

## **Todo list**

John: Do this section . . . . .	4
John: Finish this section . . . . .	5
Jake: Add the textured pavements section . . . . .	15
Jake: Add the dignified zones section . . . . .	17
John: Add the traffic circles section . . . . .	17
John: Add the midblock crossings section . . . . .	18
Jake: Talk about the methodology we used . . . . .	18
Jake: Rank the practices . . . . .	18
Jake: Discuss the results . . . . .	18
Nakul: Conclude . . . . .	19

University of Southern California  
Los Angeles  
California 90007

6<sup>th</sup> December 2013

Community Health Councils, Inc.  
3731 Stocker Street,  
Suite 201  
Los Angeles, CA 90008

To whom it may concern,

We are four students at University of Southern California expected to graduate next year, May of 2014. With each of us majoring in a different subfield/subject, we tried to see this project from various perspectives in order to seek what fits best for CHC.

After the insightful site visit, we decided to target ways in which we can improve pedestrian and biker safety as well as for mobility as a whole for the greater Los Angeles. With many traffic-calming techniques already available, we have narrowed down the list to eight specific techniques that we found to be the most reliable and efficient and analyzed them thoroughly. Those eight techniques are chokers, curb radius, raised crosswalks, curb extensions, textured pavements, dignified zones, traffic circles, and midblock crossings. After going deeply into each technique, we have ranked them from top to bottom for you to easily be able to see which ones are the most suitable for Los Angeles.

We have focused this project to cater to CHCs needs and we hope that you find this information helpful for your future plans and projects. Thank you so much for taking the time to answer our emails whenever we needed any clarifications.

Sincerely,

Jake Hermle  
Nakul Joshi  
John Lally  
Christine Noh

# An Analysis of Best Practices in Traffic Calming

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## **Abstract**

In order to improve mobility and safety in Los Angeles, we have looked upon eight distinctive traffic-calming practices. These include chokers, curb radius, raised crosswalks, curb extensions, textured pavements, dignified zones, traffic circles, and midblock crossings. We will go in detail for each of these techniques and in the end, discuss which one would be the better alternative for Los Angeles specifically.

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# 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 city's 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.

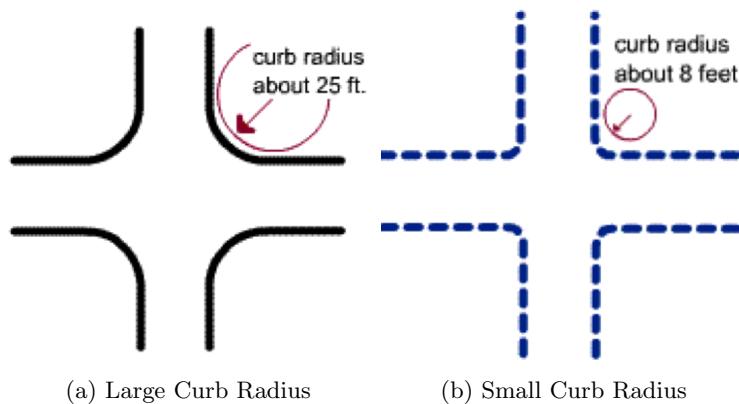
Factors to consider when creating chokers are to consult with the local fire and sanitation department before setting minimum width and to double check to make sure that the bicyclist safety and mobility are not diminished. Also when reducing two-lane street to one lane, the width of the travel way should 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 choker 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 Figure 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

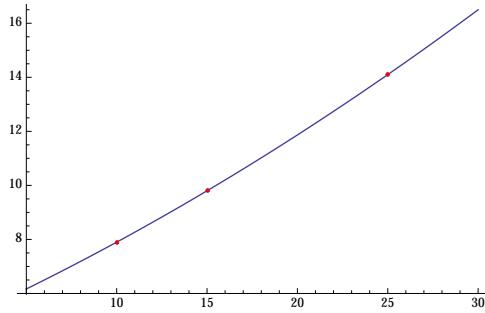


Figure 6: A plot of the data from Table 1



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].

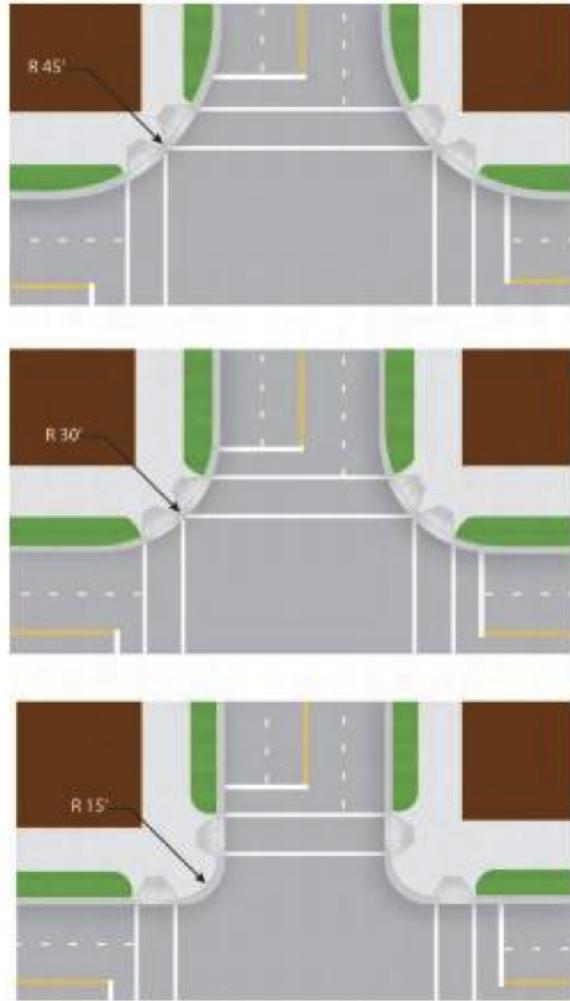


Figure 8: Different Curb Radii Depending on the Location

### 3.3 Raised Crosswalks

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

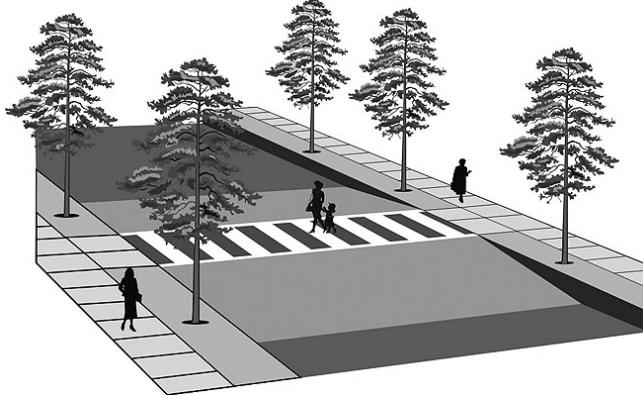


Figure 9: A raised crosswalk [10]

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 <i>Raised crosswalk</i>	33.3	39.8	6.5
Durham, NC Towerview Drive <i>Raised crosswalk, overhead flasher</i>	18.5	38.4	19.3
Montgomery County, MD <i>Raised Crosswalk</i>	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 for 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 availability 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

Textured and colored pavements refers to the use of varied pavement materials to alter the color or texture of a street surface. This practice can be used as a traffic calming measure or as a way to distinguish special areas of the street.

Changes in pavement texture from normal concrete or asphalt surfaces can cause a change in audible road noise inside the car body. This effect can be utilized to alert drivers to slow down or take notice of potential hazards. Textured or colored pavements can also be used to visually distinguish special areas of the street, such as crosswalks or bike lanes, to make drivers more aware of their location [?].

Altered pavement textures and colors have been found to cause reductions in vehicle speed, though there is limited data available to quantify this [?]. This practice can be used in combination with other practices to produce a traffic calming effect, such as raised crosswalks, speed tables, or raised intersections.

#### 3.5.1 Materials

**Cobblestones** Cobblestone roads are paved with quarried stone with rounded tops. The advantages of this material are that it will create a significant audible disturbance to drivers and can provide a unique aesthetic appeal; however,

cyclists and wheelchair users might find this pavement difficult to navigate. Additionally, the unevenness of the pavement makes it more difficult to remove snow and ice [?].



Figure 12: Cobblestone street in Lymm Cross, Cheshire, England

**Setts and Bricks** Setts are quarried stone blocks that are flat-topped (in contrast with round-topped cobblestones). They are typically arranged in a uniform manner, as pictured in Figure 13. Bricks are used and placed in a similar nature, but come from a different source material. The road texture of sett-paved roads can vary depending on the evenness of the selected setts [?].

**Concrete Blocks** Concrete blocks are pre-cast, individual blocks of concrete that are placed similarly to bricks or setts. An advantage of using concrete blocks is that they can be shaped and colored in different ways to create a desired appearance. For example, concrete blocks can be made to look like setts and bricks by casting them in a certain size and applying the proper coloring. An additional advantage of concrete blocks is their reduced cost [?].

**Colored Pavement** Pavement can be colored through the use of pavement striping paint, as similarly used to make normal pavement markings. While textured pavements generally are made up of more earthen tones, bright colors can be used to create a very noticeable visual effect, as demonstrated by the green bike lanes in Figure 16.



Figure 13: Streets paved with setts



Figure 14: Speed hump utilizing brick paving

### 3.5.2 Cost

The cost of utilizing textured or color pavements is dependent on a) the material used and b) the total area of the pavement. The Victoria Transport Policy Institute estimates a cost range of 5–16 per square foot [?]. A crosswalk 10 feet in width crossing a four-lane road, for example, would have a total material cost ranging from 2400 to 7680.

## 3.6 Dignified Zones

Jake: Add the dignified zones section

## 3.7 Traffic Circles

John: Add the traffic circles section



Figure 15: Concrete block paving



Figure 16: Green-colored bike lanes in Portland

### 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



Figure 17: Brown coloring used to distinguish a bike path crossing in the Netherlands

## 5 Conclusion

Nakul: Conclude

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# James (Jake) Hermle

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## EDUCATION

---

**University of Southern California**, Los Angeles, CA

Viterbi School of Engineering

Bachelor of Science, Civil Engineering

Expected May 2014

Cumulative GPA: 3.668

**Honors:** Viterbi Dean's List, Presidential Scholar, Chi Epsilon Honor Society, Rusch Engineering Honors Program

**Thomas Jefferson High School for Science and Technology**, Alexandria, VA

June 2010

GPA: 4.319

## EXPERIENCE

---

**Arup**, Los Angeles, CA

Summer 2012, Summer 2013

*Infrastructure Intern*

- Modeled light rail underground guideways to perform soil settlement analyses.
- Produced horizontal and vertical roadway alignments for the Gerald Desmond Bridge Replacement Project.
- Chaired civil engineering group task force meetings and took minutes.
- Coordinated with the NOAA PORTS program to determine design constraints for bridge air gap sensor.
- Created utility routing plan for pipes servicing Gerald Desmond Bridge maintenance vehicles.
- Produced potholing and CCTV surveying exhibits for utility upgrading projects.

**Dominion Virginia Power**, Woodbridge, VA

Summer 2011

*Design Intern*

- Designed new service lines to connect businesses and residencies requesting electricity to the power grid.
- Communicated with customers to configure power line designs to individual needs.

**American Society of Civil Engineers, USC Chapter**

January 2011 - Present

*Concrete Canoe Co-Captain (August 2011 – Present)*

- Manage a team of 30 students to design and construct a concrete canoe to be raced against other universities in the Pacific southwest.
- Coordinate team paddling practices, design and construction meetings.
- Developed concrete mix design using lightweight aggregates to design a concrete mix that floats in water while staying within ASCE rules and regulations.
- Composed technical write-ups of the design and construction of the canoe.

**Troy Camp, USC**

September 2012 – Present

*Counselor*

- Assisted in the organization of specialized programming for students at West Vernon Elementary in musical theater and leadership programming for middle school students in the Leaders In Training program.

**Institute of Transportation Engineers, USC Chapter**

April 2011 - Present

*Publicity Chair (August 2011 – August 2012)*

- Helped establish newly formed chapter of ITE.
- Maintain communication with member base concerning ITE events.

## SKILLS

---

**Software:** MS Office (Word, Excel, Powerpoint), AutoCAD, Revit Architecture, SolidWorks, SAP2000, MicroStation (+InRoads)

**Languages:** Conversational German

# Nakul Joshi

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## EDUCATION

---

### B.S. Computer Engineering/Computer Science

University of Southern California GPA: 3.575/4

#### Relevant Coursework

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

Expected Graduation May 2014

## TECHNICAL SKILLS

---

**Languages** Java, C/C++, Python, HTML, JavaScript, Verilog

**Tools** Eclipse, NetBeans, SVN, Git, Mathematica, Xilinx ISE

**Packages** Microsoft Office, L<sup>A</sup>T<sub>E</sub>X

## WORK EXPERIENCE

---

### Viterbi School of Engineering

*Undergraduate Teaching Assistant, Data Structures*

January 2013 - Present  
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

*Research Intern*

May 2012 - July 2012  
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

*Peer Tutor/Supplemental Instruction Leader*

January 2012 - Present  
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**  
*Placed 6<sup>th</sup> out of over 90 teams*

Fall 2010

### IEEE Eta Kappa Nu Honors Society

Member since Spring 2012

# JOHN TIMOTHY LALLY

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**BS in Mechanical Engineering**  
**Minor in Engineering Management**  
Viterbi School of Engineering  
University of Southern California

Expected 12/2014

## 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
Mechophtronics Laboratory	Heat Transfer
Computational Solutions to Eng. Problems	Aero-Mechanical CAD
Linear Control Systems	Flight Mechanics

## Work Experience:

### **Co-op Mechanical Engineer**

Carlisle Interconnect Technologies

5/2013 – 8/2013  
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**

USC Stevens Center for Innovation

5/2013 – Present  
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**

Summer Real Estate

5/2008 – 8/2012  
Boston, MA

- Maintained and updated Boston-area residential properties
- Designed and led remodeling and renovation projects
- Carpentry, roofing, flooring, heating, electrical, plumbing

### **Valet Attendant**

Chatham Bars Inn Resort and Spa

5/2012 – 8/2012  
Chatham, MA

- Provided valet, bellman, and chauffeur 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

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CN

## 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