

Oregon Walks GIS Jammers

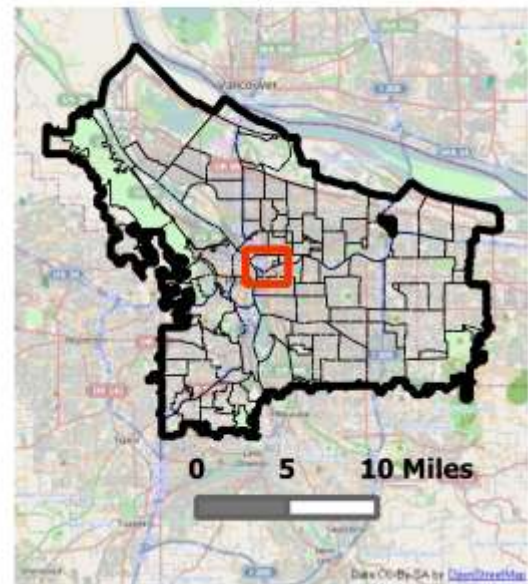
September 2013 Curb Ramp Survey

Lloyd District, Portland, Oregon

Survey Area



Portland with Neighborhoods



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Report Date, January 2014

Executive Summary

For Portland, Oregon, a city-wide survey of curb ramp conditions is needed. A low cost survey of curb ramps in the Lloyd district was completed in September, 2013. This report describes the survey methods and results and recommends further work to expand this survey to multiple Portland neighborhoods. With a neighborhood by neighborhood workflow, a city-wide survey is doable.

Per Portland's Bureau of Transportation [Asset Status and Condition Report for 2012](http://www.portlandoregon.gov/transportation/article/436843) [http://www.portlandoregon.gov/transportation/article/436843] , "*The City's Americans with Disabilities (ADA) Transition Plan aims to build 700 to 1,000 ADA compliant corners each year.*" That is a tall order considering that, per the same report, 45% of improved corners have curb ramps and that the costs to remedy unmet sidewalk, curb ramp, and corner needs are over \$200 million.

Because funding for sidewalks is often a disputed transportation priority, discussion, both in and outside of city hall, about how to advocate for, prioritize, and build sidewalk infrastructure is important. Whether we are limited to repairing fewer than one thousand curb ramps per year, or suggesting that this rate of repair is too slow, we need strategies to prioritize curb ramp projects.

A walkway network analysis forms the basis of prioritizing infrastructure investments. In this curb ramp survey a walkway network was enhanced with data about curb ramp conditions. In future projects this data will be used to analyze universally accessible walkways. The main focus of this project was data collection about curb ramps.

Currently, when a wheelchair user approaches any given curb ramp, there is a 55% chance (using the City's 2012 report) that there will be no curb ramp to allow the person using a wheelchair to cross the street. If a visually impaired pedestrian approaches a curb ramp, there is only a small chance the curb ramp will include a tactile warning plate to demarcate the edge of the curb ramp. On many of Portland's crossings, which do have curb ramps, the state of those curb ramps is not entirely known (whether they have cracks, how steep they are, etc). In addition, while the City maintains a street network file which can be used to model motor vehicle trips and provide routing instructions, there is no similar network maintained that can be used to model travel for pedestrians of all abilities.

The report has sections about the survey region, technical components, the Web application narrative, a data review, a preliminary analysis, test goals, and evaluation points, an evaluation, and recommendations.

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Introduction

Oregon Walks, an Oregon non-profit dedicated to making the conditions for walking safe, and the GIS Jammers (a group of Geospatial Information Systems volunteers), approached the need for better curb ramp information by developing a web application to collect data about curb ramps. The Web application relies on a walkway network model and a connection to a spatially enabled, online, database, CartoDB. By combining a walkway model with curb ramp condition data and weighting factors for each walkway, crossing, and curb ramp, we can carry out a cost-weighted analysis to better understand the walkable routes available to all pedestrians.

This report summarizes a test of this curb ramp survey web application. It also shows a simple walkway cost-weighted analysis, although this was not the primary goal of this project. The test was completed in the late summer of 2013 in the Lloyd District, an urban neighborhood in Portland, Oregon. The Lloyd Center Mall, the Moda Center, the Memorial Coliseum, a TriMet transit center, the Oregon Convention Center, and numerous hotels and large employers bring many pedestrians through the district.

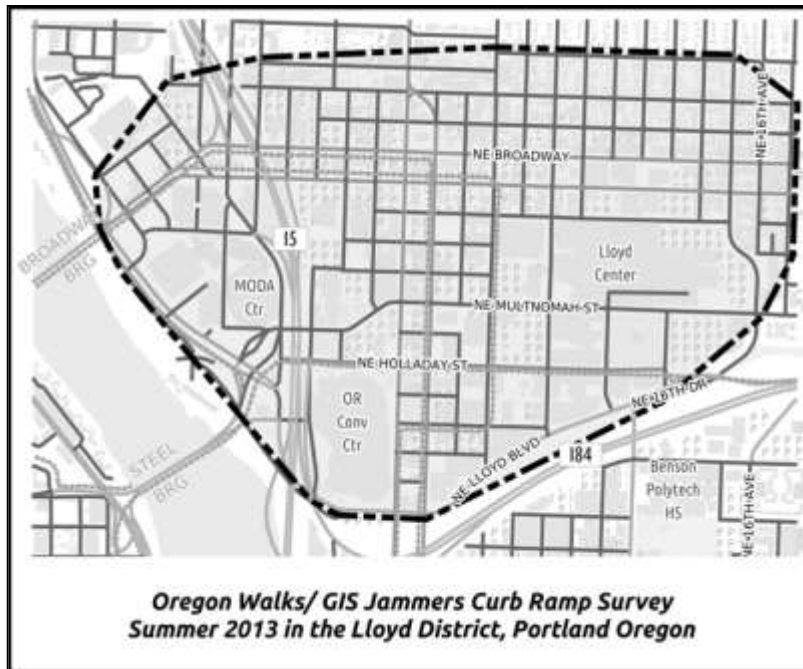
The goal of the project was to evaluate the mobile data collection application for ease of use, speed of entering information, and completeness of intersection coverage. Because only one person made all the observations it was not possible to do statistical analysis of consistency but the report includes insights into the difficulties of many people making consistent observations.

The methodology is based on a pedestrian walkway network of sidewalks and crossings, and in most cases does not route pedestrians on street centerlines. The logic used to model sidewalks is configurable and can be simplified to assign walkable routes along the centerlines of streets that are assumed to be quiet with slow traffic. The analysis does not use a zonal model. In other words, the analysis can tell us which curb ramps and sidewalks are needed by the most people, so we can quantifiably make the case for prioritizing improvements where a curb ramp will serve the greatest need.

We thank Portland State University Geography Department, Moira Green at the Lloyd District Transit Management Association and the Lloyd TMA Pedestrian Advisory Committee for providing a home-base for this test. We also thank Paul Cone, Gabe Graff, Clay Veka, all from the Portland, Oregon Bureau of Transportation, for their support and advice. Melelani Sax-Barnett created the first version of the web application.

Survey Region, Lloyd District, Portland, Oregon

The Lloyd District Curb Ramp Survey was completed over 5-7 days during a 2 week period. One dedicated volunteer walked the district and inspected the approximately 1,500 curb ramps at approximately 200 intersections. Time on the street was about 30 hours. The District is approximately 1 square mile. The City is just over 134 square miles. (US Census American Factfinder)



Technical Components: data, software, equipment

- *A walkway model* of sidewalks and corners based on a street centerline spatial model. This is generated with an ESRI ARCMAP addin.
- *A web-based application* hosted at Github.com. With: jQuery, jQuery Mobile, OpenLayers, JavaScript library. Map layers are from OpenStreetMap, and from Bing aerial imagery.
- *Three database tables* hosted on a free CartoDB account, a cloud-based database service (cartodb.com) There are two ESRI Shapefiles, intersection.shp and ramps.shp, and one CSV file of comments. At each intersection attributes in the shapefile are updated and if the intersection seems confusing or has been changed by construction, the data collector has the option of adding a note. This note is saved in the comments.csv file. Similarly for curb ramps; attributes are updated in a shapefile and notes about curb ramp conditions (too steep, broken surfaces, drainage problems, obstructions) may be added to the comments.csv file.
- *A mobile phone repurposed as a small tablet device*, a mobile hot-spot for access to the web application and the CartoDB tables, and an ice-pack to cool the mobile hot-spot. A smart phone with built-in wireless access could also work.
- *Additional equipment*: a camera, an inclinometer-application on the iPhone, and a low-cost proto-type slope gage. A digital inclinometer would be required to measure slope to within 0.5%.

Web Application, narrative

The Web app has two screens. The first screen is the main or home screen. The second screen shows the intersection being surveyed. Two popup dialogs are available from the intersection screen.

The main screen in the web app is a map of the survey area (Lloyd District in this case) with an icon marking each intersection. There are blue circle icons for yet to be inspected intersections, and orange triangle icons for intersections that have been evaluated. Once the user selects an intersection, they are taken to the intersection screen.

On the intersection screen, the user can record the state of each curb ramp and the intersection as a whole. The top of the screen shows an aerial photo of the intersection, with the curb ramp under inspection highlighted and labeled. The buttons lower on the screen allow the user to note the presence of a curb ramp ("yes" for present, "no" for non-existent, or "sort-of" for ramps which are present but deficient), the state of the intersection as a whole, and to save or cancel the edits made at the current intersection. For "sort of" curb ramps, the user is prompted to specify any problem found at the curb ramp (the curb ramp may be too steep, the surface may be cracked, or drainage issues may be noted as problems). Intersection-wide notes can be added (for example, to flag an intersection as confusing or under construction) via the notes button.

If the user clicks "save," the responses (for the intersection, the curb ramps, and associated comments) are saved to CartoDB. Should the user decide to "do nothing", their edits



are discarded and they return to the map screen. The screenshots below show the screens and popup menus the user should expect.



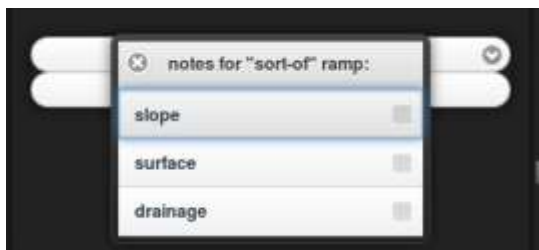
Web Application Screens



The main screen showing possible intersections. Bright Blue circles indicate intersections which have not been surveyed. Intersections shown with orange triangles have been surveyed.



Intersection Screen with Bing Aerial and curb ramp state selection buttons. Highlight-cyan prompt, “crossing 9th.” refers to the cyan highlighted curb ramp shown on the overlay.



Ramp condition popup menu. Selections are added to the comments.csv file on CartoDB.



Intersection condition popup menu. Selections are added to the comments.csv file on CartoDB.

Web Application- Intersections and Corner popup menu field notes

In the intersection screen a data collector can efficiently survey curb-ramp presence and conditions. We anticipate asking people of varying technical capabilities to complete the survey. In order to have consistent results which can be used for analysis, measurement criteria are few and unambiguous.

- Default, no additional information collected about the intersection is stored in the comments file.
- Marking any of the following conditions is an indication to either re-inspect the intersection or to correct the model.
 - Confusing Intersection
 - Bridge or Tunnel
 - Construction

Curb Ramps Percentage Slope and Additional Conditions Popup menu.

Slope state (yes, sort of, no) is stored in the ramps ESRI Shapefile. Additional conditions about ramps are stored in the comments.csv file.

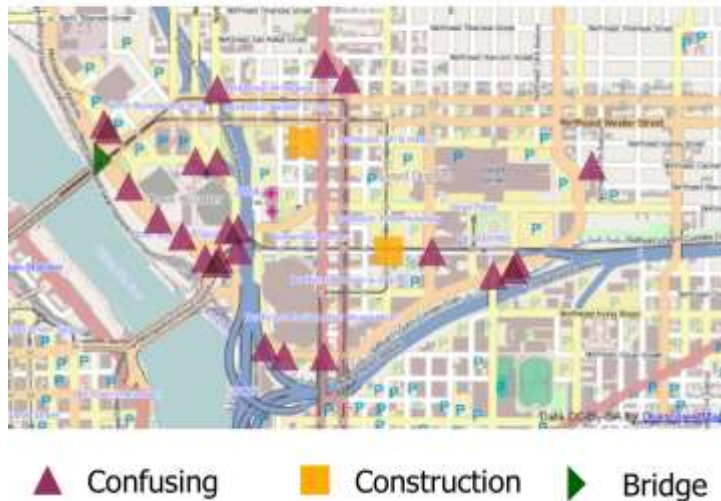
Prompt	Definition		
Yes	Slope is 5% or less		
Sort Of	Slope is between 5 and 10 %	Additional Conditions for Ramps rated Sort Of	
		Slope	Slope is greater than 10%.
		Obstruction	The crossing is obstructed or legally closed by a sign.
		Drainage	Weeds, a drain grate, or a puddle indicate drainage problems.
		Surface	The surface of the curb ramp is damaged or the truncated half-dome plate is black in color.
No	No curb ramp		

Data Review- Intersections

Comments were added at 30 intersections with the most frequent being “confusing.” Many of the confusing intersections are near freeway ramps, bridges or transit centers.

Condition	Count
Confusing	25
Construction	3
Bridge or tunnel	2
Total	30

Intersections with Comments



All Intersections



Data Review- Ramps

The CartoDB ramp table had 1503 entries, for 1496 distinct ramps. Duplicates were removed. Fewer than fifty ramps were annotated with comments (49 of 1496 curb ramps). Slope was the most frequent comment.

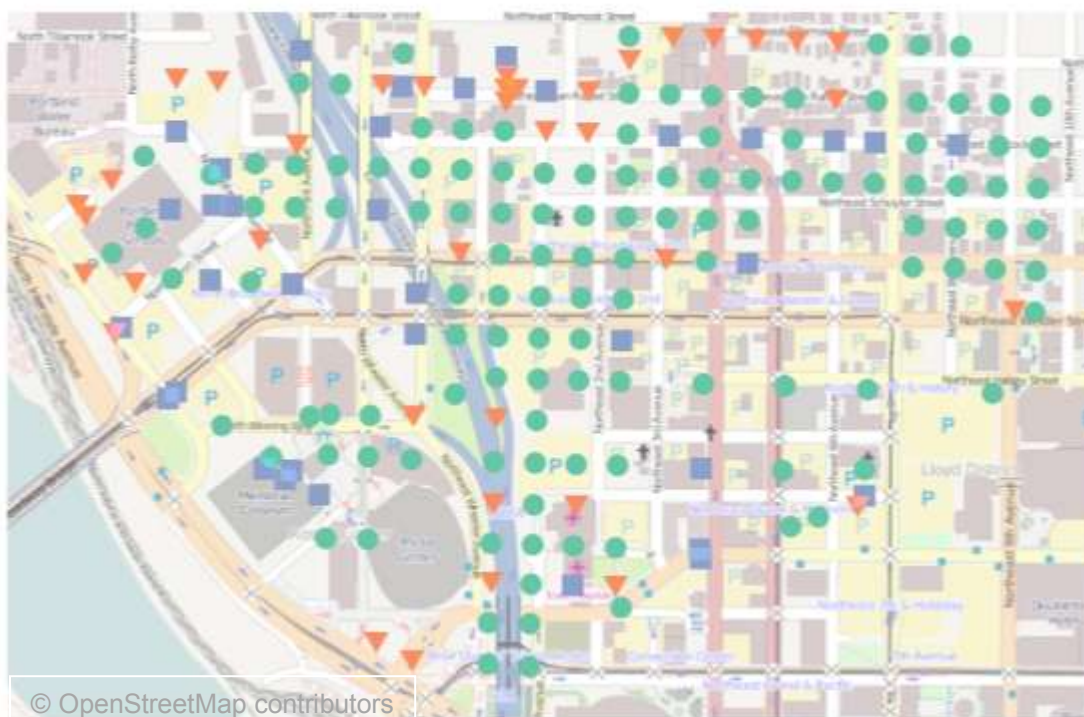
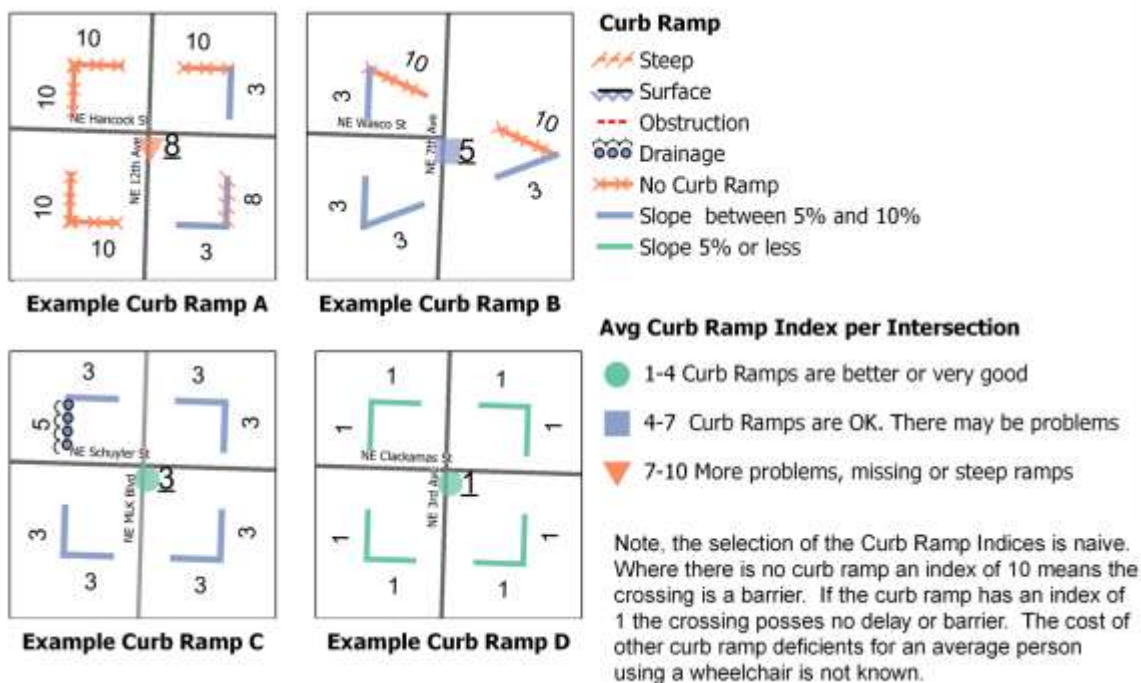
The data required some cleanup besides removing duplicates. There were cases where “yes” as well as “no” ramps had comments. Comments for these cases were removed for the 12 places these were found.

Ramp State	Count
No	396
Sort_of	750
Yes	357
Total	1503

Ramp Comment	Count
Drainage	5
Obstruction	1
Slope	35
Surface	8
Total	49

A simple intersection-based visualization of the survey area was constructed by tallying an average quality for each intersection using a lookup table for ramps. At a later date experts may fine tune these measures of curb ramp quality. A better cutoff between “sort of” and “steep” is 8%, not 10%.

Web Prompt	Definition	Quality
Yes	Curb ramp exists	1
No	Curb ramp does not exist	10
Sort Of	Curb ramp exists with slope greater than 5% and up to 10%	3
Steep	Curb ramp slope is greater than 10%	5
Drainage	Weeds in gutter, obvious puddles, or grate in line of travel	2
Surface	Too rough to roll over, a truncated dome plate needs to be replaced, it may be damaged or it may be black	2
Obstruction	An object blocks wheelchair access to sidewalk	3



Average of Ramp Quality at Intersections

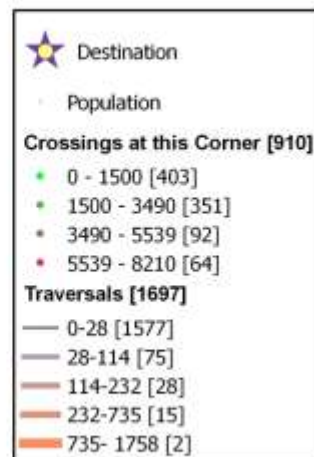
- 1-4 Curb Ramps are better or very good
- 4-7 Curb Ramps are OK. There may be problems
- 7-10 More problems, missing or steep ramps

Preliminary Network Analysis

A walkway network analysis can tally crossings at corners and use of walkways. This analysis could benefit from business census data as well as extending the area. The warm colored/wider lines in the north-east quadrant may indicate the high senior and residential populations in this area. The high counts at corners to the north and west of the Rose Quarter may be a border effect. The destinations were taken from known problem intersections, access points to shopping, transit and the Eastbank Esplanade. Populations are from city population data and do not reflect employees or transit users passing through the district.



Destination	Number
Wheelchair Purchase	15
Employer	14
Recreation	13
MAX, Hotel	12
Business, Recreation	11
MAX, Recreation	10
Lloyd Mall	9
Employee, Shopping	8
Access to Lloyd	7
Bank	6
Senior Housing, Students	5
Restaurant or Coffee Shop	4
Shopping or Restaurant	3
Drug Store	2
Streetcar CL to Downtown	1



Test Goals and Evaluation Points

To evaluate this test survey we ask several questions. How long does it take to collect data from a few square miles? How can we improve the database model before moving on to more neighborhoods or on to the entire City? Can we estimate the time needed to survey a neighborhood? What training materials will assure consistent survey results? What data collection equipment is critical? Do we need to modify our base walkway model?

Goals

- How fast can data be entered?
- How does the user interface work on a 3.5 inch (diagonal) screen?
- What is the average time to survey an intersection?
- Are users able to correctly orient their view of an intersection?
- What is the best method to assign a number to curb ramps for the cost-weighted network analysis?
- What is the right balance between high quality and detail of information at each intersection versus a large number of intersections with a smaller quantity of simpler information?

Evaluation

How long did this survey take? Capturing the time per intersection or the time per ramp was not easy to calculate from the default CartoDB fields because the data format, an ESRI shapefile reported only the date, not a timestamp. While timestamps were reported in the comments CSV file, there were too few to work with, and the time zone added by Cartodb was in GMT +1 while the survey was done in GMT -7. Thus knowing the day a late afternoon survey was lost (8 hours between GMT +1 and GMT-7).

The iPhone was easy to carry and easy to hold in one hand. However the 3.5 inch screen limited the number of factors to be addressed at each intersection and also restricted the size of text. A rugged case and or tether are recommended.

Date	Count of Intersections Surveyed
8-21	1
8-26	1
8-27	31
8-28	16
9-1	15
9-5	35
9-18	53
9-19	25
9-20	22

The mobile hotspot's power depleted in about 4 hours and thus ended each day's work. So, looking at the most productive days, about 30 intersections were completed in 4 hours time. If the data below represents about 7 days at 4 hours per day, then the total survey time was 28 hours. If it is necessary to ask data collectors to spend more than four hours collecting data, then more power-efficient devices are needed.

At the start of each day's work, the slope measurements were assisted by an inclinometer I-Phone Application. Subsequent measurements were estimated. Midway through the day, estimates were checked against the inclinometer.

Results and Discussion

The initial goal of this project was to develop a process to complete a city-wide survey of curb ramps. For this process, the data collectors would be volunteers or non-technical, but paid staff. This curb-ramp project feeds into a larger project which compares walkway enhancement projects using cost-weighted network analysis.

To what extent is the curb ramp survey web application scalable to a full city? A very rough projection for surveying the city is this. If Lloyd District is 1 square mile in a dense urban area and one person spent 30 hours to survey the district, then for 150 square miles (Portland is 134 square miles), it would take 4500 hours. If 10 people worked 4 hours per day, it would take 113 days or 4 months. If the survey form is changed to require more accuracy or more curb ramp conditions, the time would increase. Of course in Portland the street grid is not consistently urban; there are super blocks and tangles of cul-del-sac streets in other neighborhoods. It would be useful to complete the survey in a suburban or East of 82nd neighborhood to make a time comparison. However, until that comparison is completed, it seems reasonable that a city-wide curb ramp survey could be completed within one year.

The city has a data set of improved corners polygons which has information about some, but not all curb ramps. If the data from this survey could be correctly spatially joined with the walkway network, it might be possible to shorten the field work or to augment the field work. See the map of known improved corners at the end of this document.

A discussion about how well the curb-ramp project supports the walkway analysis project is best understood by looking at current strategies for studying our walkway environment.

There are three ways of gaining insight into the walkway environment: **zonal analysis**, **network analysis**, and **highlighting**. Zonal analysis gives us insight at the neighborhood level (we can tell walkable neighborhoods from less walkable) but we can't know much about what it's like to walk from a specific dwelling to a specific transit stop. The data aggregation that is inherent in zonal analysis reduces the need for data consistency and coverage.

Network analysis gives us good insight about the value of individual intersections and walkway segments in the context of transportation needs. Since it is based on individual routes it requires data to be consistent and coverage to be complete. Highlighting gives us insight into specific situations but there is little connection to broader transportation problems. Data requirements for highlighting are minimal. What we record for highlighting does not need to be consistent or even quantified. Gaps in coverage do not reduce the value of the observations.

Zonal analysis is easy and popular but there is not a good connection to results on the ground. There are enough organizations doing this and we don't think one more is needed. Citizens are justifiably critical of zonal analysis as an "academic exercise."

Highlighting is also easy and popular; and it has good connection to results on the ground. The weakness of highlighting is that improvements driven by highlighting do not necessarily work together for overall transportation improvement. There are many organizations that have communication and recording systems for highlighting.

How well does the curb ramp data support the walkway network analysis project? And how well does the curb ramp data meet the expectations of the partner groups who will walk and inspect miles of streets? To complete the walkway network analysis, each curb ramp condition (yes, sort-of, steep, cracked, flooded, none) needs to be assigned a number. In the walkway model a number is associated with each curb ramp, crossing, sidewalk. For sidewalks the number is the length of the sidewalk. For curb ramps the number is the equivalent distance that a person would walk to avoid a missing or “sort-of” curb ramp. So, the curb ramp data requires an informed, quantifiable and consistent understanding of this equivalent distance. Besides this, the nuances of various curb-ramp conditions may have a negligible influence on analysis of routes. Only after we are confident that an equivalent distance for a steep curb ramp can be assigned will the curb ramp data be a significant data set for the walkway analysis tool. More work is required to understand the behavior and decisions that people make when choosing to use or to avoid a corner with a missing or deficient curb ramp.

On the other hand, because the data collectors may want to take the time to highlight significant barriers to mobility, the curb ramp survey web application should be modified to allow some additional information to be added to the spatial model. This may be photos or narratives about specific locations which might generate information for photo-voice projects or other projects that develop the culture of why walking and barrier free walking is important for our cities. These notes and highlights about the walkway environment would not be used by the walkway network analysis project.

Some obvious walkway factors were not addressed in the project and should be mentioned. First, we did not collect data about sidewalks. The walkway model estimates the locations of sidewalks and does at times place a sidewalk where none exists. Sidewalks were not part of this project because other groups are already working on this and we did not feel that it would be an efficient use of time to ask data collectors to inspect sidewalks. Some groups have suggested using aerial photos and tax lot data to document sidewalk coverage. In 2008 Bellevue, Washington used a modified ultra-light, slow-speed inertial profiler (ULIP) mounted on a Segway Human Transporter to complete a sidewalk and curb ramp inventory. And, at the Georgia Institute of Technology the School of Civil and Environmental Engineering has developed a sidewalk assessment tool which uses a tablet computer attached to a wheelchair.

Some reviewers mentioned that the slope of a sidewalk segment is also a potential barrier for mobility. Because lidar data can be used to calculate slope, this should be added to the walkway before any wheelchair accessibility analysis is completed.

Recommendations

While the web application and walkway model provided a useable foundation for collecting data, changes in the user interface and use of training materials will be needed to assure consistency and accuracy when data collection is done by many. We learned in this first trial that intersections near bridges, overpasses, and freeway ramps were confusing. Where possible we should correct or simplify the walkway model before publishing to the curb ramp web application. And if the walkway model would be added as a layer to the web application it would help data collectors understand the expected sidewalk configuration. Other changes and improvements to the project are listed in more detail at <https://github.com/OregonWalks/curb-ramp-survey/issues>.

Measurement Requirements

- Change the acceptable “sort of” slope to 8 percent
- Designate slopes greater than 8% as steep
- Do not attempt to judge drainage problems

Training and User Interface, pre-survey data enhancements

- Add informative icons to the user interface which are as specific as screen space allows
- Consider using 7 inch tablets, not iPhones
- Display the modeled walkway network as well as the aerial photo
- Do more pre-survey cleanup of the model, especially around bridges
- Leverage information in existing PBOT data. It may be possible to integrate or overlay known information about drainage, curb ramp material, installation dates, and style of tactile warnings.

Enhancements

- Invent a method to input the location of additional crossings, barriers
- Include trails and urban walkways in the model
- Invent a wireless gadget that captures the slope at ramp and fills in the form
- Add a more useable timestamp with timezone to the ramp and intersection CartoDB shapefiles

Requirements for Scaling up

- A paid account at CartoDB
- Integrate CartoDB login authentication into the web application
- Continue to encourage PBOT to maintain durable node_ids at intersections
- Database enhancements by professionals-possibly to handle transactions by CartoBD Accounts
- A method to publish multiple neighborhood walkway networks to CartoDB, possibly a third user interface dialog to select a neighborhood or user-defined region
- Quality control goals and methods
- A method to allow data to be collected offline then uploaded when a network is available

Recommendations to prepare for Analysis

Wheelchair routing depends on terrain information and until the walkway segments have an associated running slope as well as reliable information about sidewalk presence and condition; any walkway analysis will not be improved by adding weights for curb ramps, unless it is known that an area has a consistent and flat terrain.

We also need to increase our knowledge and confidence in how we quantify the difficulty and risk in using deficient curb ramps. Ideally we would ask urban planners and people in the disability community to use the GIS Jammer cost-weighted analysis tools integral and to answer the question “how far out of the way would a typical person with a mobility disability travel to avoid this steep curb ramp.”

Analysis results will be improved when we have population information for employees in local businesses, likely hotel residents, and an estimate of transit users and shoppers passing through the district. Additionally, it would be useful to start with useful questions to direct the analysis. What are important trip destinations? Are these bus stops? Stores? Clinics? Offices?

Finally, to get the most from the analysis we need images for print and web viewing. Cartographic styling will better highlight findings. The analysis results can be displayed as a surface. We would like to show the analysis results in a game-like environment with a transparent 3d visualization of the surfaces, draped in a Google Earth-like viewer. By exporting analysis surfaces to Collada (DAE/digital asset exchange) files we could develop static or animated views of the usefulness of a complete walkway network or a surface of challenges for pedestrian travel.

We also conclude that this type of mobile app and process is not the best way to collect detailed information such as drainage and detectable warnings.

This was the first large scale test of our app. We proved that the app works while identifying a number of areas for improvement. We were able to relatively quickly survey 1500 curb ramps and we identified 396 missing ramps and 750 ramps that certainly do not meet current ADA requirements. Or, in this district approximately 75% of the crossings are deficient. It is also possible that some of the 357 corners with existing curb ramps do not meet current ADA requirements.

Additional Information and Access to a sample web application, maps and documentation

Sample Curb Ramp Web Application	http://oregonwalks.github.io/curb-ramp-survey/
Issues for the Curb-Ramp-Survey	https://github.com/OregonWalks/curb-ramp-survey/issues
Code and documentation on GitHub	https://github.com/OregonWalks
CartoDB Visualization of Curb Ramps	http://cdb.io/Jjx0jb
Oregon Walks Links to the GIS Jammers	http://oregonwalks.org/programs/gis-jammers
Bellevue, Washington modified ultra-light, slow-speed inertial profiler + Segway Human Transporter	http://www.bellevuewa.gov/pdf/Transportation/ada_report_summary0708.pdf
Georgia Tech tablet application to automatically assess sidewalk	http://transportation.ce.gatech.edu/node/2604

