Concentric Circles Maps: Data and Implications

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Abstract. Schematic maps based upon concentric circles/spokes can present a powerful coherent image of a transport network, albeit with poor simplicity of line trajectories. Roberts, Newton, & Canals (2016) compared maps of the Berlin U-/S-Bahn finding that a concentric circles version performed worse than a more conventional one both for objective measures of usability and subjective ratings, but for reasons that were unexpected. The research highlights the issue of how usability should be evaluated, and suggests that new methods of measuring this for schematic maps should be developed. It is also noted that the structure of some networks is very compatible with a concentric circles approach.

Keywords: Schematic maps, Concentric circles, Usability testing.

1 Concentric Circles Maps

In 2012, the London Overground was extended from Surrey Quays to Clapham Junction, and a number of individuals suggested that the London Underground map should now be based on circles in order to emphasise the new orbital connectivity. However, early attempts were extremely distorted topographically, had poor balance, and merely combined circles with straight lines at conventional angles (horizontal, vertical, 45°) resulting in elements that related to each other poorly (Fig. 1a). A map based upon concentric circles around a central point, with straight lines radiating from this, or else tangents to circles (and, exceptionally, straight lines parallel to tangents or spokes) solves the balance and relationship problems for London, as well as reducing topographical distortion at the centre (Fig. 1b).

Fig. 1a (left). Circles map by Jonathan Fisher, 2012.
Fig. 1b (right). Concentric circles map by Maxwell Roberts, 2012.
The positive responses via the Internet to the design in Fig. 1b surprised the authors. Normally, users expect schematic maps to conform to convention, with adverse ratings for designs that depart from this (Roberts, Grey, & Lesnik, 2017). However, caution is required interpreting informal responses given the lack of correlation between objective measures of map usability and subjective ratings (e.g., Hegarty, 2013; Roberts, Grey, & Lesnik, 2017). Roberts, Newton, & Canals (2016) suggested that although concentric circles maps have complex line trajectories compared with conventional designs, their construction results a high degree of organisation and coherence, possibly compensating for this. They therefore compared two Berlin designs in a usability experiment: a conventional one (Fig. 2a) and concentric circles version (Fig 2b), both created with the same design priorities: a preference for simple line trajectories rather than high topographical fidelity, and a regular shape for the Ringbahn. Berlin was chosen because it is a relatively complicated network, but its structure permits all straight line elements of a concentric circles map to be true spokes.

![Fig. 2a (left). Conventional (octolinear) Berlin U-/S-Bahn map, 2012. Fig. 2b (right). Concentric circles map, 2013. Both designs by Maxwell Roberts.](image)

## 2 Summary of Methods

This was a within-subjects design in which 40 people each planned six complex (two-transfers-necessary) journeys for both of two Berlin U-/S-Bahn maps. For each trial, origin and destination stations were flagged and subjects planned the journey using a dry-wipe marker on a large laminated map. The experimenter timed the duration with a stopwatch. Once the subject announced that planning was complete, the time was recorded and the final choice of journey transcribed onto a paper map.

There were three sets (A, B, and C) of six journeys, two of the sets from these were allocated to each subject (e.g. Set B for the concentric circles map, Set C for the conventional map). Journey set allocation, along with map presentation order (conventional first, or concentric circles first) were counterbalanced. Objective measures of usability were (1) mean planning time per map; and (2) mean estimated journey duration per map (based upon a simple station/transfer count). Subjective measures of map ratings were also taken, comprising (1) a questionnaire score based upon a set of aggregated statement ratings (e.g. *interchange stations were easy to negotiate*: strongly agree–agree–neutral–disagree–strongly disagree); and (2) a simple selection decision between the two maps.
3 Results

There was no evidence for cross-talk between the two versions despite the within-subjects design. Table 1 gives mean performance comparing the two maps. The concentric circles map was significantly worse for all measures except estimated journey duration, indicating that the actual directness of journeys was no worse for this map than the conventional version. Just 6/40 subjects preferred the concentric circles map, with one undecided.

Table 1. Mean performance for the two maps (standard deviations in parentheses).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Conventional</th>
<th>Conc. Circles</th>
<th>F (df = 1, 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning time (secs.)</td>
<td>25.2 (7.6)</td>
<td>30.9 (9.6)</td>
<td>46.1, p &lt; .01</td>
</tr>
<tr>
<td>Est Journey Duration (mins.)</td>
<td>62.5 (6.6)</td>
<td>62.4 (5.9)</td>
<td>0.01, p &gt; .05</td>
</tr>
<tr>
<td>Quest. score (high = favourable)</td>
<td>44.4 (7.2)</td>
<td>33.7 (10.4)</td>
<td>27.0, p &lt; .01</td>
</tr>
</tbody>
</table>

4 Implications

The concentric circles map was associated with poor planning performance, perhaps owing to its relatively complex line trajectories. It was also unpopular with subjects, but comments solicited in the questionnaire indicated a frequent dislike of its holistic qualities: it appeared to make all journeys seem roundabout, making the most efficient one hard to identify. This is not reflected in the estimated journey durations, but suggests that there may be more to map usability than a few seconds difference in journey planning times. If efficient routes are hard to identify, a loss of several minutes could result. Hence, a wider concept of schematic map usability, alongside other measures of utility, should be considered in the future.

![Fig. 3a (left). Concentric U-s map of Amsterdam, 2017.](image1)

![Fig. 3b (right). Concentric circles map of Cologne, 2016. Both designs by Maxwell Roberts.](image2)
The concentric circles map performed poorly, but this does not mean that the concept should be rejected, for two reasons. First, the orderliness and coherence of a design might lead to its components and their relatedness being made more salient, hence making the underlying structure of the network easier to learn. This would be hard to capture in a short-term usability study, where complex networks would yield floor effects for memory for their structure. Nonetheless, this is an important aspect of usability that should somehow be measured in the future. Second, a number of cities have a concentric circles structure, notably Cologne, and Amsterdam, and both have official conventional-design schematic maps with poor simplicity and coherence. If design rules are incompatible with a network, for example by mis-matching available angles with actual line trajectories, then this can result in maps that offer little benefit to the user in terms of simplifying network depiction.

References