GIS has layers of information showing a specific theme or subject; location of water pipes, data on health or property values are examples. GIS can also combine map information with aerial photographs or satellite images, as well as address, postcode and market research information.

GIS have advantages over paper maps because they can be used to analyse the information, eg 'find me all locations more than 5 km from a fire station'. They can also model landscapes in 3-D, and measurements (such as areas) are easy to perform. The typical output from a GIS query is a map.

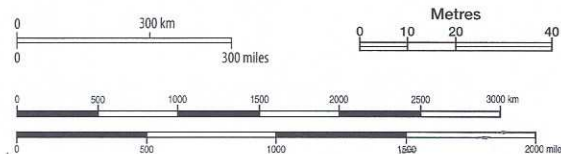
did you know...?

GIS software and principles underlie the customised mapping and earth-viewing websites you're probably familiar with. If you type in a postcode to find a map of an area, it's a GIS that links the postcode to the right part of map.

GULLIVER ON HIS TRAVELS discovered a people who had produced a map of their territory at a scale of one to one! But all other maps are at a scale smaller than that. Scale is expressed as a ratio of the map distance to the ground distance — a scale of 1: 250 means that one map unit represents 250 of the same units on the ground.

The most usual ways of showing scale on a map are:

- as a WORD STATEMENT — one inch to one mile
- as a RATIO — 1:10 000
- as a REPRESENTATIVE FRACTION — $\frac{1}{1250}$
- or graphically using a SCALE BAR —



Not all maps require a scale. If the map shows a very familiar area or is a sketch-map, then a scale may not be needed or be appropriate. But if the map is to carry any authority, it probably needs one.

useful tip

A scale bar changes in correct proportion if the map is changed in size (eg by photocopying) and it stays useful. A ratio or fraction becomes wrong as soon as the map changes size.

did you know...?

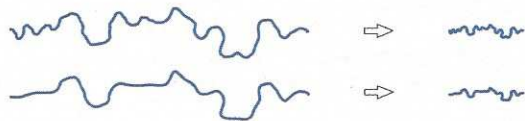
Confused by small and large scales? Small-scale maps require a small sheet of paper to show an area with a small amount of detail; large-scale needs a large sheet for the same area and shows large amounts of detail.

A MAP CAN'T SHOW every feature of the landscape and should never try to. Maps are selective in the features they show and feature selection is related to the purpose of the map. For instance a general reference atlas will show more detail than a junior school atlas of the same area.

Compiling a map means deciding which features to leave out rather than what to include. Large-scale maps and plans (very large-scale maps) usually contain more detail than small-scale maps and so if you are reducing the scale of a map you will probably need to generalise it.

Feature selection is part of the process of generalisation. As well as choosing which real-world objects to leave out, generalisation involves other processes:

SIMPLIFICATION: Making features easier to read by leaving out small variations — eg smoothing a meandering river.



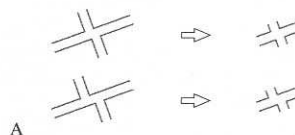
Simplification: The important features of the line have been retained. When reduced in size, the simplified line is appropriate for the smaller scale map.

EXAGGERATION: Many small or narrow features need to be increased in size. Roads show up on a map by making them wider than their true scale.

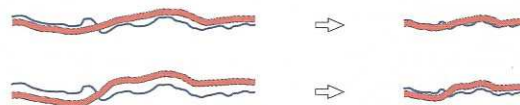


Exaggeration: Part of a map feature may be small but significant in determining its shape. As scale is reduced, part of the feature is exaggerated to maintain its shape.

DISPLACEMENT: Nudging features so that they can be seen more clearly, often required as a result of exaggeration.



A



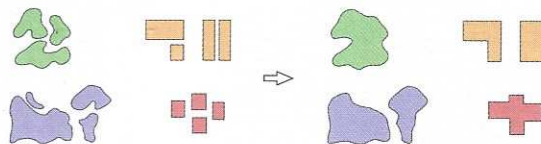
B

Displacement: A feature may be moved for emphasis or clarity.

In example A, a junction which is slightly staggered has been displaced to make it clearer. Exaggerating the width of the road may mean moving buildings that border it.

In example B, the road is displaced to prevent it overlapping with the river at the reduced scale.

MERGING: Joining similar, adjacent objects together — eg merging individual buildings to form a built-up area.



Merging: This involves simplifying, aggregating and typifying in order to make the map clearer. The local importance of the object must be taken into account.

useful tip

Generalisation means losing detail, and it's a one-way process. If you increase a small-scale map in size, then you don't get more detail, only symbols that become over-generalised. To compile a new map, always go from large scale (detailed) to small scale (generalised).

A MAP PROJECTION IS A WAY of transforming the 3-D globe onto a flat sheet of paper or computer screen. In transferring the shape of land or oceans, a mathematical approach is needed to ensure that each point on the globe appears at the right point on the paper. The systematic process for doing this is known as *map projection*.

When you project the real shape of the world by plotting it on a map, you can't avoid introducing distortions. For example, you can keep distances between points correct, or relative areas correct, or angles correct, but you can't keep more than one of these properties at any one time. Different map projections keep different characteristics correct and some of them are hybrids — they combine different properties of several projections.

You need to choose the right projection if you map anything larger than a small country on a medium-sized sheet of paper. There are no 'right' or 'wrong' projections to use — only bad choices for particular purposes. For world maps, if your map is aimed at historians, geographers, ecologists and for most general purposes, you'll probably need to use an equal area (or equivalent) projection, especially if it's a distribution map. If it's to be used for navigation or by engineers, then you should use a projection which keeps angles correct (*conformal*). For maps of small areas, the projection chosen becomes less important because the distortions reduce as the area of the world shown gets smaller.

did you know...?

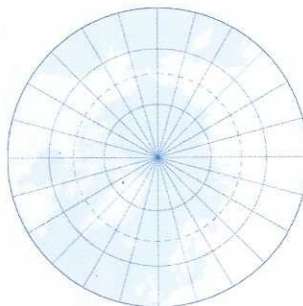
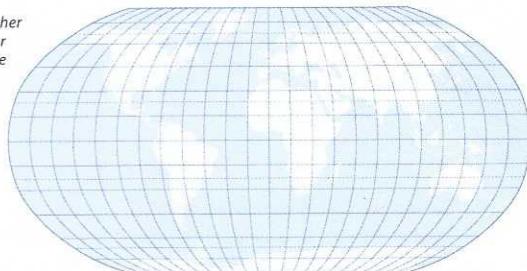
One of the first collection of maps to be called an 'atlas' was put together by the Flemish cartographer, Gerardus Mercator (1512-1594). The Mercator projection is named after him and was devised for sea navigation.

The angle measured between two places on his map relates to a compass bearing. It's widely used for maritime and air charts.

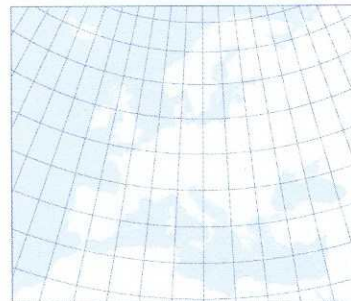


If you need to show the whole world on a map, then try using one of these equal area projections: *Cylindrical equal-area*, *Mollweide's*, *Sinusoidal*, or *Hammer-Aitoff*. Another useful projection which is not strictly equal area is the *Robinson* projection which keeps the world's shape familiar. An *orthographic* projection looks like a view of the globe. The *Peters* projection, although equal area, introduces shape distortions which make the shape of some regions of the world unfamiliar. Mercator's projection shouldn't generally be used for world maps because it distorts areas, especially in high latitudes.

Although neither equal area nor conformal, the Robinson Projection is popular because shapes 'look' right



A Stereographic Projection is ideal for mapping polar regions



Albers Equal Area Conic is used for regions that are predominantly east-west in extent

SYMBOLISATION: AREAS, LINES AND POINTS

A MAP IS A GRAPHIC which shows geography in the form of symbols. On large-scale maps and plans (larger than about 1:10,000), the symbols are fewer, simpler and can be shown very close to their real-world positions. Smaller-scale maps need to summarise the complex world and usually have more symbols with the location of objects generalised. Simple lines can show a church's outline on a plan, but a symbol is used on a small-scale map.

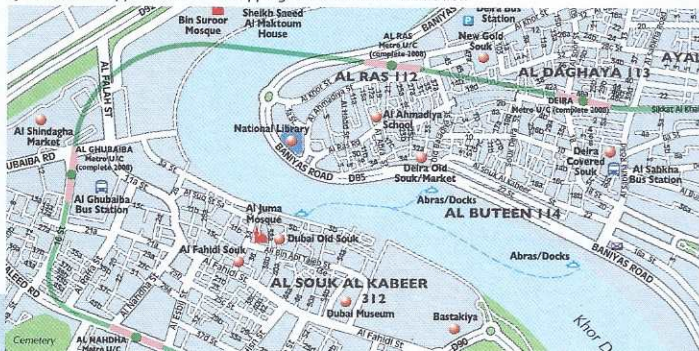
Maps use three types of symbol to show almost all features:

- POINTS (eg a well),
- LINES (eg a railway), and
- AREAS (eg a county).

Map text is also a symbol of sorts, and is used to label and identify features.

These three graphic symbols are modified in various ways to help to communicate different types of map information. The variations are in size, shape, colour, lightness, orientation and pattern or texture. Varying these symbols allows for a huge range of options on a map, and map readers naturally see and assign meaning to these variations.

Symbolisation applied to tourist mapping © Automobile Association



SYMBOLISATION: AREAS, LINES AND POINTS

POINTS

Point symbols can be either:

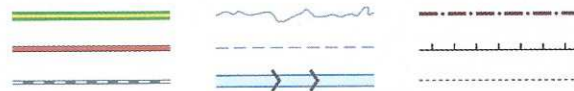
- GEOMETRIC (based on circles, squares and triangles)
- CONVENTIONAL (like a red cross for a hospital) or
- MIMETIC (looking like some aspect of the object they're representing, such as an aeroplane to indicate an airport).

A simple filled square can represent a town on a small-scale map, but add a cross to it and it represents a church.



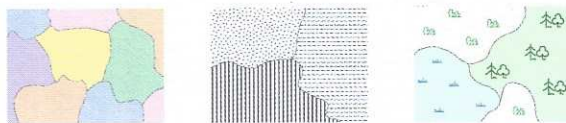
LINES

Lines can be simple strokes, but most are more complex. For instance, roads are often *cased* with two lines enclosing a coloured fill. Many lines are varied by adding to them, such as the conventional symbol for a railway, or broken up (*pecked*) like many boundary lines.



AREAS

Areas form the background to a map and may be important symbols in their own right. Areas are either filled with colours or with textures and patterns. They often have a thin bounding line or *keyline*.



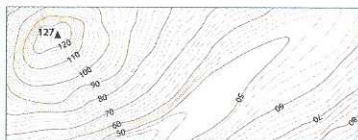
RELIEF

FROM EARLY TIMES, maps have tried to show the height differences in the landscape. Early maps used pictorial symbols of hills to depict relief, but it is hard to tell much about the heights of the mountains or hills shown or about more gently changing scenery in between. Depicting relief has always been a challenge for cartographers, and showing height and slope without graphically overloading the map can be difficult.

There are a number of ways of depicting both height and slope on maps.

SPOT HEIGHTS: These show the height at points above (or below) a datum, usually sea level.

CONTOURS: These are lines of equal height printed in a neutral colour such as brown or orange. They are usually derived from aerial photographs and are widely used. Although familiar, many people find it hard to visualise the landscape from them.



useful tip

If numbering contours, the numbers should read uphill and only the main 'index' contours need labelling.

HACHURES: Hachures are patterns of fine lines which run parallel to the direction of slope. Line length varies according to the length of slope they depict, and steeper slopes are represented by thicker lines or closer spacing.

HYPSONETRIC TINTING:

Heights are grouped into different bands and a colour applied, typically ranging from greens and yellows for low areas through oranges to browns for the highest areas.



RELIEF

HILL SHADING:

Hills and mountains are made to stand out by illuminating them, making slopes in one direction appear sunlit and slopes in the opposite direction appear in shadow.



did you know...?

Hill-shaded maps always show the light coming from the top left (usually north-west — a direction the sun rarely shines from). If it comes from the bottom right, mountains look like valleys and vice versa. Try turning a hill-shaded map upside down and see the effect for yourself.



Lake District map showing different techniques for depicting relief and terrain. © Harvey Maps

Many maps use more than one method to show relief, for instance by combining spot heights, contours and hypsometric tinting.

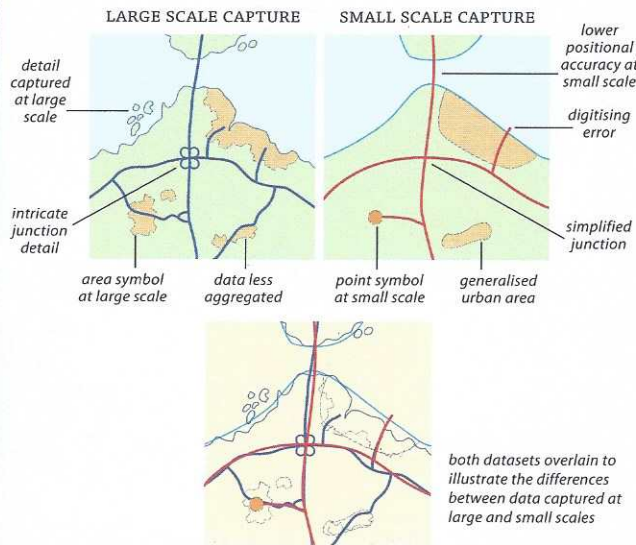
Leatherhead DSM
© The GeoInformation Group

The latest way of visualising the landscape is through a digital terrain model (DTM) or a digital surface model (DSM). A DSM is similar to a DTM but includes all the surface material not included on a DTM. They are generated from digital height data within a GIS to create a 3-D model of a landscape which can be viewed from different angles.



A MAP CAN ONLY BE as good as the information that goes into it. Working with source data of the highest quality is really important if a good, reliable and honest map is to be produced. Digital map data vary in origin and reliability and it's worth finding out something about the data quality before use. Check the metadata:

- **INPUT SCALE.** If the digital data have been captured from a map at a smaller scale, it will have been generalised, and you can't get out of it more than went into it! Cartographers always compile a new map from the *larger* to the *smaller* scale.
- **DATE OF CAPTURE OR UPDATE.** Is the information up-to-date?
- **MAP PROJECTION.** Vital for matching maps of large areas of the world.

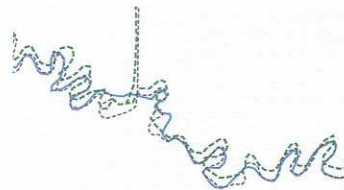


If you're combining information from a number of different sources, you need to assess each source to see if each is of the same standard. It's worth considering whether your data match up on the following tests:

- **COMPLETENESS.** Do the datasets show all the features they should show? For example, have some major roads been shown, but others missed out for no apparent reason?
- **CONSISTENCY.** Do the datasets show similar objects in the same way, and have they been classified consistently? For instance, is there confusion between land *use* (eg recreation) and land *cover* (eg a grass field)?
- **ACCURACY AND PRECISION.** Are the objects in the right place, and is the level of detail used appropriate for the scale? Compare a printout of the data with a map you already trust. This can show whether objects are in the right place, and whether source datasets are complete.
- **SOURCE SCALE.** Remember that you can get more information from a large-scale map and so you need to compile information from a larger to a smaller scale map. Ideally, all sources of data should have been compiled at about the same scale otherwise you'll have a lot of work in making them compatible.

An example of mismatched data where the state boundaries (green) and the county boundaries (purple) have been taken from different datasets that have been captured at different levels of detail. The two sets of boundary lines are not correctly aligned to each other and, in addition, neither set perfectly matches the rivers (blue).

Careful checking against other sources will help ascertain which of the three datasets is the most accurate. Much manual editing of the linework would have to take place in order to improve the compatibility of the different elements.



INTELLECTUAL HONESTY is vital in cartography. Why? Because maps are seen as authoritative documents which are widely trusted.

The problem is that it's usually impossible for the map user to distinguish between the quality of the information and the quality of the presentation. If they are both well designed and produced, a map with good information and one with bad information are equally credible. It's only when you come to use it that you find the errors. They are usually not introduced intentionally, but they creep in.

The idea of an 'accurate' map is one which is hard to define, but users have a feeling for what is accurate and what isn't. Accuracy includes:

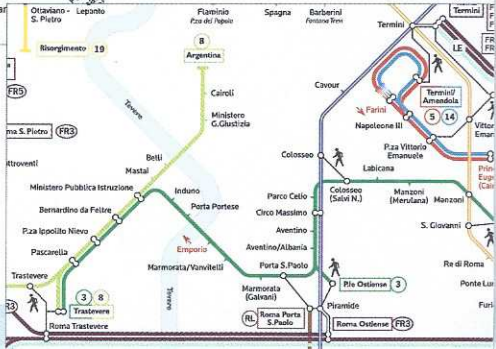
- **POSITIONAL ACCURACY** (objects being in the right place),
- **COMPLETENESS** (all objects being on the map when you expect them to be), and
- **CONSISTENCY** (similar features treated in the same way).



Compare the official map (left) with the Communicarta map (below) which has been prepared following extensive field research. Note particularly the careful use of interchange, connecting symbols and the clear relationships between the stations on the Communicarta map. All the stations are represented in their correct relationships to each other, correctly named, and in relatively correct geographic positions. The result is a much more accurate map.

Useful details are included on the Communicarta map, such as terminus stations and interchange links to adjacent stations by way of walking at street level. Tram line 3 (dark green) is totally missing from the official map.

Rome Transport
© Communicarta



However, all maps include 'errors' — falsehoods necessarily or unintentionally introduced in the process of representing the real world graphically. Errors include:

- **SIMPLIFICATION** introduced by generalisation,
- **DISTORTION** of locational position as a result of map projection, and
- errors of **CLASSIFICATION** when statistics are put on maps.

Map users tolerate a lot of distortions and errors in maps, for good reason: it makes them more useful. The London Underground map, for example, greatly distorts real geography, but it's a wonderfully useful map!



A cartogram showing the population of the countries of the world where the sizes of countries are proportional not to their actual landmass but instead to the number of people living there. Courtesy of Mark Newman, University of Michigan

did you know...?

Mapmakers can introduce small deliberate errors on their maps as 'copyright traps', to find out if others are copying their products illegally. They add inconsequential errors, such as small details that don't exist.

Any mapmaker has a duty to minimise potential errors on a map, and to try to envisage how a map might be mistrusted. Ask yourself this when you're making a map: *Would you trust your own map?*

WHAT MAKES FOR GOOD MAP DESIGN?

A WELL-DESIGNED MAP communicates its message much better than a badly designed one. There isn't a formula for making a well-designed map, but there are key issues to consider.

CLARITY AND LEGIBILITY

It sounds obvious, but can you easily read the map, without confusion, without difficulty? Ensure that all symbols are large enough to be seen, and distinct from one another (separated by at least 0.2mm).

HIERARCHY AND STRUCTURE

Separate map information into broad classes (eg settlements or rivers), then subdivide by size or importance. Vary the size of symbol and text to reflect relative importance: larger and darker usually means more important. One object imposed on top of another (a road crossing a river, for instance) establishes hierarchy.

COLOUR AND PATTERN

Use conventional colours (like blue for water) where you can, and avoid complex patterns that give you visual indigestion. See also page 44 on choosing the right colour.

VISUAL CONTRAST

Visual contrast comes through varying symbol size, colour, shape and orientation. Ensure that symbols are sufficiently different to be correctly identified — for instance that a series of circles vary enough to be recognised without confusion.

Contrast can be created or enhanced by varying a symbol's

colour



size or weight



shape or form



separation



WHAT MAKES FOR GOOD MAP DESIGN?

FIGURE AND GROUND

Figure-ground means determining what's important (the figural, on which your eye settles) and separating it from the background (the ground). Symbols can be made more figural by having fewer of them. Closed forms (like islands or country outlines) stand out, as do dark objects and familiar objects (like your own country's shape). Small objects stand out from larger backgrounds.



Poor contrast between land and sea



Contrast improved by bringing the most important elements to the foreground.

BALANCE

A map needs to be balanced, both internally and as part of the page layout.

TYPOGRAPHY

Good typography makes a map. Avoid fonts which are too large or fancy and use type sizes in proportion to the map. Titles and text which are too big look unprofessional and distracting.

useful tip

Shades of a colour which appear clearly distinct next to each other in a legend may become difficult to identify on the map when they are separated. Equal percentage steps do not look like equal visual steps, so increase the differential between shades as the colours get darker.

THINKING ABOUT YOUR AUDIENCE

THE BEST MAPS WORK because they're well designed and the mapmaker has thought about the purpose of the map and the target audience.

The term 'fit for purpose' is often used by cartographers and what it means is that the map should show what it is required to show in the clearest way possible. Unfortunately, perfectly good maps created for one use can instantly become poor maps when they find their way into the hands of a different user because the design and content are inappropriate for that use.

Think about why the map is being made:

- what's the reason for making the map?
- what information is it communicating?
- where will it appear, at what size, and in what format?

Think also about your audience and their characteristics. Are they:

- already knowledgeable about the subject?
- learning about it?
- novices?

The purpose and target audience will affect your design. A knowledgeable audience will expect a sophisticated map, with more complex symbols and less legend information or explanation. Tailor your map to the level of the audience by reducing the number of categories of information, and choosing simpler graphic symbols. If it's for the 'general public' aim your map at the most important readers (or the largest group of readers) since you can't satisfy everyone.

It is important to consider the medium of presentation too, before making your map. The design of maps prepared for use on a computer screen is very different from those intended for eventual printing.

THINKING ABOUT YOUR AUDIENCE

A sequence of three maps at increasing levels of complexity appropriate to older age groups.



Junior School Atlas © Philip's



Foundation Atlas © Philip's



World Atlas © Philip's

useful tip

Novices don't need simplistic maps, but ones where the information is presented more simply. Use fewer and simpler symbols, rather than big ones.

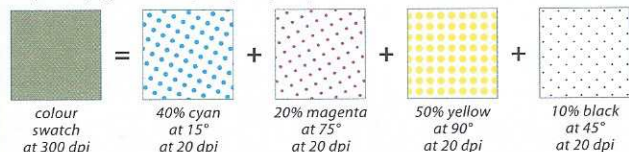
DESIGNING MAPS FOR THE SCREEN requires a different approach from designing for printed output.

PRINTED MAPS

Although production costs are higher, printed maps can show more information, use smaller symbols and use a wider range of colours than screen maps because they have a higher resolution. When designing for printed maps, bear in mind:

- You're probably going to print using the four 'process' colours (CMYK) and the colours you see on screen are RGB colours. Use a printer's colour chart to get the right colour, don't rely on what you see on screen.
- If a particular colour is required (eg for a company logo) it can be printed as a special colour in addition to the process colours — but adds to the expense.
- Resolution of images for printing should be 300 dpi.

Most printed colours can be created using the four process colours in different proportions, from 0 to 100% of each. The first step in the printing process is to generate colour separations to obtain the screens. Each screen consists of tiny dots - the higher the percentage, the bigger the dot. The primary screens are printed on top of each to form the colours. When viewed on the printed page the dots optically merge to produce the tint.



The khaki colour comprises 40% cyan, 20% magenta, 50% yellow and 10% black. The separated screens are shown enlarged to 20 dpi to illustrate the relative dot sizes and screen angles.

did you know...?

Most printed products use a series of small, overlapping dots of cyan, magenta, yellow and black (CMYK) to make up full coloured images. The range of colours is achieved by mixing the dots in different proportions. The grid of dots (or 'screen') of each colour is angled differently to avoid unwanted patterns. In contrast, colours on a computer screen are created by mixing red, green and blue (RGB) in different proportions, and they appear in regular grid cells (pixels).

SCREEN MAPS

Maps on screen are cheaper, easier to send out and can be interactive. But you're limited by screen size, available colours and lower resolution than printed maps. When designing a map for the Web, bear in mind:

- Design maps for screen-sized views, to avoid scrolling.
- Resolution should be 72 to 100 dpi for Web output.
- To ensure your colours will be displayed to most Internet users as you had intended, always select colours from the 216 web-safe colours. These colours should look the same on all browsers.
- Screen colours are mixed using RGB, not CMYK, so colours designed for printing won't look the same.
- Work with a few well-contrasting colours.
- Font options are limited on screen browsers, so stick to common typefaces.
- Increase the size of the text, point and line weight throughout.
- Avoid italics and text effects.
- Increase the size of symbols for screen maps, and generalise more.

useful tip

GIFs and PNGs are small files and good for 'flat' graphics like maps and logos, JPEGs are good for continuous tones (like photographs) and PDFs are good for downloadable maps.



- If you're designing for the screen, it's good to have separate higher resolution printing options available (one colour, one black and white).
- Many people print in monochrome, so check that a colour map on screen still looks OK when printed out in black and white. Insufficient contrast between tones is usually the problem.

Delivery route: Courtesy of RIN

CHOOSING THE RIGHT SYMBOL

CHOOSING THE RIGHT SYMBOL is a combination of understanding what feature you are mapping and having a sense of good graphic design.

Firstly, is your map information *qualitative* or *quantitative*? If it's qualitative (land use or soil type, for example), then all features are of equal importance. A symbol's shape, colour and design are varied, but symbols should all look to be of equal importance. If the map shows a quantity or 'ordered' data (statistics, or different classes of road, for instance), then the size, colour range or colour intensity of symbols is deliberately varied to make one feature look more important than another.

Then choose a symbol which relates to the map's size. All symbols must be easily distinguishable, so they need to be legible and vary enough in shape and colour to avoid confusion. Which symbol you choose depends partly on the type of feature and partly on the scale of the map. A town will appear as lines and areas on a plan, as an area symbol (only its boundary shown) on a medium-scale map, but as a point on a small-scale map.



areas



areas + lines



areas + lines + points



areas + lines + points + type



with linework suppressed

useful tip

When making a map, compile areas first, then add lines and then points. Text sits on the highest visual level, and is added last. Text is allowed to obscure some symbols, especially lines, as long as there is enough of the symbol visible for the reader to make sense of it.

CHOOSING THE RIGHT SYMBOL

POINTS

Qualitative maps use different symbols which all look about the same size and weight to show different classes of information. They are either geometric shapes, conventional or mimetic. They can be varied in shape or colour, but are of equal visual weight. For quantitative information, larger symbols represent higher data values. Use graduated symbols (eg circles increasing in size) to show increasing quantities at a point.

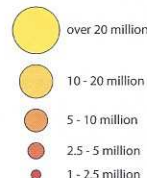
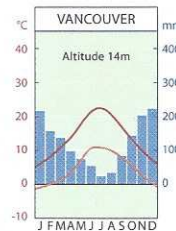
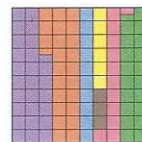
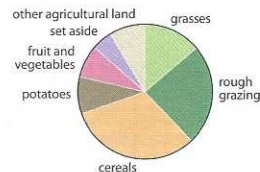
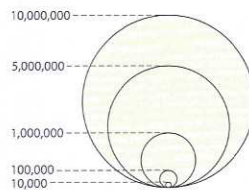
QUALITATIVE POINT SYMBOLS



useful tip

If a symbol is familiar or clear and well designed, readers probably won't need to look at the legend to find out its meaning.

QUANTITATIVE POINT SYMBOLS



CHOOSING THE RIGHT SYMBOL

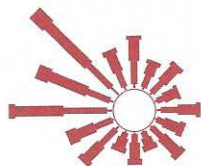
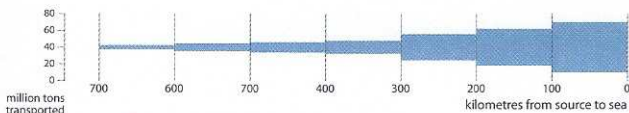
LINES

Qualitative maps use lines of similar characteristic (width, complexity, etc) but vary them in colour or design to show differences. Lines showing increasing quantities (eg traffic flow) are varied in width or in colour. Varying width usually works better.

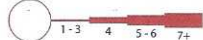
QUALITATIVE LINE SYMBOLS



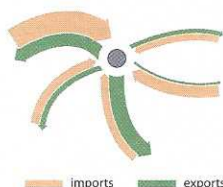
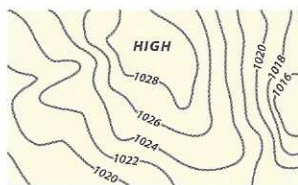
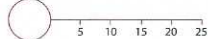
QUANTITATIVE LINE SYMBOLS



force of wind (Beaufort Scale)



% frequency of wind from a direction



CHOOSING THE RIGHT SYMBOL

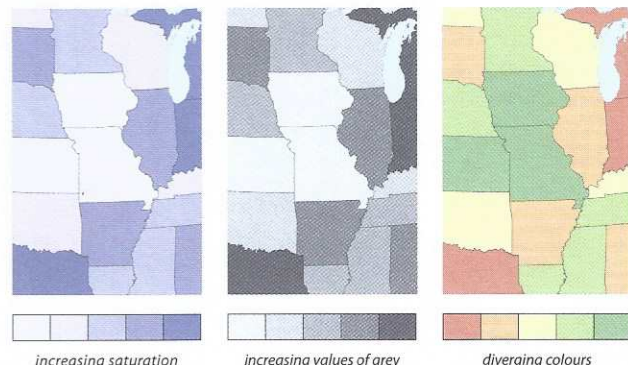
AREAS

Use different colours or fill patterns (like tree symbols) which look about the same weight for qualitative information. Vary the intensity of colours (the saturation), or the size of a repeated symbol to show statistical or ordered data — the more saturated (darker) the colour, the higher the value. Statistics with opposite characteristics (eg population increase and decrease) can be shown on one map by choosing two colours and increasing the saturation away from a neutral colour between them.

QUALITATIVE AREA SYMBOLS

Land Use	Agriculture	Bedrock Geology
residential	crops	mudstone
industrial	pasture	sandstone
commercial	forestry	limestone
open space	orchard	metamorphic

QUANTITATIVE AREA SYMBOLS

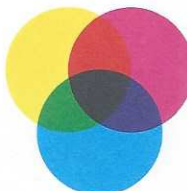


GOOD USE OF COLOUR on maps can really aid the communication of mapped detail, and colour can enhance legibility and contrast. Colour can make the important elements of the map stand out from background material. When designing a map, here are some points to consider:

PRINTED OR ELECTRONIC DELIVERY

- Maps are printed using the four 'process' colours: cyan, magenta, yellow and black (CMYK). Use a printer's colour chart to find the colour shades you want — they'll look different from the same colours on screen.

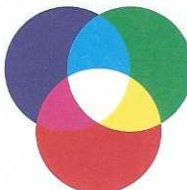
C		cyan		+		+		=	
M		magenta		+		+		=	
Y		yellow		+		+		=	
K		black		+		+		=	



Cyan, magenta, yellow and black are the primary hues used to mix colours with ink. Although cyan, magenta and yellow mixed together produce black, the density from the overprinted colours is not sufficient for lettering and a separate black ink is added. Different percentages of CMY and K produce thousands of other colours. See page 38 for a description of how this translates to the printing process.

- Maps on screen are mixtures of red, green and blue (RGB). Maps designed for screen viewing should use fewer colours with more contrast.

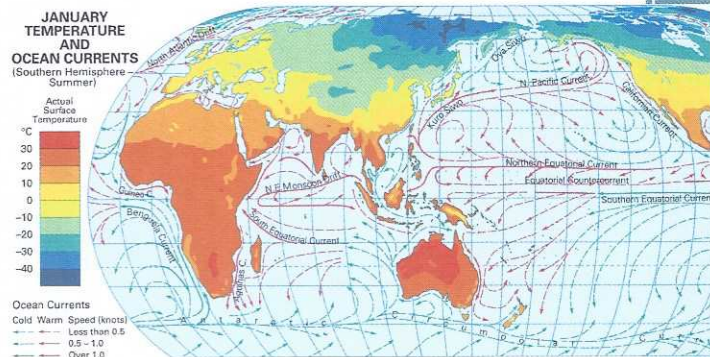
R		red		+		+		=	
G		green		+		+		=	
B		blue		+		+		=	
				+		+		=	



Red, green and blue are the primary hues used to mix colour with light on computer screens. Different proportions of red, green and blue produce thousands of other colours.

CHOOSING THE RIGHT COLOURS

- Important features need to stand out from the background and colour choice can help (especially using more saturated colours, not garish colours).
- Where appropriate, use conventional colours (eg green for vegetation) and associative colours (eg blue for cool, red for warm). Your audience will expect them.



Appropriate colour association for depicting temperatures, taken from the Australian Edition of The Philip's Modern School Atlas © Philip's

- Colours look different depending on their backgrounds, so don't choose them in isolation.



Background colours or tones affect the way we see a principal colour.



The two green squares are identical in colour but do not appear so.

- Good maps often use subtle, balanced colours, and bold colours can look inappropriate. However, a flat range of colours can look too bland.

QUALITATIVE MAPS

- These are maps where one area is not meant to be more important than another, just different — geology and ecology maps, for example. Don't show a hierarchy; choose colours which have the same visual 'value' and look equally important. Strong, saturated colours will stand out, so reserve them for small areas to make them show.
- Using part of the spectrum can make a good sequence.



Colours of same value with accents



Spectral colours

QUANTITATIVE MAPS

- These maps *should* show a hierarchy. Darker colours have greater importance, so the best sequences of colour are from light to dark to represent 'least' to 'most'.
- There are a number of different colour sequences which can be used (and often the default options on a GIS are the worst!):
 - progression of a single colour (eg light green to dark green)
 - mixing grey with a single colour, and reducing the amount of grey.



Single colour progression



Two colour, blue green progression



Three colour, yellow green blue progression



Value progression

useful tip

Use a maximum of 7 or 8 classes of data on a choropleth (area fill by value) map — and preferably no more than 6 — to allow easy understanding. More than that and it's hard to tell one infill colour or pattern from another.

useful tip

Don't be afraid to forego conventional colouration if your particular application warrants a more adventurous approach BUT take care to adhere to the principles of balance and legibility.

did you know...?

You can experiment with different colour options for a statistical or qualitative map and choose from a palette of ready-made colour ranges at www.colorbrewer.org

SOME OTHER HELPFUL POINTERS:

- Small letters and small symbols need more intense colours to show.

map symbol map symbol map symbol
map symbol map symbol map symbol
map symbol map symbol map symbol
map symbol map symbol map symbol



Adding a fine keyline to symbols will enhance the visual contrast and aid interpretation

- The most legible colour combinations for lettering are black, dark brown or blue on white.

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- The greatest contrast is between yellow and black.

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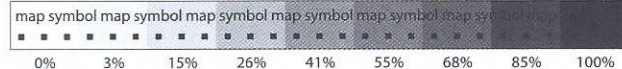
- Background colour affects the legibility of coloured type.

map symbol map symbol map symbol
map symbol map symbol map symbol
map symbol map symbol map symbol
map symbol map symbol map symbol



Background colour affects the appearance of symbols too (squares are same top & bottom)

- If you're limited to black and white, then use no more than six shades of grey for fills, and don't use a grey that's more than 70% black, especially if you want to place type on top of them.



- If you use more than 12 different colours on a map, it becomes very hard to interpret!

GOOD TEXT CAN ADD much to a map; poor text detracts from an otherwise good map.

There are six aspects of type which can be varied:

- typeface (font or fount)
Arial Garamond Helvetica LITHOS Univers Times
- type style — serif or sans serif - determined by the choice of font.
serif — Baskerville Galliard Palatino Times Warnock
sans serif — Century Gothic Futura Gill Myriad Trebuchet
- type characteristics — UPPER or lower case, SMALL CAPS, roman or *italic*, **bold** or **semi-bold**.
- type size — usually expressed in points

5pt 6pt 7pt 8pt 9pt 10pt 12pt 16pt 20pt

- letter spacing — fonts can be letter spaced, extended or condensed and the spacing between lines (leading) adjusted

Newcastle
upon Tyne

7pt type on 8.4pt leading 7pt type on 7pt leading

- colour — association of colour with feature

River Thames **Regents Park** CITY Tower of London

TYPEFACES

Simple and popular typefaces work best on maps and won't cause problems to readers of digital maps. Limiting yourself to a few fonts on a map and varying them by size, characteristic and spacing often works much better than using many fonts. Serif typefaces are often used for natural features and sans-serif for human features, but there are many exceptions to this rule. Serif typefaces aren't old-fashioned, either – they're easier to read in paragraph texts.

did you know...?

Many well-known typefaces are produced by different 'foundries' but given different names for copyright reasons. Likewise, two typefaces with the same name but from different foundries might look quite dissimilar!

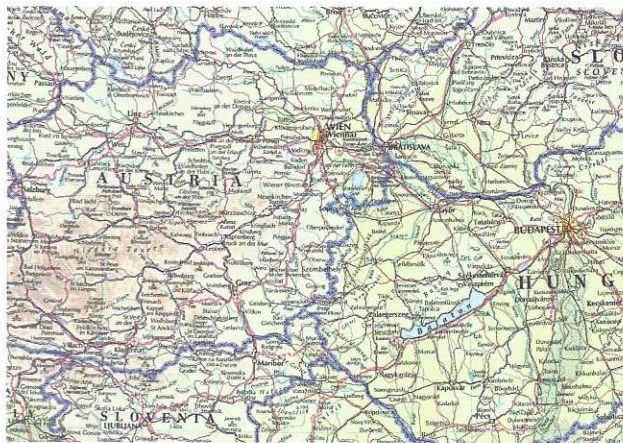
TYPE SIZE

Maps use smaller type sizes than you might think, typically 6 to 12 point — most people can read 6pt map text without a problem. Large text takes up space and looks bad. Even map titles look better in smaller sizes.

Work out a hierarchy of feature class and then vary size, case, spacing or colour of typeface to differentiate them eg, distinguish counties from districts by using a larger type size for counties. Keep associated features in the same font using size and weight to indicate importance — such as towns ranging from 5pt Helvetica Regular to 12pt Helvetica Bold according to population category.

useful tip

If map type looks cluttered try condensing the font or 'horizontally scale' it to 80-90%. If paragraph text looks crowded, decreasing the point size but increasing the leading can improve the readability.



Appropriate type styles, sizes, and fonts with careful name placement applied to reference mapping, from *The Times Comprehensive Atlas of the World* © Collins Bartholomew

TYPE PLACEMENT

For labelling **POINTS**, there is a preferred list of positions for the label. If you can avoid the label and the point being in line, so much the better to avoid confusion between symbol and label. Keep a consistent distance between points and their labels.



Romeo ○ London
Rome ○ London

Poor alignment of name with town symbol (top) and improved position (bottom)

Preferred positions for labeling points



Automatic placement of town names (left) and improved positions following custom edit (right)

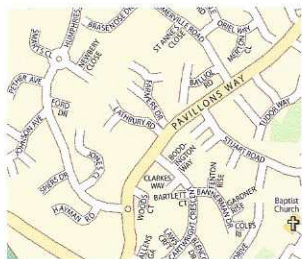
useful tip

Place names on coastlines or the edges of large lakes look better if placed entirely out at sea or across the lake. Try not to straddle the land/water boundary.

For labelling **LINES**, position labels above lines where you can, alongside and parallel. Don't try to spread out the letters for a long feature; repeat the label if necessary. If the feature has complex curves (like a river) the label should follow a simpler curve which shows the same trends.

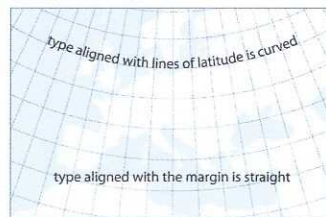


Type placed along river axes and repeated



Type curved to follow road alignments

When labelling **AREAS**, spread out the name across the extent of the area but not too close to the bounding edges. Either keep it horizontal, aligned with lines of latitude (for regional or world maps) or make it deliberately curved. It's fine to space out the letters for an area name, but make sure it still reads as one word and doesn't become a series of disjointed letters separated by surrounding type.



In maps with graticules, names are usually curved to the lines of latitude, whereas in maps without graticules the type is aligned to the map frame.



Type spaced and curved to fit shape of feature



Type size and extent scaled to suit administrative area



Poor type placement (above) and improved (below)



PAGE LAYOUT AND MARGINALIA

A MAP IS USUALLY ONLY one element of a graphic. Consider the *marginalia* (the other map-related graphics), as well as a page margin. A good page layout will balance the map with any text, photographs and other graphics, as well as using empty spaces to good effect.

Work out what elements you need to include on the page. As well as the main map, you'll probably have marginalia such as:

- titles
- insets
- location maps
- legend
- scale bar or statement
- north arrow
- technical information about the map
- copyright notice
- source acknowledgement
- explanatory texts

If it's for printing, decide on the page format: landscape, portrait or square. Then do some brainstorming of graphic ideas, for example by sketching 'thumbnails' of how the elements might be laid out, using page outlines of the right proportion. Perhaps use as a model a map that works.

- Balance the elements (including blank spaces) for harmony.
- Balance the elements around the page's optical centre, which is about 5% higher than the actual centre, and leave a bigger margin at the bottom than at the top.
- Elements which are related should be close to one another — eg a scale bar or title close to the map it refers to.
- Small, dark objects balance larger, light ones.



- Align page elements vertically and horizontally.

useful tip

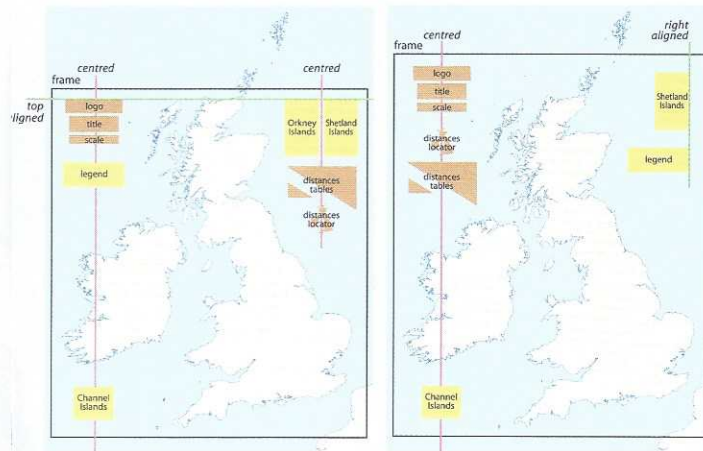
Try turning your page upside down and squinting at it to see if it still looks balanced.

PAGE LAYOUT AND MARGINALIA

TITLES AND LEGENDS

Map titles should convey the subject of the map, the geographic location and the date it refers to. Alternatively, some of the elements can be featured as subtitles or text annotations, depending on the nature of the map. In any case, a title should be proportional to the size of the map and not overpower the sheet.

Legends should contain a description of the symbology used on the map, although symbols that are self-explanatory (such as coastlines) can be excluded. Symbols used should be easy for the user to familiarise themselves with otherwise interpretation of the map is jeopardised.

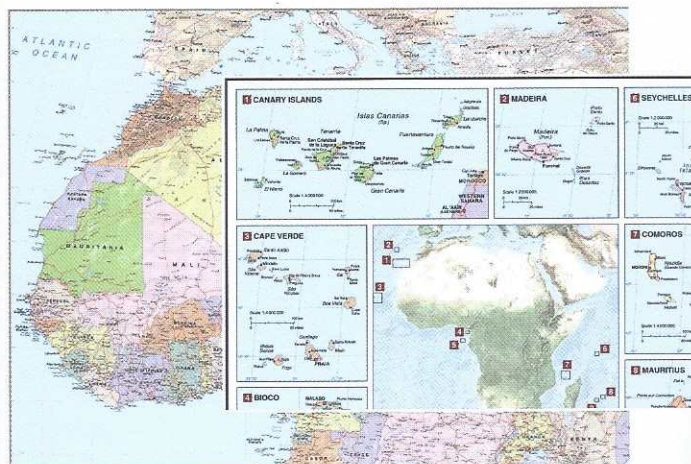


Two possible options are prepared above for the positioning of titles and legends. The version on the left shows the most compact option with both the Orkney and Shetland Islands as insets. On the right the Orkney Islands are included within the frame resulting in a larger map. Geographically the Channel Islands are too far removed to show in situ so an inset is the only option. Note the symmetrical positioning and edge alignment of the various elements.

LOCATOR MAPS AND INSETS

A locator map can be a valuable addition to a map to help the user identify the geographical context at a glance.

An inset may be required as an extension of a map at the same scale or to show a particularly detailed area at an enlarged scale. It is important to remember that a larger scale inset should show more detail and be to a similar specification, not simply an enlargement of the area from the main map. Scale details are essential if the inset is at a different scale, and the area shown in the inset should be indicated on the main map.



The islands insets on the wall map of Africa are well presented with titles and scale details and their positions indicated on the locator map. White borders help separate the different maps and the black frame unifies all the insets as a single unit.

A desirable improvement would be to reproject each inset map with standard parallels and meridians selected to suit the individual inset area, rather than making localised extracts from the main map. Note the extreme graticule curvature that occurs for insets 1, 2 and 3.

Original inset layout and frame detail (right). There are more graticule lines on the smaller scale inset map than on the main map. Scale bars are lost in the corners and scale ratios and titles are missing.



te the symmetrical layout of titles and scales in : amended map (above) and the new position of : legend. A simple black line is all that is required frame the map and the white borders separate the ets from the main map.

LEGENDS

THE PURPOSE OF A LEGEND is to explain map symbols. Not all maps need a legend, but the more technical or specialist the map, the more it's likely to need one.

If you have a legend, it should be comprehensive. Include all symbols shown on the map, even if familiar; only omit basic information (like roads and rivers) if you really don't have room. Symbols should be shown in the legend in exactly the same size, colour and manner as on the map.

LEGEND LAYOUT

- Group related features together — so anything to do with railways (track symbols, stations, level crossings etc) should appear together.
- Good legends often group symbols of the same graphic type: show all point symbols together, likewise line and area symbols.
- Show samples of text, with the same fonts and colours as used on the map.

Index and explanation 1:625,000 bedrock geology map © NERC



Key to Map Symbols

- ▲ Active volcano
- △ Dormant volcano
- ▲ Extinct volcano
- U Canyon
- ▲ Cave
- Geyser
- Impact crater

Styles of Lettering

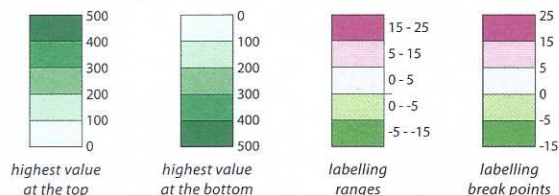
- FRANCE Country
- MONTANA State/Province
- Sardegna Island
- Antarctic Peninsula Peninsula
- ANDES Mountain range
- Everest Mountain peak
- GRAND CANYON Featured location
- Gilboa Desert Desert
- Age of Good Hope Cape
- Amazonas River
- Lake Victoria Lake
- ATLANTIC OCEAN Ocean
- Caspian Sea Sea
- Gulf of Carpentaria Gulf

LEGENDS

LEGENDS FOR DATA MAPS

A legend for a choropleth (area fill by value) map should show the colour fill or pattern used, and should label the data range.

- Decide if the highest value will be at the top or bottom of the scale (usually at the top). Be consistent across a series of maps.
- Label each entry with its range (eg 101–200) or label the breaks between classes (which may simplify the legend).
- State the units being used, especially for ratios, eg 'percentage', 'density per km²', etc. If the map shows change across time, you need to state dates, eg 'percentage change, 1991–2001'.



useful tip

For legends on choropleth maps you should show the data ranges in connected boxes, but for qualitative area fills keep the boxes separate.

If you are showing proportional symbols (scaled circles or squares) then the legend should show at least three representative symbols including the smallest and largest symbol used.

SCALE BARS

Scale bars need not necessarily be placed within the legend area. It may be more appropriate to position a scale bar with the title, depending on the type of map and layout design. Whatever the application, a scale bar should use logical units and divisions based on whole numbers which are easily understood (so 0, 5, 10 not 0, 2.3, 4.6, etc). Often scale bars on topographic maps have a section to the left of zero which subdivides the major units shown to the right.

THE DEFAULT MAPS PRODUCED from a GIS query often don't convey a message well because the cartography is poor. Default maps take little account of the essential cartographic principles of legibility, good structure, correct use of colour and pattern, visual contrast, the figure-ground relationship, balance and good typography.

Most GIS maps can be improved with a little work. If you have sophisticated cartographic tools as part of the GIS program, then use them. Otherwise, it's worth exporting the map file to a graphics program like Illustrator where you have much more design flexibility. Programs like MAPublisher can act as a bridge between GIS and graphic design.

CHECKLIST FOR BETTER MAPPING:

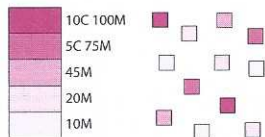
TITLES: Don't use the file's default name as a map title. Put in your own, meaningful title and omit the word 'map'.

Map of the British Isles showing number of people living in each square km for 2006

BRITISH ISLES
Population Density
people per sq km, 2006

A succinct title, subtitle and note (right) is so much better than the wordy description (left)

COLOURS: Default colour ranges are often poor, particularly for choropleth (area fill by value) maps. Have a look at www.colorbrewer.org for some suggested colour schemes.

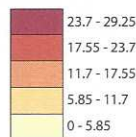


A single colour progression may appear clear in a legend but when the colours are scattered randomly they become difficult to differentiate

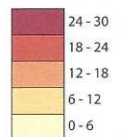


By increasing the cyan at the top of the range and adding yellow at the bottom the colours are more easily identified

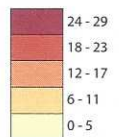
DATA CLASSES: GIS queries often result in a huge number of data classes, but map users can only distinguish seven or eight colours and only five tones of grey with ease. Reduce the number of classes. Equal data intervals rarely reveal much about the statistics. Consider different classification options, including logical break points (like zero).



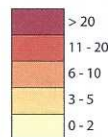
decimal places can be meaningless in some data



equal class intervals are a common default



avoid repetition of data values



consider alternative class intervals

useful tip

Never use white as a class colour, even for areas with no data. It will always look like a mistake!

TYPE: Poor type placement, inappropriate type sizes and poor default fonts like Courier make a map unreadable. Improve the type and the message gets through.



Names in Courier (left) must be smaller to occupy the same space as in Myriad (right) and are consequently much harder to read.

SYMBOLS: Check the colour and size of symbols. All symbols should be clear, legible and distinguishable from one another.



Smaller symbols require stronger colours to tell them apart

LEGEND: A legend should explain all symbols shown on the map. Check that data labelling is clear and correct, and that the units are shown (eg Density per km², 2006).

BETTER MAPPING IN 5, 15 AND 50 MINUTES

Even if you have checked and checked again it is always worth one final check before the map is signed off as complete. The more you work on a map the less you will see the errors — it is the obvious ones which will get through, such as the misspelling of familiar words. Here are some tips on what to check in 5, 15 or 50 minutes.

In 5 MINUTES...

CHECK...

- your map title — is it brief and directly related to the map?
- the scale of the map — is it correct?
- the units in your scale bar — are they rounded (eg 5km, not 4.85km) and easy to understand?
- the legend — do all the symbols in your legend match the map?
- the insets — does each have a title and scale bar?

In 15 MINUTES...

AS WELL AS THE ABOVE, CHECK...

- if it's designed to be a screen map, is it WYSIWYG?
- does the map fit the page or screen?
- does your legend state the right units (eg density per km²)?
- check your spelling

In 50 MINUTES...

AS WELL AS THE ABOVE, CHECK...

- get a second opinion on your map design
- if it's a web map, try it on different platforms
- print it and proof it!
- try printing a colour map in mono — does it still look OK?
- double check the spelling of place names!

BETTER MAPPING IN 5, 15 AND 50 MINUTES

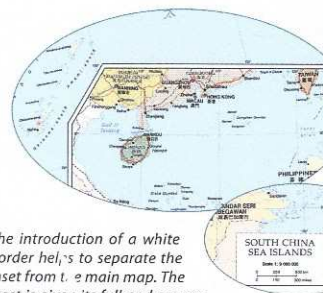
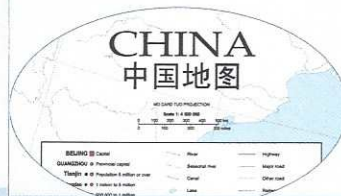


A few simple changes improve a poor map.

The original map (above) features a rectilinear grid as well as lines of latitude and longitude. The grid has been removed together with the grid references since there is no need for either in the absence of an index. When a grid reference is required the figures and letters should be placed outside the legend.

The very poor layout of the legend (above) has been improved and the superfluous heading removed. The title of the map is shortened and moved to sit above the new legend with the scale bar (below).

Note the incorrect scale details on the original map — the scale ratio is given as 1:12,000,000. In fact, its scale is actually 1:4,500,000!



The introduction of a white border helps to separate the inset from the main map. The inset is given its full and proper title and the scale details corrected. The background to the title panel is made white as for the main legend for easier identification.

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Apple	15 top
www.apple.com/uk/iphone	
Automobile Association	1 centre, 69, 26
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Collins Bartholomew	611, 12, 17 bottom, 49
www.bartholomewmaps.com	
Communicarta	62, 17 top, 32
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www.imray.com	
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www.rin.org.uk	
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www.steerdaviesgleave.com	
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The GeoInformation Group	10, 29 bottom
www.citiesrevealed.com	
The XYZ Digital Map Company	4-5, 610
www.xyzmaps.com	
United Kingdom Hydrographic Office	13
www.ukho.gov.uk	

The numerous examples of mapping that appear throughout this booklet without acknowledgement on the page have been specially created by Mary Spence MBE from data supplied by The XYZ Digital Map Company and from maps published by Global Mapping. Special thanks must go to both companies for permitting their work to be used in this way.

The sketches employed to illustrate cartographic principles have been prepared and supplied by Mary Spence MBE.

FURTHER INFORMATION

Some useful further reading:

Designing Better Maps A Guide for GIS Users by Cynthia A. Brewer
ESRI Press, Redlands, California

Making Maps A Visual Guide to Map Design for GIS by John Krygier
and Denis Wood
The Guilford Press, New York & London

The British Cartographic Society

The British Cartographic Society is a registered charity open to all with an interest in maps and cartography. Its aim is to promote all aspects of cartography in the UK and abroad by offering a forum for the exchange of ideas and the sharing of cartographic knowledge.

The British Cartographic Society publishes *The Cartographic Journal* and *Maplines* (an informal newsletter), hosts special-interest groups and holds an annual symposium. It has a wide membership drawn from practising mapmakers, map curators, the GIS community and many who are simply interested in maps.

Details of activities and membership can be found on the Society's website www.cartography.org.uk. If you're interested in maps, we hope to welcome you soon.



CARTOGRAPHY *an introduction*

The British Cartographic Society (BCS) is committed to promoting good cartographic practice as an essential component in the preparation and dissemination of all maps and map products. Through the Better Mapping Campaign BCS is reaching out to the mapmaking community to assist in understanding the principles behind the creation of a good map. This booklet introduces the fundamentals of good cartographic design.

UK Price £4.99

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