Transport schematics: usability, aesthetics, and evaluation

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Cognitive Psychology: Key Concepts

- Performance determined by:
  - Cognitive load
  - Cognitive capacity
  - Attention capture
  - Expertise

- Preferences determined by:
  - Metacognitive knowledge
  - Expectations and prejudices
  - Aesthetic judgement
Psychology: Literature Examples

- **Intelligence Testing**
  - Cognitive load: How many elements and rules?
  - Information salience: Elements and pattern identification

- **Deductive Inference**
  - Cognitive load: Length of processing sequence
  - Information ambiguity: How many possibilities encompassed by problem premises
High versus Low Load

12

1 2 3 4

5 6 7 8

23

1 2 3 4

5 6 7 8
High versus Low Salience

34

34a
Reasoning, Problem Solving, Intelligence

- High information quantity and ambiguity $\rightarrow$ Harder to represent the problem

- High problem complexity $\rightarrow$ Solution sequence overwhelms working memory capacity

- High expertise $\rightarrow$ Constrains representation, permits memorised direct solutions
Fred Stingemore, 1932
Why did Beck’s Map Help?

- Simplified routes easier to follow when journey planning
- Simplified information reduces cognitive load of journey planning
Why did Beck’s Map Help?

- Pre-organised map: elements easy to identify
- Network structure easy to understand
- Network expertise easier to acquire
- Cognitive load reduced still further
Why did Beck’s Map Help?

• Because he used *regular octolinearity*?
• Horizontal, vertical, and 45° diagonals only
• Tightly radiused curves
• A schematic design ‘gold standard’?
A Schematic Design Gold Standard?

- These angles will always give the best design?
- Alternatives will always give a poor design?
- NO: Octolinearity a tool for optimising a map
A Schematic Design Gold Standard?

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- Tools may be applied more or less successfully
A Schematic Design Gold Standard?

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- NO: Octolinearity a tool for optimising a map
- Tools may be applied more or less successfully
- Network may be incompatible with angles
Principles of Map Design

- **Simplicity**: simplified trajectories, few angles
- **Coherence**: shape and structure
- **Balance**: clear focal points and even density
- **Harmony**: aesthetically pleasing elements
- **Topography**: low conflict with expectations
- **Supplementary information**: low quantity/high quality
Principles of Map Design

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- If these are achieved, the rules don’t matter
... or Information Pollution?
Fare Zone Application Clumsy
Blind Interchanges
Unreadable Messages
Warning Daggers
Wheelchair Blobs
More than Anyone Needs to Know
Consequences of Information Pollution

- Additional information raises cognitive load
- Attention capture detracts from main task
- Ignoring information raises cognitive load
- Poor quality information raises load further

- *And the designer can’t cope either!*
Topographical Distortion

- Trade-off between optimising geometry and distorting geography
  - High expertise: poor tolerance of distortion
  - Low expertise: high tolerance of distortion
- To what extent does a conflict with the user’s mental model damage performance?
- Can the distortion be misleading?
• 30% of all journeys mis-planned?
• ABSURD
• 30% of journeys from a specially-chosen part of the map were mis-planned.
• 70% of them were planned just fine
• Along with most of the journeys on the rest of the map.
Demonstrating Simplicity

- Simplest trajectories are straight lines
- Aim is to have straightest lines using the smallest number of angles
Poor Design Taken to an Extreme
Improve Simplicity by Enlargement?
But Keep the Design Balanced
Journey Planning Studies

- Plan journeys using different maps
- Independent-groups designs
- Task: identify and draw best route between pair of marked stations
- Measures:
  - Planning SPEED (1/Time, high scores = good)
  - Journey QUALITY (high scores = bad)
    - 2 minutes per station
    - 10 minutes per interchange
### Results

<table>
<thead>
<tr>
<th>Planning Speed Journeys/Min</th>
<th>Mean</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
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<td>Journey Quality Minutes</td>
<td>Mean</td>
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<td>SD</td>
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- Order of means matches predictions
- Linear trend significant
- 20% improvement in planning speed possible
Beyond Octolinearity

- Straight trajectories have usability benefits
- Can we simplify further?
- Octolinearity ONE way of simplification
- Other angle sets possible too
- No psychological reasons for any priority
Simplify by Changing Angle?
But Match Angles to Network
But Some Angles Lack Harmony
And it is Easy to Lose Coherence
Simplify by Relaxing Linearity?
Problems with Changing the Rules

- Enormous space of possibilities to explore
- Unusual rules require unusual care: appropriateness versus quality of implementation
- Familiarity with old rules may cause difficulty with new ones (cf QWERTY)
- And then, one size may not fit all
- But some networks demand unusual solutions
The Paris Metro Network

- Highly interconnected lines and twisting routes
- Requirement to preserve spatial relationships
- Zig-zagging kinks bury network structure
The Paris Metro Network (cleaned)
All-Curves Map of the Paris Metro
## Results: Objective Measures

<table>
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<tr>
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<th>Mean</th>
<th>SD</th>
<th>Mean</th>
<th>SD</th>
<th>Mean</th>
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<tr>
<td>Journeys/Min</td>
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<td></td>
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<tr>
<td>Journey Quality</td>
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<td>3</td>
<td>60</td>
<td>4</td>
<td>62</td>
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<tr>
<td>Minutes</td>
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<td></td>
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</tbody>
</table>

- 30% speed advantage for All-Curves
- Interesting potential quality differences
- Replicated many times
### Results: Subjective Measures

<table>
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<th>Questionnaire Score</th>
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<td></td>
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<td><strong>Switch</strong></td>
<td><strong>Stay</strong></td>
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<tr>
<td>52</td>
<td>59</td>
</tr>
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</table>

- Subjective usability versus objective usability, only correlated for worst designs
- Map usability versus map engagement
Subjective versus Objective Measures

- Standard finding in psychology: novices find evaluation difficult.
- Focus on superficial/obvious surface features.
  - Does the map look like how a good map should look?
  - Are the colour combinations attractive?
  - Are there other obvious features that are likable, such as topographical accuracy?
- Asking users what they need, or like, can result in incoherent messages for the designer.
Docklands Light Railway Study

- Journey-planning and station finding tasks, touch-screen responses
- Questionnaire and preference ratings
- The most popular map:

- The worst by far for journey planning accuracy
• The equal second most popular maps:

• Journey planning inefficiency, roundabout routes
• The least popular map:

• A little bit slower than the others

• The most accurate journey planning

• The most efficient journeys
Summary

- Beck’s rules not necessarily a ‘gold standard’
- Departures can result in very usable designs

- Too many maps are poorly optimised worldwide
- Clear priorities and attention to detail lacking?
- Simplicity, coherence, balance, harmony needed?

- Subjective opinions on map design by novices are at best incoherent, at worst misleading.
- Evidence-based methodology under refinement
Conclusions

- UNDERSTAND COGNITION OF THE USER
- BEWARE SUBJECTIVE MEASURES
- BEWARE TRADITION
- RULES ARE FOR ACHIEVING OBJECTIVES
- DESIGN MAKES A DIFFERENCE
Underground Maps After Beck

The London Underground is one of the most important rail networks in the world, in a single day as many
people travel on it as on the rest of Britain's railways put together. To help them find their way, over 3,000,000
Underground maps are printed every year, absolutes of Henry Beck's groundbreaking design, first published
in 1931.

A diagrammatic map for the Underground is essential but hard to design. Good maps guide people in the right
direction, contributing to the efficiency of the network. The maps will be used by passengers, even walking people
the wrong way. However, the best maps don't just communicate the essentials of the network; they are
attractive in their own right.

This book picks up where Ken Galliard completed his
to tell the story of the map from when Harry Beck's
services were displayed with, to the present day. Based
upon extensive research of London Transport archives
and at London Transport Museum, this book outlines the
major changes that have taken place over the years, and
the meaning and political background that led to them.

Published 2005, Updated 2008
Published 2012