



NORAD supported project in MRRD covering
Capacity Building and Institutional Cooperation in the
field of Hydrogeology for Faryab Province
Afghanistan

GIS Course 4.9 Introduction to Cartography

By Andreas de Jong
December 2013

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PURPOSE OF THIS COURSE

The purpose of this course is to provide an introduction to:

1. The cartographic planning process.
2. Choosing appropriate data for mapping needs.
3. The cartographic design principles.
4. Designing map layouts.

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KEY REFERENCES

ESRI Mapping Centre: www.mappingcenter.esri.com

Harvard University GIS Manual:
<http://www.gsd.harvard.edu/gis/manual/style/>

ESRI Courses:

- Making Better Map Layouts with ArcGIS
- Layout Design Essentials for ArcGIS 10.1
- Getting Started with Cartographic Representations
- Advanced Techniques for Cartographic Representations
- Designing Maps with ArcGIS (10.1)
- Etc..

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Tentative Course Schedule

Day	Date	Activity
1	10/12/2013 Morning	Opening & Introduction Lecture: Introduction to cartography
	Afternoon	Workshop: Hydrogeology Maps
2	11/12/2013 Morning	Practical: Designing map templates
	Afternoon	Practical: Designing map legends

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TOPICS TO BE COVERED

1. Introduction
2. Cartographic planning process
3. Evaluating data
4. Cartographic design principles
5. Advanced symbology techniques
6. Map text
7. Designing Layouts

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Optical Illusions

Are the purple lines straight or bent?



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Optical Illusions

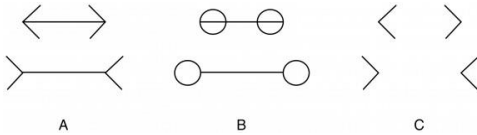
Which middle dot is bigger?



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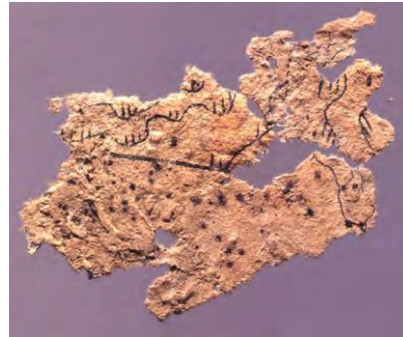
Optical Illusions



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Earliest Paper Map – West Han Dynasty, China



- Early 2nd century BC
- Shows mountains, waterways and roads

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Map of Hecataeus, Ancient Greece (~500 B.C.)



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The Yu Ji Tu (Map of the Tracks of Yu the Great)



- Carved in stone
- Year 1137 (Song Dynasty)
- 100 li (Chinese mile) grid
- Accurate rivers & canals

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Source: <http://wiki.gis.com/wiki/index.php/Cartography>

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Source: http://wiki.glx.com/wiki/index.php/Gierard_van_Sichag

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Source: <http://www.mapsinternational.co.uk/blog/wp-content/uploads/2012/10/white-environmental-world-map-poster.jpg>

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2:

Source: <http://www.esri.com/software/arcgis/extensions/trapping-charting>

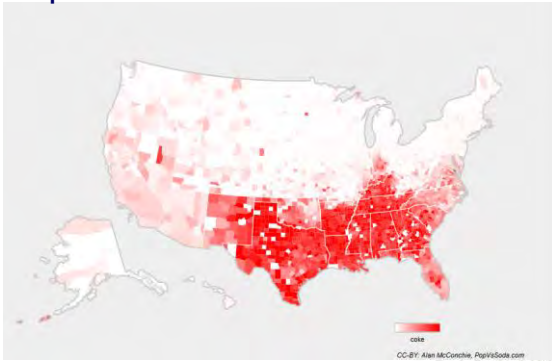
23

....but what is the message?

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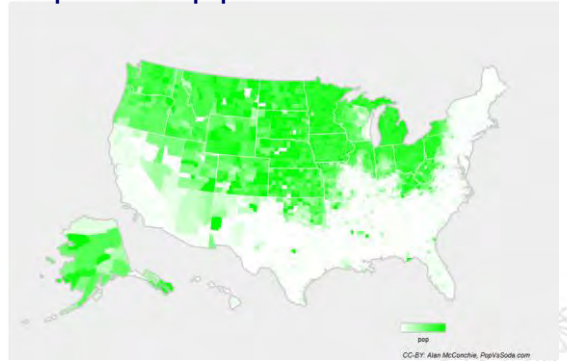
2.

Pop v. Soda – “coke”



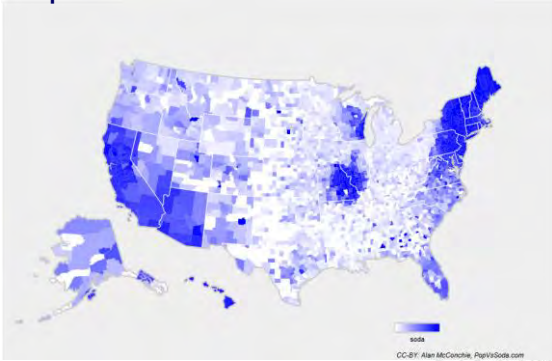
25

Pop v. Soda – “pop”



26

Pop v. Soda – “soda”



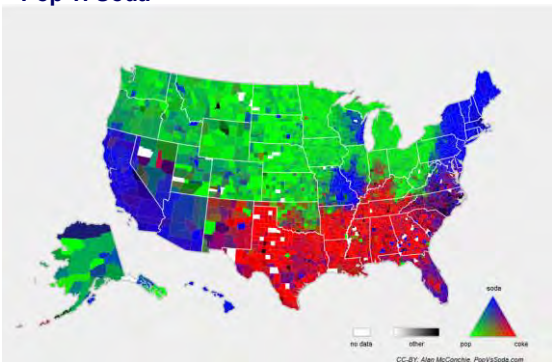
27

Pop v. Soda – “other”



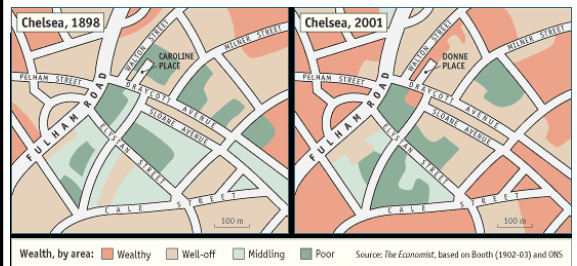
28

Pop v. Soda



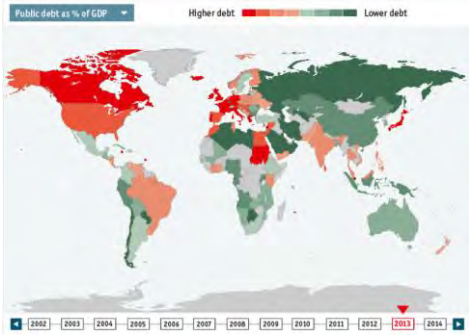
29

London Neighborhoods (The Economist)



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Public Debt (The Economist)

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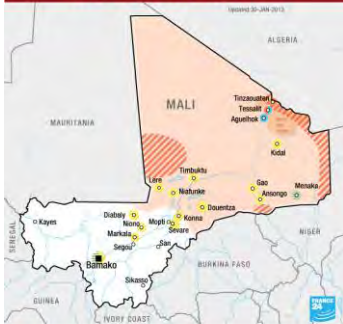
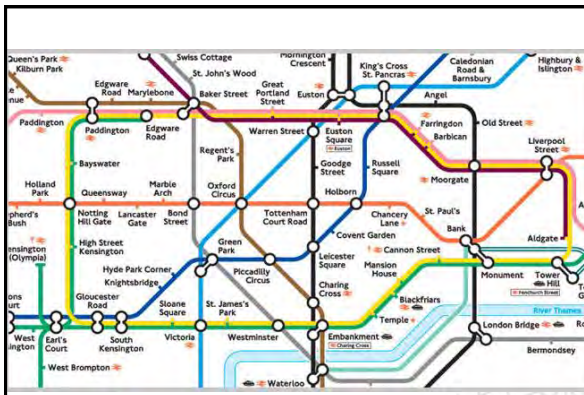
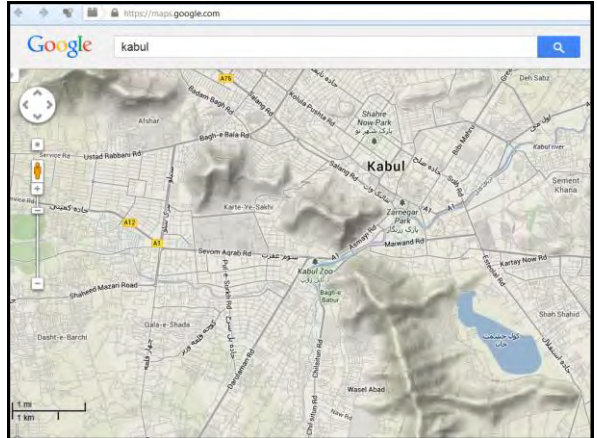
2011 Esri International User Conference Map: “Where We’re From”



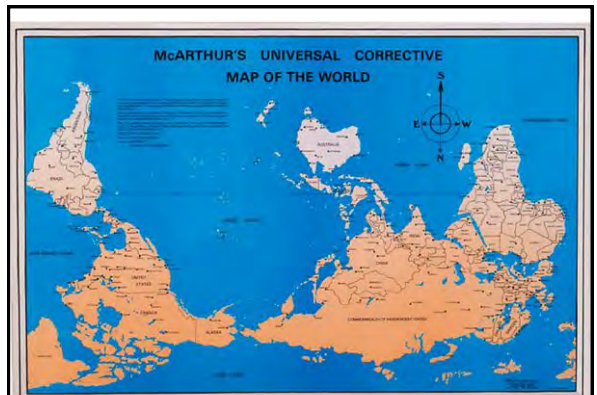
esr

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WAR IN NORTHERN MALI

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Source: <http://www.fatcodeign.com/1064892/london-tube-map-sparks-force-over-what-design-means>

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Source: <http://willing101.net/2008/02/14/questioning-tradition/>

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Evaluating Scale

Risk

High

Low

Strategy • Tactics • Details

Risk

Size

Population

\$

Etc.

Decisions Fuel

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Source: <http://www.aes.com/news/sectors/energy/17/tactics-on-scale-and-complexity-and-the-need-for-rigorous-analysis.html>

Scale	Resolution (precision)	Detection (accuracy)
1:1,000,000	500m	1,000m
1:500,000	250m	500m
1:250,000	125m	250m
1:100,000	50m	100m
1:50,000	25m	50m
1:10,000	5m	10m

Evaluating Levels of Complexity

Map scale 1:5,000,000

A

Too detailed

B

OK

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Source: <http://www.esri.com/news/arcuser/08/01/Working-a-map-meeting-it-all.html>

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Evaluating Levels of Complexity


Map scale 1:1,000,000

C




OK

D



Not enough detail

Source: <http://www.esri.com/news/arcuser/09/09/working-a-map-making-it-all.html>

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[illegible][illegible]

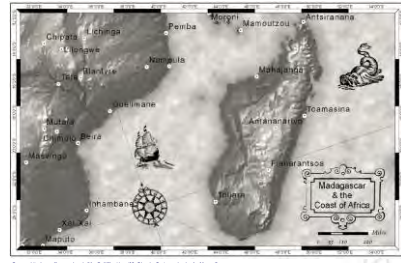
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Design considerations

- ✓ What is the 'look' & 'feel' of the map?
Historical, modern, detailed, simple, technical?



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Design considerations

- ✓ What is shown on the map and for what purpose?
- ✓ What is the subject of the map?
 - Thematic, reference or schematic maps
 - What information does the user require?
- ✓ Who is the map for?
 - General audience or technical staff.
 - What is the appropriate map vocabulary or terminology?

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Design considerations

- ✓ Where will the map be used?
 - Office, field, inside a moving vehicle...
 - What base layers are required for visualization and/or navigation purposes (aerial imagery, streets, land parcel boundaries, etc).
- ✓ Are there any technical limits?
 - Colours on computer & print are different.

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Design for Purpose: What will the map be used for?



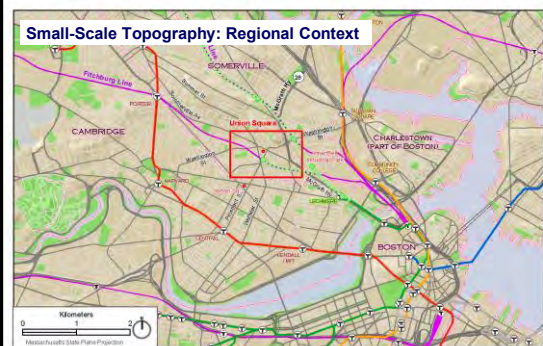
Bad mobile map



Good mobile map

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Small-Scale Topography: Regional Context

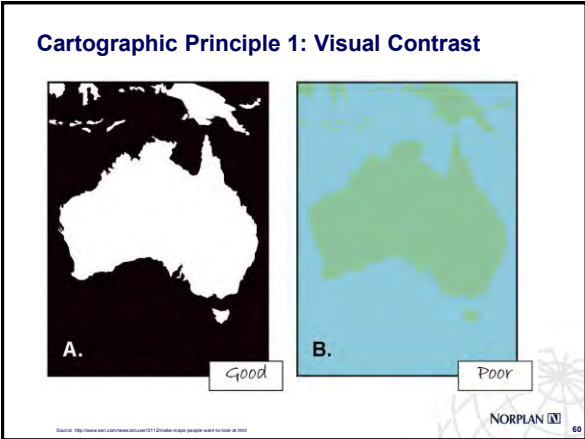
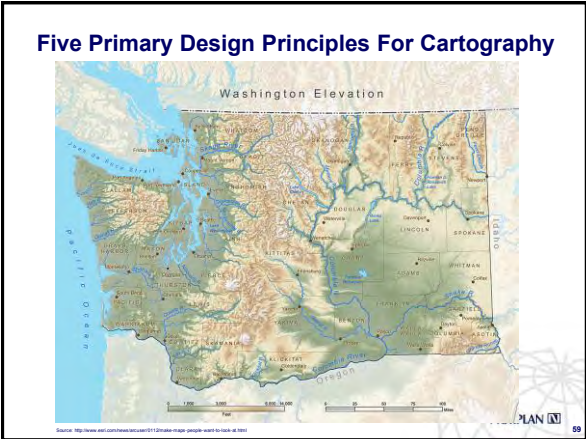
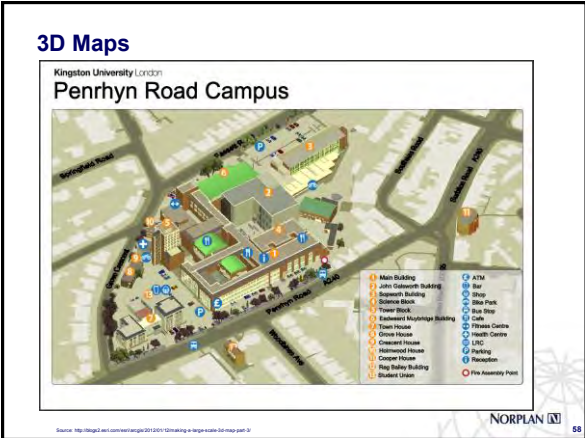
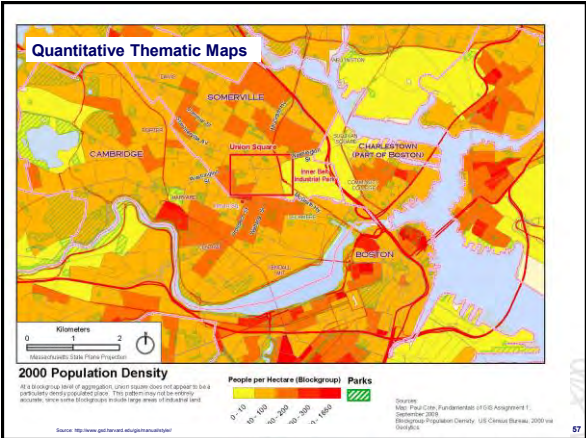
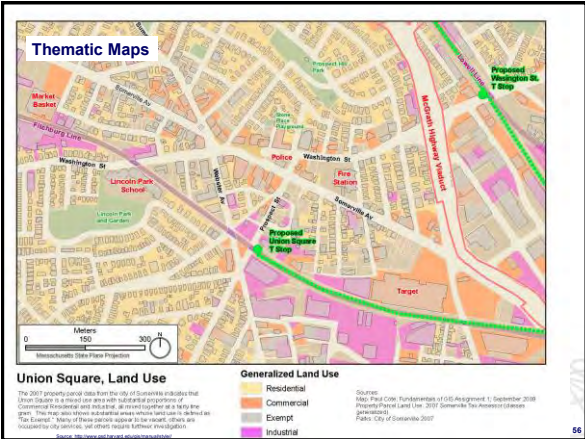
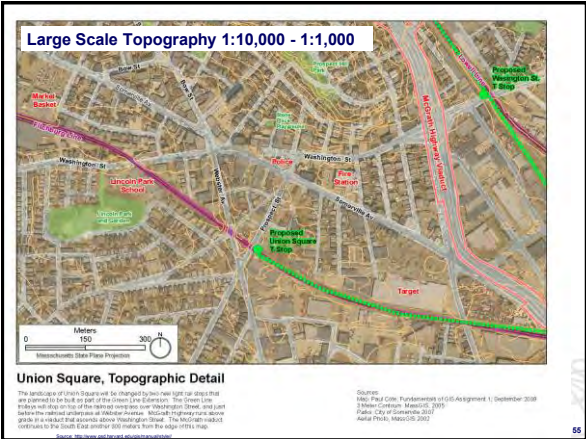


Union Square and the Green Line Extension

Just over 2 kilometers from downtown Boston, Union Square is a new commercial center and will be a major transit hub. The Massachusetts Department of Transportation is under a federal order to build the Green Line Trolley extension through Union Square by 2014. This extension will bring the existing Green Line to the commercial center and will include a stop for Union Square along the 'B' Branch Line. Union Square will be a pedestrian-friendly area with a new bus stop and a new bus stop. Union Square will be a major transit hub.

Sources:
Map: Paul Code, Fundamentals of GIS, 1st Edition, 2009.
Boston: Massachusetts Department of Transportation, 2007.
MIT: Institute for Transportation and Logistics, Office of Transportation, 2008.
Proposed Green Line Extension and Station from
Proposed Green Line Extension and Station from
Proposed Green Line Extension and Station from

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Cartographic Principle 2: Legibility

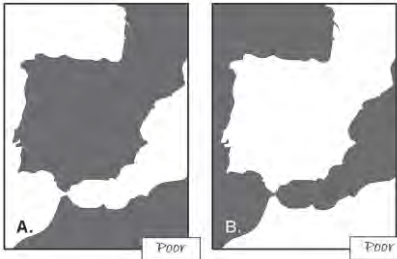


Harry Beck's 1933 plan of the London Underground

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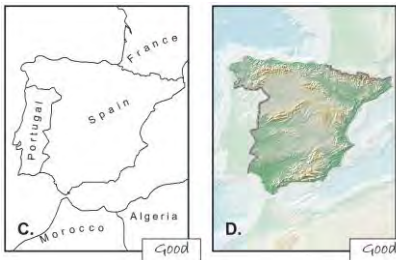
Cartographic Principle 3: Figure-ground Organization



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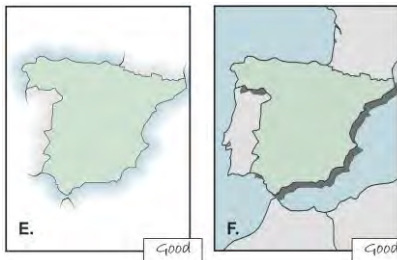
Cartographic Principle 3: Figure-ground Organization



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Cartographic Principle 3: Figure-ground Organization



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Cartographic Principle 4: Hierarchical organization



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Cartographic Principle 4: Hierarchical organization



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WASHINGTON SOILS

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Source: <http://www.eeri.com/news/arc/eeri/0112/make-maps-people-want-to-look-at.html>

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Cartographic Principle 5: Balance



POOR

Poor

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Cartographic Principle 5: Balance



GOOD

6,000

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Source: <http://www.eeri.com/news/arcus/eri/0112/make-rage-people-want-to-look-at.html>

78

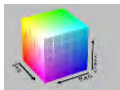
Remember your Audience!

- ✓ It should take them < 7 seconds to “get it”.
- ✓ They do not want to read the legend.
- ✓ They do not want to have to re-read the map title.
- ✓ They want it to look pretty.

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Understanding effective use of colour



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Source: http://en.wikipedia.org/wiki/VGL_and_VLS

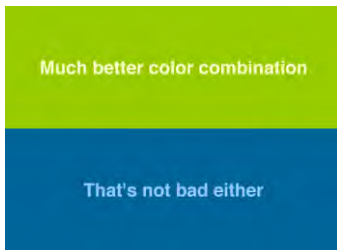
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Clashing Colours

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Colour Harmony



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Colour Harmony



The Colour Wheel



Monochromatic
Different shades of a single colour.

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Colour Harmony



Analogous Colours
Close to each other
on the colour wheel



Triadic colours
Spaced evenly on
the colour wheel.

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Colour Harmony



Complementary Colours
Opposite one another
on the colour wheel

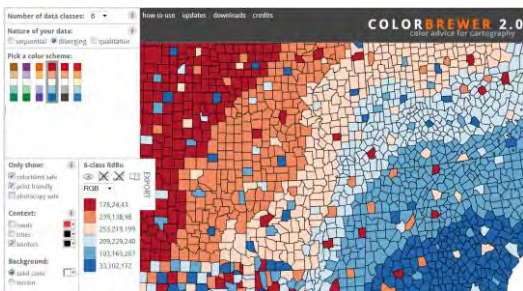


Neutral Colours
Not in the colour wheel.

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<http://colorbrewer2.org>



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WHYMAP - <http://www.whymap.org>



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Understanding effective use of colour

Legend:

- Militant control
- High risk
- Medium risk
- Low risk

Provinces shown on map: JOWZJAN, BALUCHI, KUNDUZ, TAKHAR, BAZIDMOHSHAN, BACHAN, PAKISTAN, NOBISTAN, PARIWAN, KAPISA, PAKISTAN, KUNAR, BAMIYAN, WARDAK, KANDAHAR, NANGARHAR, GHOZAT, DAYKUNDI, GHAZNI, PAKTIA, PAKTICA, FARAH, NIMRUZ, HELMAND, KANDAHAR, URGUZGAN, ZABUL, KANDAHAR.

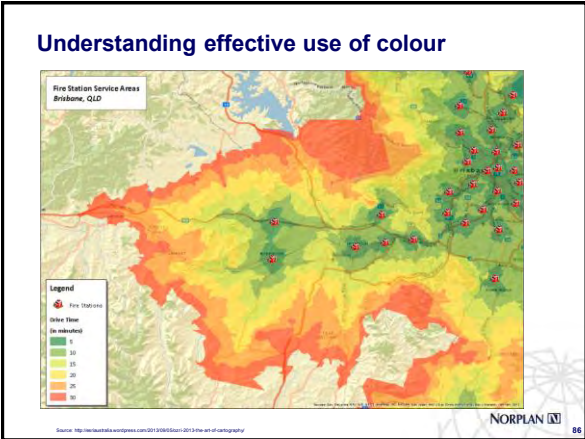
Voting day 20 August

- 30 Presidential candidates
- 3,197 Provincial council candidates
- 6,969 Potential polling centres
- 250,000 Observers/journalists
- 15-17 million Voters (40% women)

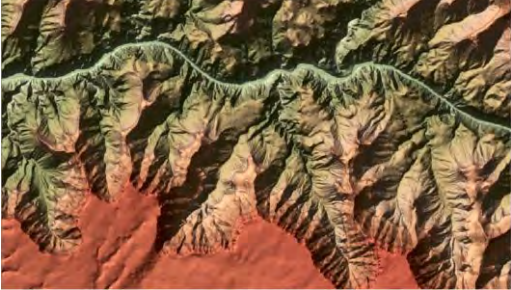
SOURCE: Afghan Interior Ministry, Reuters

BBC - Afghanistan: Security map 19 August 2009


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Understanding effective use of colour




Source: <http://blogs2.aol.com/earthangel/20110607/how-the-edge-54-designing-the-deaths-in-grand-canyon-map/>

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Designing colour schemes and symbols


- ✓ Use familiar symbols, intuitive symbols, or good explanations for symbols that are not familiar or intuitive.




Live Tree



Dead Tree




Source: <http://www.esri.com/news/arcuser/0001/creating-a-map-meaningful.html>

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









Designing colour schemes and symbols

- ✓ For **qualitative data** (signifying difference in type), use colour hue (e.g., red, green, blue) and shape (e.g., points, lines).



Source: <http://news.and.commerce.com/2011/locating-a-map-meaningful.html>

Designing colour schemes and symbols

Feature Type	Visual Variable		
	Shape	Orientation	Color Hue
Point	 Spring  House  Tower	 Live Tree  Dead Tree	 Live Tree  Dead Tree
Line	 National Border  Trail  Section Line	 Asphalt Road  Concrete Road	 National Border  State Border
Area	 Gravel  Sand	 Orchard  Field Crop	 Land  Water

Qualitative Data
(signifying difference in type)

Source: <http://www.and.com/newsroom/2001/branding-in-map-making/41.html>

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Designing colour schemes and symbols

- ✓ For **quantitative data** (signifying a difference in magnitude), size or colour lightness and/or saturation are your best choices. **The eye will intuitively see larger or darker symbols as more.**

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Designing colour schemes and symbols

Feature Type	Visual Variable			
	Size	Pattern Texture	Color Lightness	Color Saturation
Point	Small ↓ Large	Coarse ↓ Fine	Light ↓ Dark	Pale ↓ Intense
Line	Medium ↓ Low	Medium ↓ Low	Medium ↓ Low	Medium ↓ Low
Area	High ↓ Low	High ↓ Low	High ↓ Low	High ↓ Low

Quantitative data (signifying a difference in magnitude),

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Remember your Audience!

- ✓ Do not use colour which are "loud".
- ✓ Do not use colour which "clash".
- ✓ Use "soft" colours for printed maps.
- ✓ Make sure there is a contrast between the colours.
- ✓ No one colour should over-balance the picture, unless you deliberately want the colour to stick out.



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Cartographic Checklist

Source: Aileen Buckley and Kenneth Field, ESRI

1. Do I know what my map's story is?
2. Am I using the right map projection?
3. Am I using data at the right level of generalization?
4. Is my symbology clear?
5. Do my symbols match my data?
6. Have I used the right text symbols?
7. Does my map have figure-ground organization?
8. Does my map have good visual hierarchy?
9. Do I need to add anything else to my map?
10. Has an independent person(s) given their comments?

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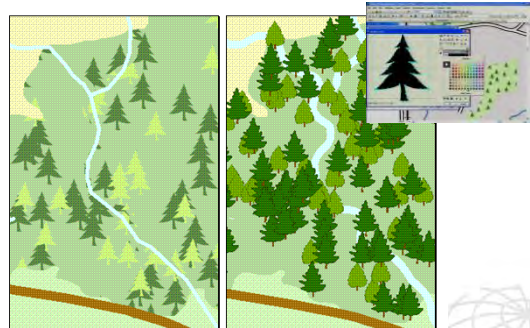
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Cartographic representations



Depicted using traditional ArcMap layers

Depicted using Representations

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Cartographic Representations


The flowchart illustrates the process of cartographic representations, organized into four main categories: GIS Feature, Representation Rule, Override, and Output.

- GIS Feature** (Green boxes):
 - Feature Shape
 - Feature Attributes
- Representation Rule** (Blue boxes):
 - Representation Rule ID
- Override** (Pink box):
 - Overrides (if any)
- Output** (Yellow boxes):
 - Basic Symbol
 - Screen or Print

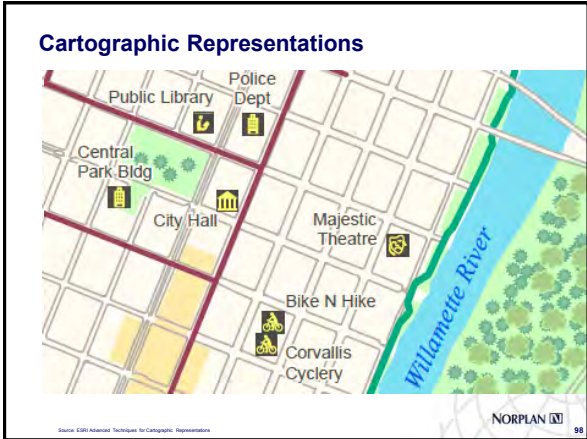
The process flow is as follows:

- Feature Shape** and **Feature Attributes** feed into the **Rule** box.
- The **Rule** box feeds into the **Geometric Effect (Offset)** box.
- The **Representation Rule ID** box feeds into the **Geometric Effect (Offset)** box.
- The **Geometric Effect (Offset)** box feeds into the **Geometric Effect (Dash)** box.
- The **Geometric Effect (Dash)** box feeds into the **Basic Symbol** box.
- The **Geometric Effect (Dash)** box also feeds into the **Geometric Effect (Marker)** box.
- The **Geometric Effect (Marker)** box feeds into the **Basic Symbol** box.
- The **Overrides (if any)** box feeds into the **Rule** box, the **Geometric Effect (Offset)** box, the **Geometric Effect (Dash)** box, and the **Basic Symbol** box.
- The **Basic Symbol** box feeds into the **Screen or Print** box.

Source: <http://www.esri.com/news/arcnews/article/000600/arcnews/000600.asp?topic=the-art-of>

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Designing Advanced Symbols

Source: <http://blog2.aec.com/enr/angle/01105807/over-the-edge-54-designing-the-deaths-in-grand-canyon-map/>


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- 
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Labelling in ArcMap

- ✓ Labels are placed on the map according to:
 - Geometry.
 - Value of the Label text string.
 - Text placement rules.
 - Prioritization of layers.
- ✓ Labels are dynamic and cannot be edited.
- ✓ Annotation
 - Stored in a Map or in a Database.
 - Editable
- ✓ Label placement engines
 - ESRI Standard
 - Maplex Extension



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- ## Labelling in ArcMap
- ✓ Labels are placed on the map according to:
 - Geometry.
 - Value of the Label text string.
 - Text placement rules.
 - Prioritization of layers.
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 - Stored in a Map or in a Database.
 - Editable
 - ✓ Label placement engines
 - ESRI Standard
 - Maplex Extension
- 
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- 101

Labelling in ArcMap

Labels	Annotation
Dynamic	Static
Managed as a group	Managed individually
Stored in map document	Stored in map document or in GDB
Linked to a feature	May or may not be linked to a feature
Layer property	Can be a graphic or a feature

The aerial photograph shows a landscape in Farah Province, Afghanistan. Several yellow triangles represent wells, some labeled with names like 'Well, 40 m deep (probably Soviet well)', 'Well hydrogeological early', 'Well no. 134', 'Well', 'Well', 'Well', 'Well', and 'Well'. A red polygon outlines a specific area, and a black text label 'This is a sandy area' points to it. Other labels include 'Farah - Province', 'Afghanistan', 'Pala Baha', 'Mansoor Khan', 'Bazar Qala', 'Kandahari Mahgum', 'Midan', 'Dau Aba', 'Sariyeh', 'Chadanga', 'Tik Munda', 'Ayak', 'Akra', 'Ward (former)', 'NORPLAN', and 'Globe'. The bottom right corner features the NORPLAN logo.

Labelling in ArcMap

Labels	Annotation
Dynamic	Static
Managed as a group	Managed individually
Stored in map document	Stored in map document or in GDB
Linked to a feature	May or may not be linked to a feature
Layer property	Can be a graphic or a feature

This is a sandy area

Well, 40 m deep (probably Quaternary)

hydrogeological well no 134

Well (early)

Well

Well

Well

Well

Farah - Province

Afghanistan

Pala Bala

Bazar Qala

Musharraf Khan

Kandahar

Maidan

Dau Aba

Sari

Vardana

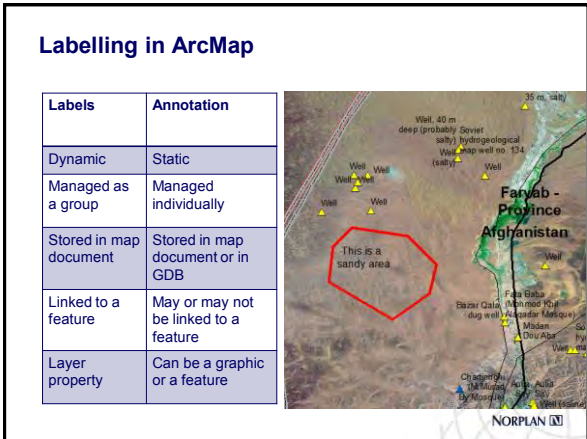
Chakrangi

Tala Muroz

Ayala

Wadi Kharab

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Labelling in ArcMap

```
graph TD; A[Labeling your map] --> B[Not feature based]; A --> C[Feature based]; B --> D[Individual labels]; C --> E[Bulk labels (dynamic)]; E --> F[Standard Label Engine]; E --> G[Maplex Label Engine]; F --> H[Options]; G --> H; H --> I[Convert]; I --> J[Map annotation group]; I --> K[GDB annotation FC]; K --> L[GP import tools]; L --> M[Coverage anno]; L --> N[CAD anno];
```

The flowchart illustrates the process of labeling a map in ArcMap. It starts with 'Labeling your map', which branches into 'Not feature based' and 'Feature based'. 'Not feature based' leads to 'Individual labels'. 'Feature based' leads to 'Bulk labels (dynamic)', which then branches into 'Standard Label Engine' and 'Maplex Label Engine'. Both engines lead to 'Options', which then leads to 'Convert'. 'Convert' leads to 'Map annotation group' and 'GDB annotation FC'. 'GDB annotation FC' leads to 'GP import tools', which then branches into 'Coverage anno' and 'CAD anno'.

GP = geodatabase data model of ArcGIS
GP = geoprocessing tools in ArcGIS

FC = feature classes.
CAD = computer-aided design data formats.

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Label Management – Layer Properties Dialog

Label Manager – Labeling Toolbar

Label Manager – Labeling Toolbar

Maplex Label Engine (Extension)

The screenshot displays the Maplex Label Engine (Extension) interface, which is used for configuring map labeling. The interface is organized into three main panels:

- Label Properties:** This panel on the left contains settings for 'General Placement' and 'Text'. The 'General Placement' section includes options for 'Overplacement' (set to 'None'), 'Curved and offset lines', 'May place label horizontal at secondary offset', 'Position' (set to 'Bottom'), 'Label Offset' (set to 'Bottom'), and 'Description'. The 'Text' section includes options for 'Repeat label', 'Align' (set to 'Left'), and 'Spread characters' (set to 'None').
- Label Strategy:** This middle panel shows a list of labeling strategies. The 'Simple Label' strategy is selected and highlighted. Other strategies include 'Character Label', 'Distance Label', 'Distance Between', 'Distance Label', 'Minimum Space Size for Wrapping', and 'Maximum'. A 'Strategy Options...' button is located at the bottom.
- Label Placement:** This panel on the right contains settings for 'Feature Weight', 'Background Label' (set to 'Background Label (printed first)'), 'Character Displacement' (set to 'None'), 'Label Offset' (set to 'None'), 'Text Rotation' (set to 'None'), and 'Text Rotation (after offset)' (set to 'None').

A small inset window in the top right corner shows the 'Maplex Label Engine Options' dialog, which includes a 'Labeling' section with various icons and a 'Use Maplex Label Engine Options...' button.

[illegible]

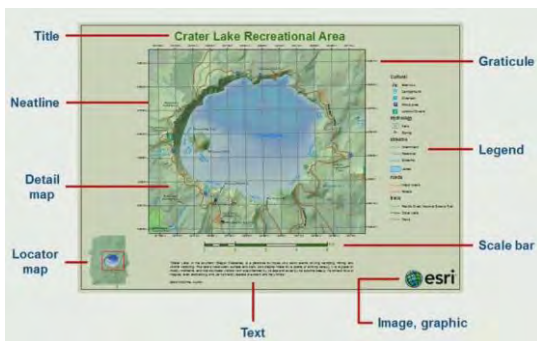
TOPICS TO BE COVERED

1. Introduction
2. Cartographic planning process
3. Evaluating data
4. Cartographic design principles
5. Advanced symbology techniques
6. Map text
7. Designing Layouts

What is a Layout?

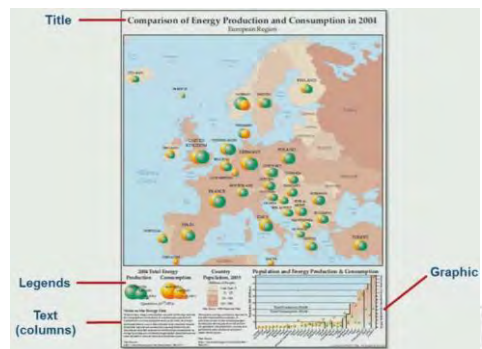
- ✓ A map layout is a product you create to share your map with others.
- ✓ The main elements on a map layout are:
 - Map body
 - Legend
 - Scale indicator
 - Title
- ✓ A map template is a pre-designed layout that can quickly be modified to create a map product

Layout Terminology



Source: Layout Design Guidelines for ArcGIS 10.1

Layout Terminology

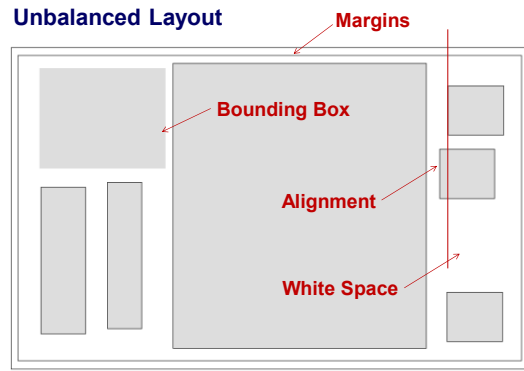


Source: Layout Design Guidelines for ArcGIS 10.1

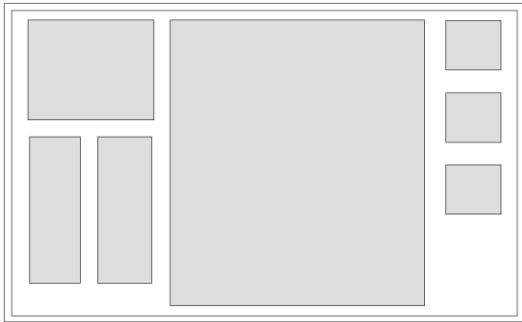
Layout Design

- ✓ Balance
 - Margins
 - White Space
 - Bounding Boxes
 - Alignment

Unbalanced Layout



Balanced Layout

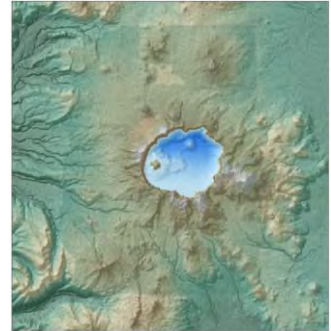


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Layout Design

- ✓ Visual Contrast

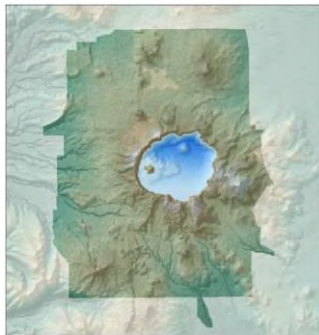


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Layout Design

- ✓ Figure-ground

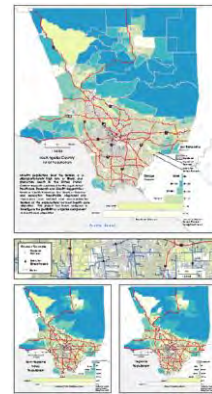


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Layout Design

- ✓ Visual Hierarchy



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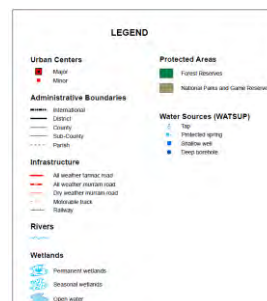
Map Components

- ✓ Map Body
- ✓ Marginalia, map surrounds & map elements
 - Titles
 - Legends
 - Scale Indicators
 - North Arrows
 - Detail/overview maps
 - Grids & graticules
 - Text blocks
 - Supporting graphics

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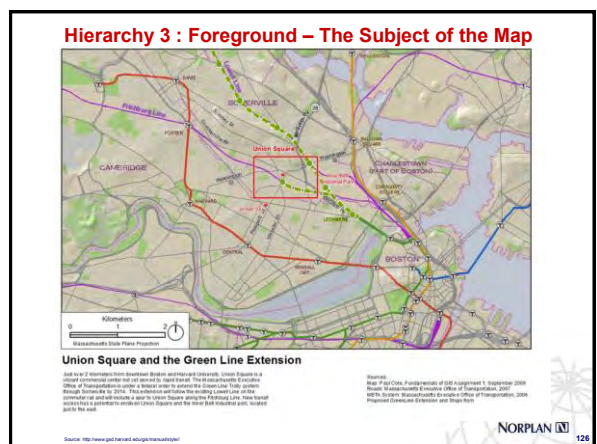
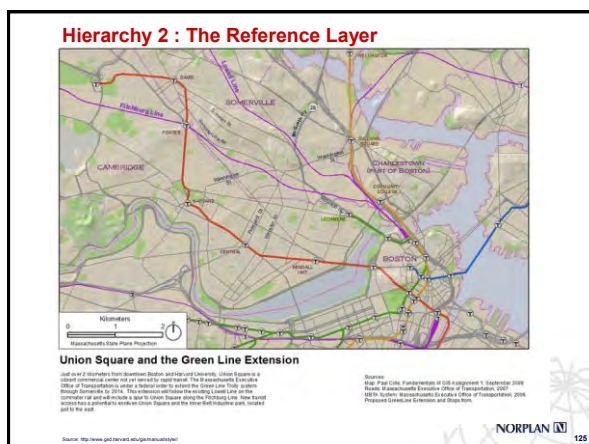
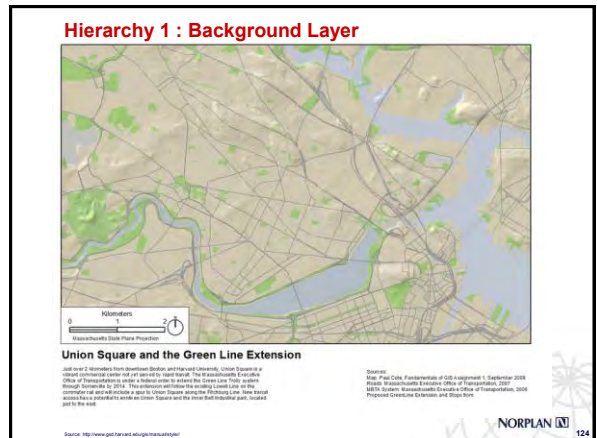
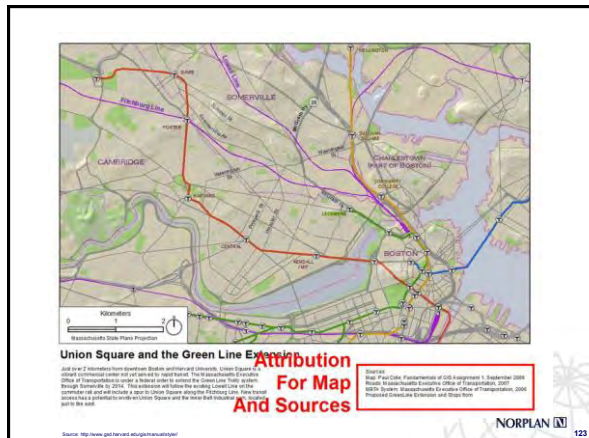
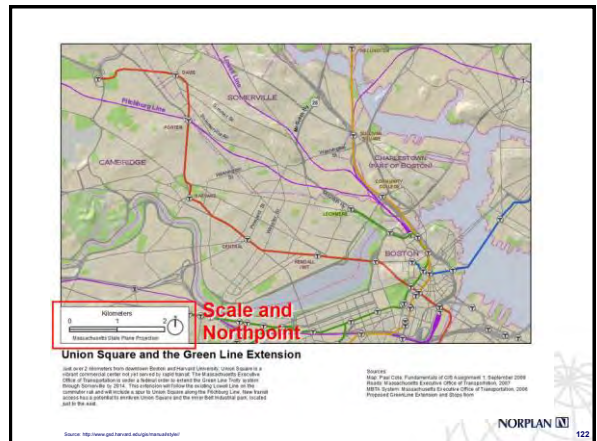
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Legend



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Map Output Options

- ✓ Print directly from ArcMap
- ✓ Export map to file (PDF, JPG)
- ✓ Copy to clipboard.
- ✓ Save as template (*.mxt)

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Output Considerations

- ✓ Printer Settings
 - Paper size
 - Paper quality
 - Ink
- ✓ ArcMap Print Driver
 - Arcpress
 - Windows
 - Postscript
- ✓ Output File Formats
 - Vector
 - Raster
 - File Format Parameters
- ✓ Transparency & rasterizing an output

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Map Production Management – Template

1. Create a workplan & set deadlines.
2. Decide on map quality criteria which will not be compromised.
3. Set up an efficient data structure.
4. Concentrate on getting the template right.
5. Do not start map production until the template is final.
6. Test the template with data, even if the data is not final.
7. Print the draft template, receive comments from users & refine.
8. Repeat until acceptance criteria are met. e.g. 90% of users understand the map within 7 seconds.
9. Announce the final template.

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Map Production Management – Map

1. Load the final data into map template.
2. Map user workshop for quality control of data.
3. Final QC of maps. No changes to map template unless there is a serious issue.
4. Map printing +/- lamination.
5. Write the map report.
6. Handover of maps & report to users.

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Thank you for your attention!



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