## Todo list



Christine: Letter to CHC

University of Southern California
Los Angeles
California 90007

6th December 2013

RECIPIENT NAME

SALUTATION

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LETTER CLOSING

SENDER NAME

# An Analysis of Best Practices in Traffic Calming


Jake Hermle
*Civil Engineering*

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*Computer Engineering*

John Lally
*Mechanical Engineering*

Christine Noh
*International Relations*


6th December, 2013

## Abstract

Christine: Write the abstract

# Contents

## List of Figures

## List of Tables

# 1 Executive Summary

John: Do this section

## 2 Introduction and Background

Community Health Councils (CHC) is producing a report for the City of Los Angeles that recommends and details guidelines for complete streets design to be included in the Mobility Element of the citys General Plan. This CHC report will be describing various best practices that can be implemented so that LA streets better adhere to the principles of complete streets. The following report details eight specific best practices that CHC may implement in their report to the City of Los Angeles. For each best practice, a general description is provided, as well as a discussion of its impact and cost. Additionally, each practice was evaluated based on its cost, impact, and ease of implementation to determine whether it is worth recommending as a design guideline in the Mobility Element. A usability index was created to more quantitatively evaluate these practices, and allowed for better comparison between them. In addition to complete street design, this report is also mindful of CHCs overarching goals of improving health in South LA.

John: Finish this section

# 3 Best Practices

## 3.1 Chokers

Chokers are curb extensions at midblock locations that narrow a street by ultimately creating wider sidewalks. They are also known as safe crosses when marked as crosswalks. Chokers can be made by widening one side of the curb or by bringing both curbs in, giving it the pinch point along the street (See Figure 1). The main purpose of chokers is to decrease speed of incoming vehicles at a mid-point along the streets, create a seamless transition between a commercial and a residential area, and to narrow exceedingly wide intersections [1].

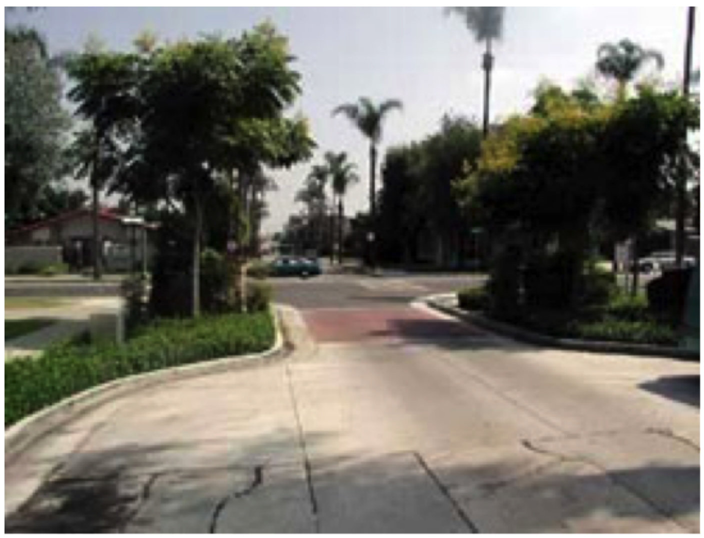


Figure 1: This choker requires drivers to yield upon entering

Two-lane chokers (See Figure 2) leave two lanes in the street cross section narrower than the width of a normal cross section, while one-lane chokers narrow the width to allow travel in only one direction at a time. These chokers are effective for areas with substantial speed problems and streets with minimum or no parking on-site.

The various advantages of chokers are:

- ability to reduce both speed and volume significantly
- easily negotiable by large vehicles (for example, fire trucks)
- improving aesthetic value when well designed

The disadvantages include:

- Eliminates on-street parking


Figure 2: Two-Lane Chokers

- Requires bicyclists to briefly merge with vehicular traffic
- Absence of vertical or horizontal deflation limiting the effect of chokers on vehicle speed.

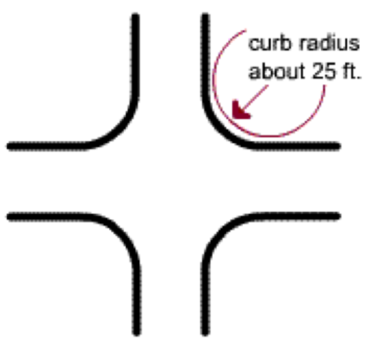
Chokers can ultimately increase the visibility of pedestrians as well as to reduce pedestrian crossing width, while the speed of vehicles is reduced by 4 percent on average for two-lane chokers and 14 percent on average for one-lane chokers [6]. Also since chokers work well with speed humps, speed tables, and raised intersections, (See Figure 3) it can be created in many sites with no extreme difficulty.

Factors to consider when creating chokers are to consult with the local fire and sanitation department before setting minimum width and to double check to make sure that the bicyclist safety and mobility are not diminished. Also when reducing two-lane street to one lane, the width of the travel way should not be wide enough for 2 cars to pass at the same time. This equals to the travel way not being wider than 4.9 meter, or 16 to 17 feet; by doing so, the effectiveness of the chocker is maximized [1]. The cost to create chokers varies depending on the site and landscape but most are along the lines of $5,000 to $20,000 (drainage representing a significant amount).

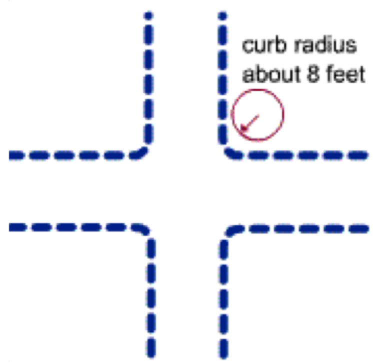
Figure 3: Speed Hump

## 3.2 Curb Radius

Curb radius is a traffic calming technique in which the grid of intersecting streets is reshaped and the radius of the curb is significantly reduced. As you can see in Figure 4a, a large curb radius will enable vehicles to go around corners faster while in Figure 4b, a smaller curb radius will slow vehicles down when turning into the corner.




(a) Large Curb Radius




(b) Small Curb Radius

Figure 4: Different curb radii

The purpose of curb radii is to slow vehicles down by enabling them to make smaller turns, which ultimately reduces the risk of pedestrians being struck by vehicles when turning into a corner. Also, small curve radii can create safer intersections, improve the visibility between drivers and pedestrians, and lead to improved signal timing. By reducing the curb radii, not only will it slow down vehicles when turning, but it will also shorten the distance and time it takes for pedestrians to cross the street by nearly half of what it used to be (See Table 1 and Figures 5 and 6).


Figure 5: Change in Distance from 25ft. Radius to 8ft. Radius

| Curb Radius (ft) | Time (s) |
|---|---|
| 10 | 7.9 |
| 15 | 9.8 |
| 25 | 14.1 |

Table 1: Average pedestrian crossing times for various curb radii

When streets have a large curb radius, motorists can make turns at relatively high speeds that decrease pedestrian safety. By contrast, 90-degree intersections and corners with tight curb radii tend to slow motorists down and therefore increase pedestrian safety. Motorists turning right at high speed can cut off bicyclists/pedestrians traveling straight on the arterial street. In addition, pedestrians crossing the residential street adjacent to the arterial may not expect high-speed turning traffic, or they may have their backs facing the turning cars as you can see in 7

The cost of reconstructing tighter turning radii is in between $5,000 to $40,000 per corner depending on the site locations/conditions. When considering curb radii, it is important to note that in order for it to be effective, the design should meet the needs of the design vehicles with consideration for nearby land uses and prevalence of roadway users. So if there are high volumes

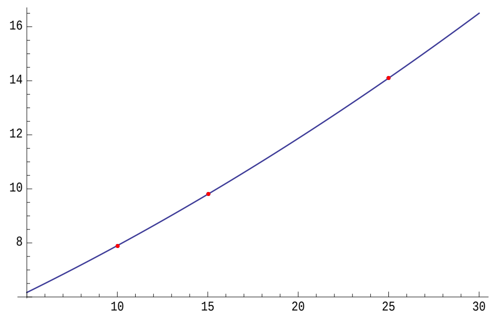



Figure 6: A plot of the data from Table 1

Figure 7: Pedestrian Facing Back Against the Car

of large vehicles making turns in a given location, a poorly designed curb radius could potentially cause the vehicles to drive over the curb and onto the sidewalk endangering pedestrians. In addition, you should always accommodate emergency vehicles, as well as school buses, and public maintenance vehicles when designing curb radii [4].

There is no magic number for the appropriate curb radius because it differs case by case depending on where it is located (See Figure 8). The length of the curb radius that should be used wherever possible is 5 to 10 feet, whereas an effective radius for urban streets with high volumes of pedestrians is 15 to 20 ft. For arterial streets with a substantial volume of turning buses/trucks, an appropriate effective curb radius is about 25 to 30 ft.; and the maximum desired effective curb radius is typically 35 feet for large vehicles [4].

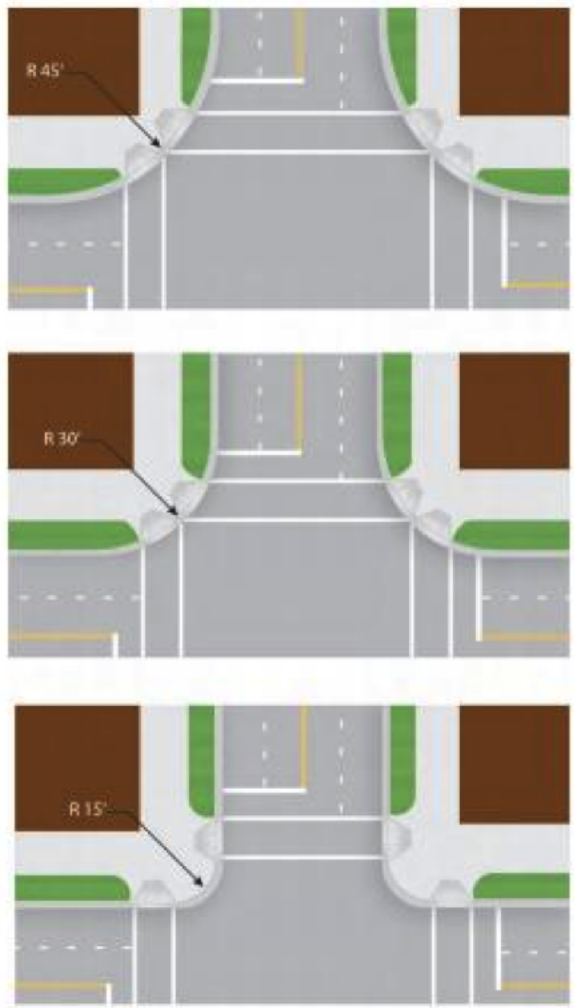



Figure 8: Different Curb Radii Depending on the Location

## 3.3 Raised Crosswalks

A raised crosswalk (Figure 9) is a designated street crossing that simulatneously acts as a speed hump by bringing the level of the roadway to that of the sidewalk.

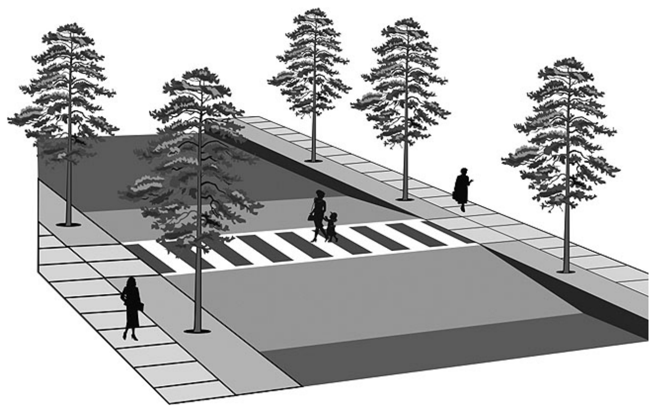


Figure 9: A raised crosswalk [10]

The advantages of such a traffic calming measure include:

- Forces traffic to slow down, improving pedestrian safety.
- Draws attention to the pedestrian, especially when combined with signage and markings.
- Makes crossing the street easier for those on wheelchairs.

The drawbacks are:

- The textured materials used tend to be expensive.
- Not suitable for emergency or bus routes.
- Drainage, especially in snowy or rainy areas, requires additional management.

Raised crosswalks are an effective traffic calming technique in that they can reduce vehicular speed (See Table 2). Further, they have also been shown effective at encouraging pedestrians to use the crosswalk instead of crossing the road elsewhere. One study [8] found that raising the crosswalk increased the percentage of pedestrians using it from 11.5% to 38.3%.

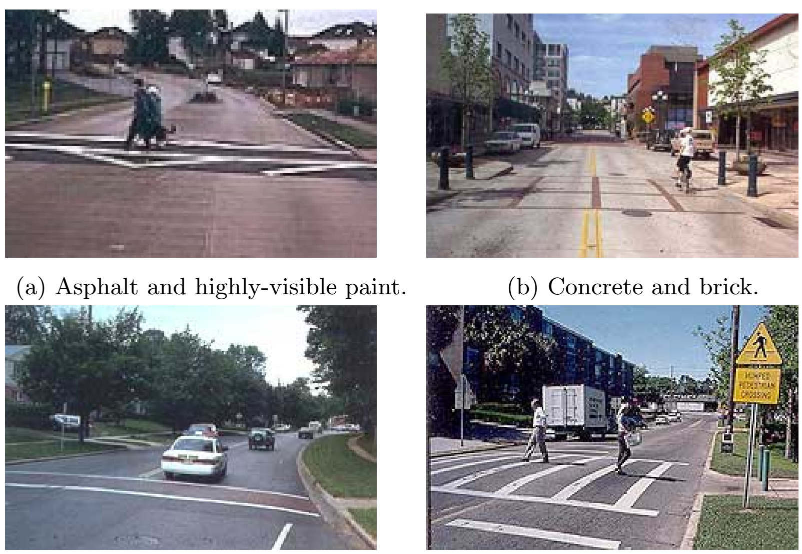
According to PEDSAFE [8], raised crosswalks can mitigate dart-and-dash type incidents in which the driver was unable to see the pedestrian until just before impact. They also prevent vehicles from 'trapping' pedestrians. Raised crosswalks are best used in areas of low-volume, low-speed traffic where safety of pedestrians takes a priority, such as residential areas and near schools. As a

| City and Measure | 50th percentile speed (km/h) | | Speed reduction (km/h) |
|---|---|---|---|
| | Treatment Site | Control Site | |
| Durham, NC Research Drive<br>*Raised crosswalk* | 33.3 | 39.8 | 6.5 |
| Durham, NC Towerview Drive<br>*Raised crosswalk, overhead flasher* | 18.5 | 38.4 | 19.3 |
| Montgomery County, MD<br>*Raised Crosswalk* | 34.6 | 38.6 | 4.0 |

Table 2: Speed reduction due to raised crosswalks (Data from [8])

side benefit, they make crossings much easier for the elderly, the disabled, and the young in these areas.

The cost of such a crosswalk varies from $2000 to $15000, with typical cost estimate for one unit being $4000 [5]. However, this might be significantly increased if a drainage system has to be added.



(a) Asphalt and highly-visible paint.

(b) Concrete and brick.

(c) Tapering at the curbs to allow drainage.

(d) Higher profile crosswalk, almost resembling a speed hump.

Figure 10: Various raised crosswalk styles. [5]

### 3.4 Curb Extensions

A curb extension (Figure 11) is an extension of the curb onto the roadway. As a traffic calming measure, they are primarily used to assist pedestrians by reducing crossing distance and slowing traffic down.

Figure 11: Curb extension

Curb extensions are thought to have the following advantages:

- Reduce the time that pedestrians are exposed to traffic.
- Increase the visibility of pedestrians attempting to cross.
- Shield parking lanes from oncoming traffic and prevent drivers from using them as right turn lanes.

The various drawbacks are:

- They pose a threat to bicyclists, who are forced into a narrowed gap along with traffic.
- Like raised crosswalks, they complicate drainage since they obstruct the gutter.
- Reduce the availibility of parking spaces, which can hurt local businesses.

One study [9] found that curb extensions significantly reduced the number of vehicles pedestrians had to wait for before one yielded. The same study also found minor increases in percents of crossings where a motorist yielded, and of vehicles yielding at advance stop bars. These results are shown in Tables 3, 4 and 5.

| Lane | Non-curb extension | Curb extension | Difference | Sample Size |
|---|---|---|---|---|
| Near | 2.58 | 1.81 | -42.7 % | 219 |
| Far | 2.36 | 1.76 | -33.9 % | 214 |

Table 3: Average number of vehicles passing before a pedestrian-cross. Results found significant by the t-test.

| Lane | Non-curb extension | Curb extension | % difference | Sample Size |
|---|---|---|---|---|
| Near | 64.9% | 66.7% | 2.7% | 234 |
| Far | 58.6% | 63.4% | 7.7% | 234 |

Table 4: Percents of pedestrian crossings with yield. The results were found insignificant by the t-test.

| Lane | Non-curb extension | Curb extension | % difference | Sample Size |
|---|---|---|---|---|
| Near | 42.6% | 53.8% | 21.0% | 99 |
| Far | 42.6% | 51.9% | 18.0% | 99 |

Table 5: Percent of vehicles yielding at advance stop bar. The results were found insignificant by the t-test.

### 3.5 Textured Pavements

Jake: Add the textured pavements section

### 3.6 Dignified Zones

Jake: Add the dignified zones section

### 3.7 Traffic Circles

John: Add the traffic circles section

### 3.8 Midblock Crossings

John: Add the midblock crossings section

# 4 Analysis

## 4.1 Methodology

Jake: Talk about the methodology we used

## 4.2 Rankings

Jake: Rank the practices

## 4.3 Discussion

Jake: Discuss the results

# 5 Conclusion

Nakul: Conclude

## References


[1] Chokers. http://www.walkinginfo.org/engineering/calming-chokers.cfm. WalkingInfo.org.

[2] Chokers. http://www.trafficcalming.net/chokers.htm. Traffic Calming.

[3] Curb radius: Better walking through geometry. http://www.missionped.org/archive/curbrad.html. Mission Pedestrian.

[4] Curb radius reduction. http://www.walkinginfo.org/engineering/crossings-curb.cfm. WalkingInfo.org.

[5] Raised crosswalks. http://www.trafficcalming.net/raised-crosswalks.htm. Traffic Calming.

[6] Traffic calming measures - choker. http://www.ite.org/traffic/choker.asp. Institute of Transportation Engineers.

[7] What are chokers? http://www.sinoconcept.com/2012/01/chokers/, 2012. Sino Concept.

[8] Herman F. Huang and Michael J. Cynecki. The effects of traffic calming measures on pedestrian and motorist behavior. *Pedestrian Safety Guide and Countermeasure Selection System*, 2001.

[9] Randal S. Johnson. Pedestrian safety impacts of curb extensions: A case study. *Transportation Development - Research Section*, 2005.

[10] Kimley-Horn and Associates, Inc.

[11] Edward R. Stollof. Developing curb ramp designs based on curb radius. *ITE Journal*, 2005.

[12] Charles Zegeer, Dan Nabors, and Peter Lagerwey. Curb radius reduction. *Pedestrian Safety Guide and Countermeasure Selection*, 2013.

Jake: Add your resume to the resumes subfolder

# Nakul Joshi

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## EDUCATION

**B.S. Computer Engineering/Computer Science**
**University of Southern California** GPA: 3.575/4 *Expected Graduation May 2014*
**Relevant Coursework**

| | | | |
|---|---|---|---|
| Data Structures | Computer Architecture | Object-oriented Programming | Software Engineering |
| Web Publishing | Calculus & Statistics | Artificial Intelligence | Digital Forensics |

## TECHNICAL SKILLS

| | |
|---|---|
| **Languages** | Java, C/C++, Python, HTML, JavaScript, Verilog |
| **Tools** | Eclipse, NetBeans, SVN, Git, Mathematica, Xilinx ISE |
| **Packages** | Microsoft Office, LaTeX |

## WORK EXPERIENCE

**Viterbi School of Engineering** January 2013 - Present
*Undergraduate Teaching Assistant, Data Structures* *Los Angeles, CA*

- Led lab sections for the course.
- Graded assignments and tests.
- Held office hours during which I answered students' questions.

**University of Paderborn** May 2012 - July 2012
*Research Intern* *Paderborn, Germany*

- Co-authored a paper on Digital Rights Management (DRM) with a Ph.D. student.
- Gained a background in cryptography through research and applied it to develop a protocol for a cloud-based DRM solution.

**Viterbi Academic Resource Center** January 2012 - Present
*Peer Tutor/Supplemental Instruction Leader* *Los Angeles, CA*

- Assisted students with engineering classes in one-on-one sessions.
- Led weekly group sessions to supplement introductory computer science lectures.

## PUBLICATIONS

**Towards practical privacy-preserving Digital Rights Management for Cloud Computing** IEEE CCNC 2013
*Co-author*

- Created a cryptographic protocol that protected the copyright on cloud-based software.
- The protocol specifically protected the privacy and anonymity of users in the system.

## ACADEMIC PROJECTS

**Factory simulation** Fall 2011

- Collaborated with seventeen students to simulate a multi-agent system.
- Designed and implemented the user interface.

**Constraint Satisfier** Fall 2012

- Wrote a program that found boolean assignments that satisfied a given set of logical statements.
- Applied the program to create a Sudoku-style puzzle solver.

## HONORS AND ACHIEVEMENTS

**Dean's List** Fall 2010, Spring 2011, Fall 2011, Spring 2012

**Engineering Honors Colloquium**

**Southern California Regional International Collegiate Programming Contest** Fall 2010
*Placed 6$^{th}$ out of over 90 teams*

**IEEE Eta Kappa Nu Honors Society** Member since Spring 2012

# JOHN TIMOTHY LALLY

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**BS in Mechanical Engineering** Expected 12/2014
**Minor in Engineering Management**
Viterbi School of Engineering
University of Southern California

**Relevant Coursework:**

| | |
|---|---|
| Fundamentals of Physics I, II, III | Strength of Materials |
| Technical Entrepreneurship | Statics, Dynamics |
| Introduction to Computational Methods | Engineering Statistics |
| Probability Concepts in Engineering | Thermodynamics |
| Fluid Dynamics | Materials Science |
| Mechoptronics Laboratory | Heat Transfer |
| Computational Solutions to Eng. Problems | Aero-Mechanical CAD |
| Linear Control Systems | Flight Mechanics |

## Work Experience:

**Co-op Mechanical Engineer** 5/2013 – 8/2013
Carlisle Interconnect Technologies Cerritos, CA
- Utilized engineering principles, processes, and methods to satisfy project objectives related to manufacturing support/development of connectors/cable process
- Created plant and equipment layouts, wrote manufacturing procedures and specifications, investigated and corrected process and tooling abnormalities
- Led investigation and implementation of SPC program on five production lines
- Trained in ITAR and EAR compliance for aerospace and military technology

**Student Associate** 5/2013 – Present
USC Stevens Center for Innovation Los Angeles, CA
- Member of Operations Team for technology licensing and commercialization
- Reviewed technology disclosures from professors and graduate students in Viterbi School of Engineering, Information Sciences Institute, and Keck School of Medicine
- Improved and developed business processes, reviewed data accuracy and metric reporting, and provided input on projects and strategic decisions

**Construction Manager** 5/2008 – 8/2012
Summer Real Estate Boston, MA
- Maintained and updated Boston-area residential properties
- Designed and led remodeling and renovation projects
- Carpentry, roofing, flooring, heating, electrical, plumbing

**Valet Attendant** 5/2012 – 8/2012
Chatham Bars Inn Resort and Spa Chatham, MA
- Provided valet, bellman, and chauffer services to resort guests
- Managed department operations as bell captain during evening shifts

## Affiliations/Leadership:

**Delta Chi Fraternity –** House Manager 1/2011 – Present
- Developed projects with Alumni Board of Trustees and USC Housing officials
- Led 10 member committee in planning and executing construction projects

**National Organization for Business and Engineering –** Officer of Investments 1/2011 – Present
- Planned guest speakers, networking events, and professional workshops

**Rocket Propulsion Laboratory –** Junior Member 9/2010 – 5/2012
- Cut carbon fiber and constructed wet-layup fiberglass body

# Christine Noh

CN

**E-Mail: cnoh@usc.edu; christinenoh@gmail.com**


## Education

Smith College, Northampton, MA.

Date Attended: August 2010 – May 2011

University of Southern California, Los Angeles, CA.

Expected Graduation Date: May 16, 2014

Major: *Bachelor of Arts* – International Relations

## Skills/Qualifications Summary

- Bilingual; Ability to speak and write English and Korean fluently with no grammatical errors.
- Avid user of Microsoft Word, PowerPoint, and Excel.
- Experience with both PC and Macintosh computers
- Able to work calmly with various groups of people under difficult situations and communicate well with others.

## Professional Experience

*Paralegal at Law Offices of Kyung Hee Lee, PC* (March 2013 – August 2013)

- Assisted an attorney with various types of immigration cases, and accumulated extensive experience in the areas of B-1; E-1/2; F-1; employment-based immigration petitions (1st, 2nd and 3rd preferences); H-1B; L-1; TN; NIW; all family-based immigration petitions; and extensions/transfers for the aforementioned nonimmigrant visas - strong background in E-2, EB-1, 2 and 3, H-1B and L-1