Evaluating the Effectiveness of 2D vs. 3D Trailhead Maps

A map user study conducted at Zion National Park, United States

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Evaluating National Park Service
3D Trailhead Maps

Tom Patterson
US National Park Service
Harpers Ferry Center
Retrospect: Vall de Núria, Spain, 2004

Maps: Patterson, 2004
User Study: Aims

To find out which map type:

- is more effective for cartographic communication?

- Imprints itself better as a mental map in the mind of park visitors?

- is more attracting for park visitors?

- is preferred by the hikers?

- allows the users better to orientate themselves and find their actual position on the map more accurately?
Methodology: equivalent test maps

Maps: Patterson, 2004
Methodology: *comparative evaluation*

Tuesday 9:00 a.m.  

Wednesday 9:00 a.m.

Images: Patterson, 2004
Methodology: *data collection*

Trailhead monitoring

Questionnaire alongside trails
Which National Park to choose?
### Zion Canyon Trail Guide

#### Winter Hiking
Hikers should be flexible and turn back if trail conditions are unsafe. Trails can be snow covered and icy. Stay on established trails and watch your footing, especially near drop-offs. Always stay back from edges. Watch children closely. Ice, snow, loose sand, or pebbles on stone are very slippery. Be careful of edges when using cameras or binoculars. Never throw or roll rocks; there may be hikers below.

<table>
<thead>
<tr>
<th>Trail &amp; Trailhead</th>
<th>Round Trip (miles)</th>
<th>Ascent (ft)</th>
<th>Description</th>
<th>Map Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisher Trail</td>
<td>3.5/5.6</td>
<td>50/75</td>
<td>Easy Pfaded trail follows Virgin River from South Campground to Canyon Junction.</td>
<td>1</td>
</tr>
<tr>
<td>Weeping Rock</td>
<td>0.5/0.8</td>
<td>38/80</td>
<td>Short but steep minor drop-offs. Faded trail ends at alcove with dripping springs. Trailside exhibits. May be icy, closures possible.</td>
<td>2</td>
</tr>
<tr>
<td>Archeology Trail</td>
<td>2.0/2.3</td>
<td>38/77</td>
<td>Easy Minor drop-offs. Faded trail follows Virgin River above bottom of narrow canyon. Trailside exhibits. May be closed because of falling ice.</td>
<td>3</td>
</tr>
<tr>
<td>Lower Emerald Pool</td>
<td>1.2/1.9</td>
<td>60/11</td>
<td>Easy Minor drop-offs. Faded trail to lower pool and waterfalls. May be closed because of icy conditions or falling from above. See page 3 for other trail options.</td>
<td>4</td>
</tr>
<tr>
<td>Canyons Overlook East of long tunnel</td>
<td>1.0/1.6</td>
<td>160/30</td>
<td>Moderate Long drop-offs. Rocky, uneven trail ends at viewpoint of lower Zion Canyon and Pine Creek Canyon. May be snow covered and icy.</td>
<td>5</td>
</tr>
<tr>
<td>Watchman</td>
<td>2.7/3.4</td>
<td>39/112</td>
<td>Moderate Minor drop-offs. Ends at viewpoint of lower Zion Canyon and Oak Creek Canyon. May be muddy.</td>
<td>6</td>
</tr>
<tr>
<td>Hidden Canyon</td>
<td>2.0/3.2</td>
<td>85/259</td>
<td>Strenuous Long drop-offs. Not for anyone fearful of heights. Ends at narrow canyon. May be snow covered and icy.</td>
<td>7</td>
</tr>
<tr>
<td>Angels Landing</td>
<td>5.0/8.0</td>
<td>143/453</td>
<td>Strenuous Long drop-offs and narrow trail. Not for anyone fearful of heights. Last 0.6 mi (1.0 km) follow steep, narrow ridge. Chains have been added. May be snow covered and icy.</td>
<td>8</td>
</tr>
<tr>
<td>Observation Point</td>
<td>0.0/0.12</td>
<td>59/55</td>
<td>Steep Trails. Climbs through Echo Canyon. Trail gains access to other East Rim plateau trails. Cable Mountain and Deering Mountain. Snow and ice likely.</td>
<td>9</td>
</tr>
<tr>
<td>Sand Bench</td>
<td>3.6/5.8</td>
<td>351/582</td>
<td>Moderate Loop trail past ancient landslide and Streaked Wall. Good views of lower Zion Canyon and the Three</td>
<td>10</td>
</tr>
</tbody>
</table>

[www.nps.gov](http://www.nps.gov)
Map production: conventional maps
Emerald Pools Trails maps
Observation Point Trail maps
Structure of questionnaire

4 parts – 31 questions

- Part 1: Background (9)
- Part 2: Questions about trailhead map (6)
- Part 3: Questions about knowledge transfer (11)
- Part 4: Positioning and preferences (5)
Trailhead monitoring

• Data monitored:
  – Time
  – Number of passersby
  – Group type
  – Is map viewed
  – Time of map reading
Outcomes: A few numbers


Monitoring: 340 Groups or single hikers

Interviews: 188 questionnaires, 185 valid

20 non-respondents

Response rate => 90 %
Interviews: Respondent universe

- 185 interviews
- 72 women (39 %)
- 113 men (61 %)
Findings: Hiking experience

Hiking frequency per trail

- **Emerald Pools Trail**
- **Observation Point Trail**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Emerald Pools Trail</th>
<th>Observation Point Trail</th>
</tr>
</thead>
<tbody>
<tr>
<td>almost daily</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>1x /week</td>
<td>15%</td>
<td>20%</td>
</tr>
<tr>
<td>1x /month</td>
<td>25%</td>
<td>15%</td>
</tr>
<tr>
<td>a few times</td>
<td>40%</td>
<td>30%</td>
</tr>
<tr>
<td>1x /year</td>
<td>5%</td>
<td>5%</td>
</tr>
<tr>
<td>1st since a year</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Findings: Rating of maps

Rating of 2d and 3d maps

- 3d design
- 2d easy to read
- 3d points
- 2d impression

Emerald Pools Observation Point
Findings: Positioning

Average position error per km by sex

**Emerald Pools Trail**
- Female: 90 meters
- Male: 85 meters

**Observation Point Trail**
- Female: 80 meters
- Male: 95 meters

Average position error per km by age groups

- **Emerald 3d**
  - 15-25: 120 meters
  - 26-40: 100 meters
  - 41-60: 90 meters
  - 60+: 80 meters

- **Emerald normal**
  - 15-25: 80 meters
  - 26-40: 70 meters
  - 41-60: 60 meters
  - 60+: 50 meters

- **Observation 3d**
  - 15-25: 110 meters
  - 26-40: 90 meters
  - 41-60: 80 meters
  - 60+: 70 meters

- **Observation normal**
  - 15-25: 70 meters
  - 26-40: 60 meters
  - 41-60: 50 meters
  - 60+: 40 meters
Findings: Map preferences

Map preferences by age groups

Map preferences by mother tongue

Map preferences by sex

Map preferences by examination of trailhead
Findings: Better depiction of reality

<table>
<thead>
<tr>
<th>Which map type depicts reality better</th>
<th>2D</th>
<th>none</th>
<th>3D</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>23,9 %</td>
<td>2,8 %</td>
<td>73,2 %</td>
<td>1% level</td>
</tr>
<tr>
<td>males</td>
<td>20,4 %</td>
<td>2,7 %</td>
<td>77,0 %</td>
<td>1% level</td>
</tr>
<tr>
<td><strong>By age groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-25</td>
<td>54,5 %</td>
<td>0 %</td>
<td>45,5 %</td>
<td>Attention: small sample size</td>
</tr>
<tr>
<td>26-40</td>
<td>15,1 %</td>
<td>3,8 %</td>
<td>81,1 %</td>
<td>1% level</td>
</tr>
<tr>
<td>41-60</td>
<td>21,7 %</td>
<td>3,3 %</td>
<td>75 %</td>
<td>1% level</td>
</tr>
<tr>
<td>60+</td>
<td>21,4 %</td>
<td>0 %</td>
<td>78,6 %</td>
<td>1% level</td>
</tr>
<tr>
<td><strong>Left- or right-handed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right-handed</td>
<td>23,8 %</td>
<td>2,4 %</td>
<td>73,8 %</td>
<td>1% level</td>
</tr>
<tr>
<td>Left-handed</td>
<td>5 %</td>
<td>5 %</td>
<td>90 %</td>
<td>1% level</td>
</tr>
<tr>
<td><strong>By mother tongue</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>21,2 %</td>
<td>3 %</td>
<td>75,8 %</td>
<td>1% level</td>
</tr>
<tr>
<td>other</td>
<td>23,1 %</td>
<td>1,9 %</td>
<td>75 %</td>
<td>1% level</td>
</tr>
</tbody>
</table>
## Findings: Accuracy

### Which map type is more accurate

<table>
<thead>
<tr>
<th>By gender</th>
<th>2D</th>
<th>none</th>
<th>3D</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>25.4</td>
<td>22.5</td>
<td>52.1</td>
<td>1% level</td>
</tr>
<tr>
<td>males</td>
<td>38.9</td>
<td>18.6</td>
<td>42.5</td>
<td>1% level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>By age groups</th>
<th>2D</th>
<th>none</th>
<th>3D</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-25</td>
<td>36.4</td>
<td>9.1</td>
<td>54.5</td>
<td>Attention: small sample size</td>
</tr>
<tr>
<td>26-40</td>
<td>30.2</td>
<td>17.0</td>
<td>52.8</td>
<td>1% level</td>
</tr>
<tr>
<td>41-60</td>
<td>34.4</td>
<td>18.3</td>
<td>46.2</td>
<td>1% level</td>
</tr>
<tr>
<td>60+</td>
<td>35.7</td>
<td>35.7</td>
<td>28.6</td>
<td>1% level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Left- or right-handed</th>
<th>2D</th>
<th>None</th>
<th>3D</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-handed</td>
<td>34.8</td>
<td>20.7</td>
<td>44.5</td>
<td>1% level</td>
</tr>
<tr>
<td>Left-handed</td>
<td>25</td>
<td>15</td>
<td>60</td>
<td>1% level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>By mother tongue</th>
<th>2D</th>
<th>None</th>
<th>3D</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>33.3</td>
<td>18.9</td>
<td>47.7</td>
<td>1% level</td>
</tr>
<tr>
<td>other</td>
<td>34.6</td>
<td>23.1</td>
<td>42.3</td>
<td>1% level</td>
</tr>
</tbody>
</table>
Findings: Knowledge transfer
Findings: Attraction at trailhead

- **3D:**
  - 50% look at map
  - 50% passersby

- **2D:**
  - 44.9% look at map
  - 55.1% passersby
Findings: Viewing time

• 3D map:
  average 47.2 seconds

• 2D map:
  average 44.1 seconds
3D maps enable hikers to more accurately identify their location on the landscape compared to 2D maps, especially for older people (over 60 years of age) and women.

Hikers viewing the trailhead exhibit preferred 3D trailhead maps (53%) over 2D maps (43%).

Older respondents, men, and native English speakers generally prefer 2D maps.

Younger respondents, women, and nonnative English speakers generally prefer 3D maps.

On the Emerald Pools trails, less experienced hikers rated the 2D map easier to read.

On the Observation Point Trail, more experienced hikers rated the 3D map easier to read.

Readers of 3D maps had a better understanding of distances, topography, and environment, while readers of 2D maps could better recall place names.

Respondents on both trails generally agreed that 3D maps depict reality better.

3D maps attract more trailhead readers than do 2D maps, and are viewed on average for a few seconds longer than 2D maps.
Full report available for download at

www.nps.gov/hfc/carto/zion_map_study.pdf