Design and Engineering Services

Induction Lighting Demonstration and Survey for Car Dealerships Exterior Display Lighting

Statewide Emerging Technologies ET 06.09

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Project Management

Nancy Clanton, PE, Clanton & Associates, Inc. of Boulder, Colorado managed this project. Subcontractors on this project included Stacia Okura and Bob Kasman, RLW Analytics of Sonoma, California and Chris Winters, Quality Light and Electric of Bloomington, California.

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Disclaimer

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Abbreviations and Acronyms

CCT	Correlated Color Temperature in degrees Kelvin
CRI	Color Rendering Index
FC	Footcandles
HID	High Intensity Discharge
IESNA	Illuminating Engineering Society of North America
MH	Metal Halide
W	Watts

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Executive Summary

The purpose of this demonstration and survey is to evaluate the visual effect of induction lamps compared to two different wattages of metal halide lamps at a car dealership. The benefits of the induction lamps are that they consume considerably less energy than high intensity discharge (HID) light sources, while providing improved color rendering at significantly lower lumen levels.

Clanton & Associates, Inc. with sub-consultant RLW Analytics, Geltz Communications, and contractor Quality Light and Electric worked with SCE to conduct this research project which was designed to provide information on the visual effect of induction lamps when compared to metal halide lamps at a car dealership. This included a side-by-side exploratory research project which gauged responses from the same respondents to the different lighting systems separately located at one car dealership.

This exploratory research project will assist SCE to understand if people have a preference between the different lighting systems and if the induction lamp technology should be further pursued. The current definition of energy efficiency states that in order of a lamp to be considered “energy efficient” it must have similar lumens and measured foot candles but use less energy than the lamp it is being compared to. The induction lamps produce considerably less lumens and measured foot candles than the metal halide sources that they are being compared to, yet they use about a third of the energy. This study will examine the Quality vs. Quantity issues related to these particular lighting systems.

The project development and survey was completed in October 2006. To the best of the researchers’ knowledge there has not been any similar market research conducted relating to induction lighting.

The subject car dealership was Metro Nissan Motors located at 1665 Industrial Park Avenue in Redlands, California (Figure 1). There were three lighting systems tested, each comprised of four fixtures mounted two to a pole. This test was conducted in the back lot area of the Nissan Dealership. System A included four one-1000 watt standard metal halide lamps (4,320 watts), System B four 750 watt pulse start metal halide lamps (3,280 watts), and System C with four two-200 watt induction lamps (1,632 watts). Each system was separated by two poles that were operating the existing fixtures that provided lighting for the back lot. These existing fixtures were switched off during the survey periods. Cars in the front were arranged in a similar manner in each test area with the same colors and locations simulating a front row and mid lot condition. A diverse set of 100 respondents were asked 19 questions that were designed to rate the visibility produced by each lighting system.

It appears there has not been any research analyzing the quantity and quality of exterior display light and the shopping experience for car dealerships. This may include visual comfort, color quality of the merchandise, reading sticker price information, appeal and expectations. This study was an exploratory research study to compare three lighting systems with the shopping experience. It should be noted that this was not a tightly controlled scientific study, but rather was intended as an exploratory experiment to determine if this technology warrants additional testing.

Figure 1: Metro Nissan Motors in Redland, CA

A diverse set of 100 respondents were asked to rate their perceptions of each lighting system with respect to glare, brightness, color rendition, security, etc (Figure 2). They were also asked two general questions about the overall quality (question 18) and how the lighting compared to similar dealerships at night (question 19).

Figure 2: Respondents at the test site.

Generally, the results (see Figure 3 and Figure 4) of the October 14 survey **did not** show that the 1,632 watt induction lighting system (C) was significantly different from the standard 4,320 watt metal halide system (A). No significant difference was identified between the 3,280 watt (B) and 4,320 watt (A) metal halide systems. All tests for statistical differences were performed at the 95% level of confidence.

A "statistically significant difference" (e.g., difference between two sample means) means there is a small probability (less than 5% in this study) that the differences observed in samples occurred by pure chance when no differences exist in the populations from which the samples were drawn. Note that it is also possible to *not* observe statistically significant differences when real differences in populations *do* exist. Also note that there are other potential sources that could cause differences in the means that are non-statistical in nature such as the experiment design.

Implementation of emerging induction lighting technology results in over a 62% reduction in lighting power energy while not significantly affecting the retail car display lighting quality.

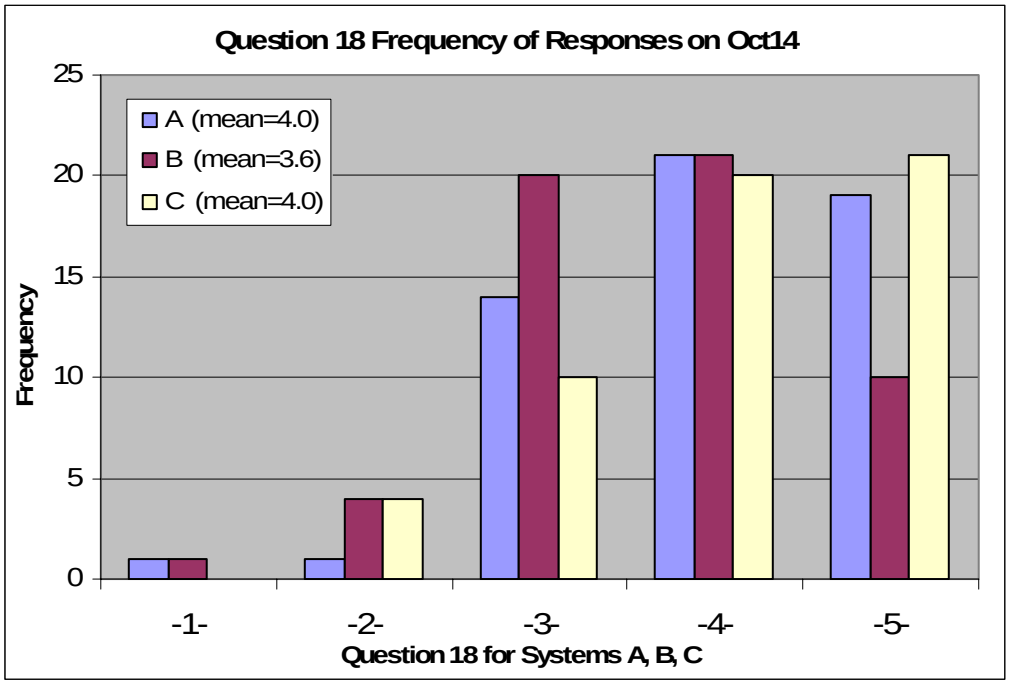

Figure 3: Frequency distribution of responses to Question18, "Please rate your impression of the overall quality of the light on a scale of 1 to 5, with 1 being very low quality and 5 being very high quality."

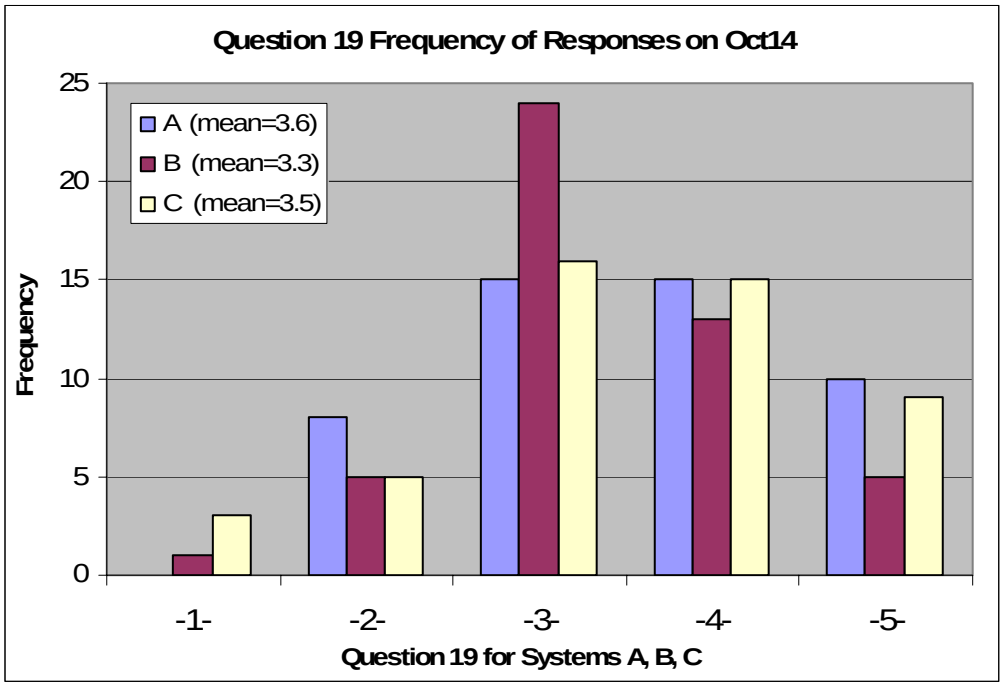

Figure 4: Frequency distribution of responses to Question 19 "How does the lighting in this area compare with the lighting at similar dealerships at night?"

There are several benefits of induction lighting over standard metal halide lamps including using less energy, up to four times the life, better color rendering, and instant on/off capability (see Table 1). Since induction lighting initial cost is two to three times more expensive, customers may be hesitant to install them because of the increased initial cost.

Baseline (A)	Standard Retrofit (B)	New Retrofit (C)
1,000 watt metal halide	750 watt pulse start metal halide	2-200 watt induction
Total system lamp wattage = 4,000 watts	Total system lamp wattage = 3,000 watts	Total system lamp wattage = 1,600 watts
Total system lamp and ballast wattage = 4,320	Total system lamp and ballast wattage = 3,280	Total system lamp and generator wattage = 1,632
3,800K CCT	4,000K CCT	4,200K CCT
65 CRI	65 CRI	80 CRI
Lamp life = 15,000V; 9,000H	Lamp life = 1,600V; 1,200H	Lamp life = 100,000 hours(rated) 70,000 useful

Table 1: Comparison of Baseline (1,000 watt metal halide); standard retrofit (750 watt metal halide) and New Retrofit (2-200 watt induction)

As the survey analysis shows, the research did not find a significant difference between the different lighting systems. Energy savings will be achieved despite lower lighting levels and darker feeling with the induction lighting system. Improvements include:

- Reduced the lighting electricity usage by 62%

- Decreased glare and brightness
- Possibility of increased color rendition
- Possibility of increased comfort

Given the potential for significant energy savings and improved visual comfort that is represented by the induction lighting systems, SCE should include this lamp family as one of many viable options for lighting retrofit and new construction applications. The end-user should understand the induction lamp will produce less measured light than the typical HID sources that it will be replacing, but it does offers long life, excellent color, significant energy savings, and a non-glaring lighting system. When considering the installation of induction lighting, test fixtures should be installed to insure that there will be adequate levels of lighting provided for human safety and for the specific tasks being performed.

Future recommendations include using the results of this exploratory research study and develop a rigidly controlled scientific experiment. This may include setting up the three systems at a different car dealership. This would best represent the overall car shopping experience. Since the lamps were all retrofitted in existing 1,000 watt luminaires, new luminaires could be installed specifically designed for the induction lamp with better distribution performance. In addition, spacing criteria can also be optimized.

1.0 Introduction

Induction lamps are an emerging technology that can be used in many lighting applications. Because of their high initial cost, many customers are hesitant in installing this technology. Advantages of the induction lamp are numerous over the life of the lamp including high color rendering properties, extremely long life (100,000 hours), high lamp efficacy, and instant on/off controls. Environmental advantages include very low mercury content compared to the metal halide lamp.

Car dealerships are typically designed with 1,000 watt metal halide lamps in order to achieve high light levels for the evening shopper. These lamps have fair color rendering properties, short life (15,000 hours vertical burn position and 9,000 hours horizontal burn position), medium lamp efficacy, require warm up time and have significantly higher mercury content especially over the life of an induction lamp.

1.1 Approach

The research team initially visited the site to evaluate if it were appropriate for the experiment. The back lot offered three separate yet similar display opportunities where the light poles had the same spacing and were each separated by a row of poles. This lot layout permitted the set up of three identical lighted areas with the separating rows of lights turned off.

Existing forward throw luminaires were retrofitted with the following. Four existing luminaires were cleaned and re-lamped with new 1,000 watt metal halide lamps (System A); four other existing luminaires were cleaned, re-lamped with new 750 watt metal halide lamps and supplied with new ballasts (System B); and four more existing luminaires were cleaned, re-lamped each with two 200 watt induction lamps and supplied with induction lamp generators (System C).

Individual switches were installed on the poles located in-between the three lighting systems such that these luminaires could be switched off during the experiment.

Cars were chosen by type and color and arranged in a similar manner in each lighting scenario. The intent was to simulate a typical shopping experience with cars located in the front row and in the middle of the lot.

The survey evaluation tool was adapted from the Public Interest Energy Research (PIER) CA Outdoor Lighting Assessment subjective evaluation tool. Additional questions about car colors and shopping experience were added to this tool.

The respondents were selected to have gender and age diversity. The survey compromised of 100 people completing the surveys on two different evenings.

Luminance measurements of each scene were taken with a Nikon E5400 (see Figure 5, Figure 6, and Figure 7). System A had the highest luminance readings and System C with the lowest. This corresponds to the survey results of System A being more glaring than System C.

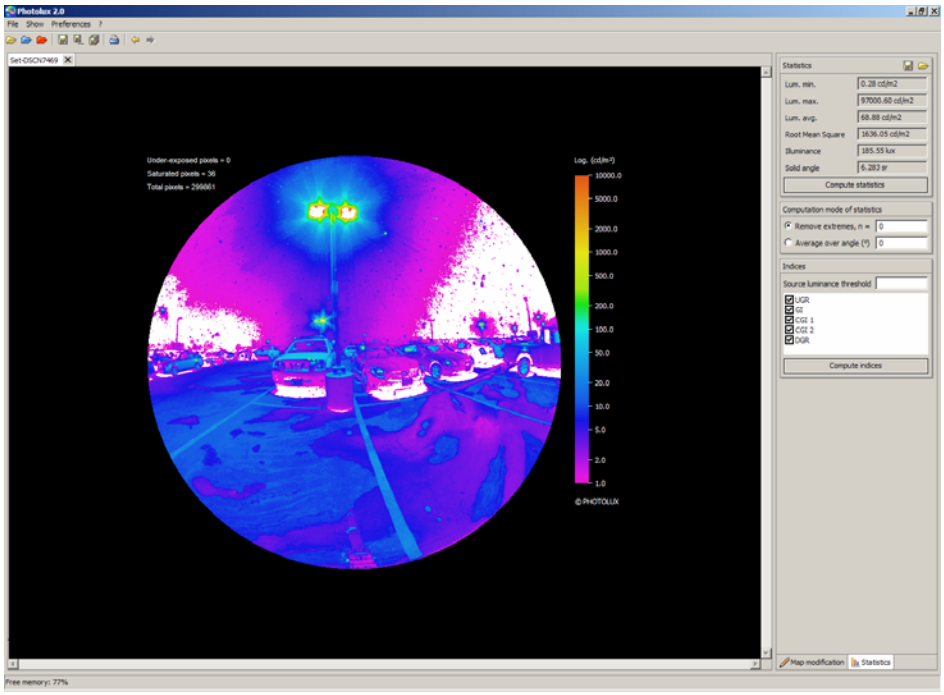

Figure 5: System A Luminance Measurements (cd/m^2) of 1,000 watt MH . This system resulted in a maximum luminance of 97,000 cd/m^2 (the highest of the three systems).

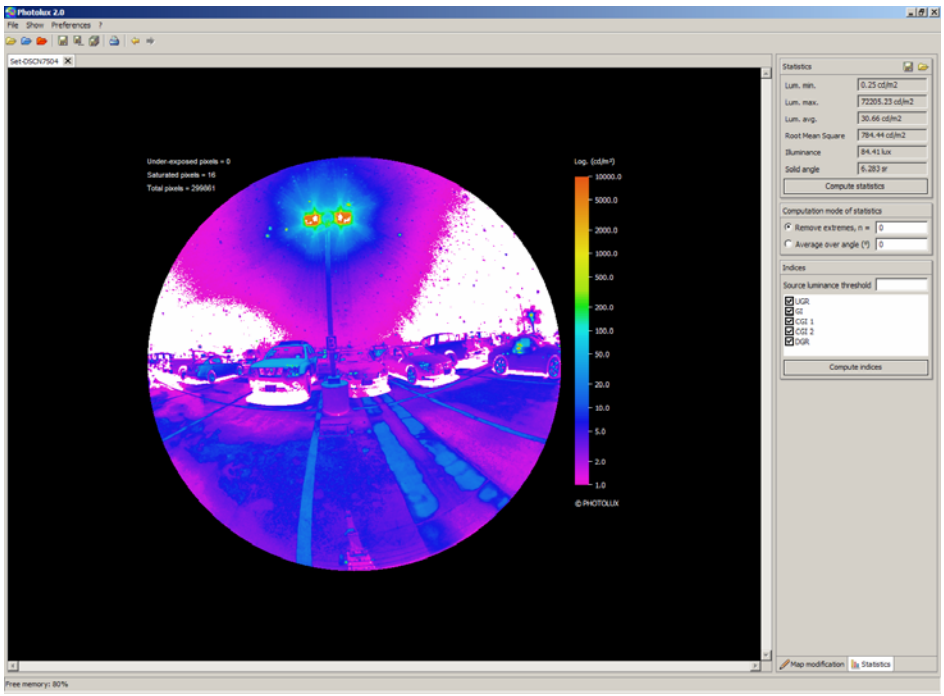

Figure 6: System B Luminance Measurements (cd/m^2) of 750 watt MH . This system resulted in a maximum luminance of 72,000 cd/m^2.

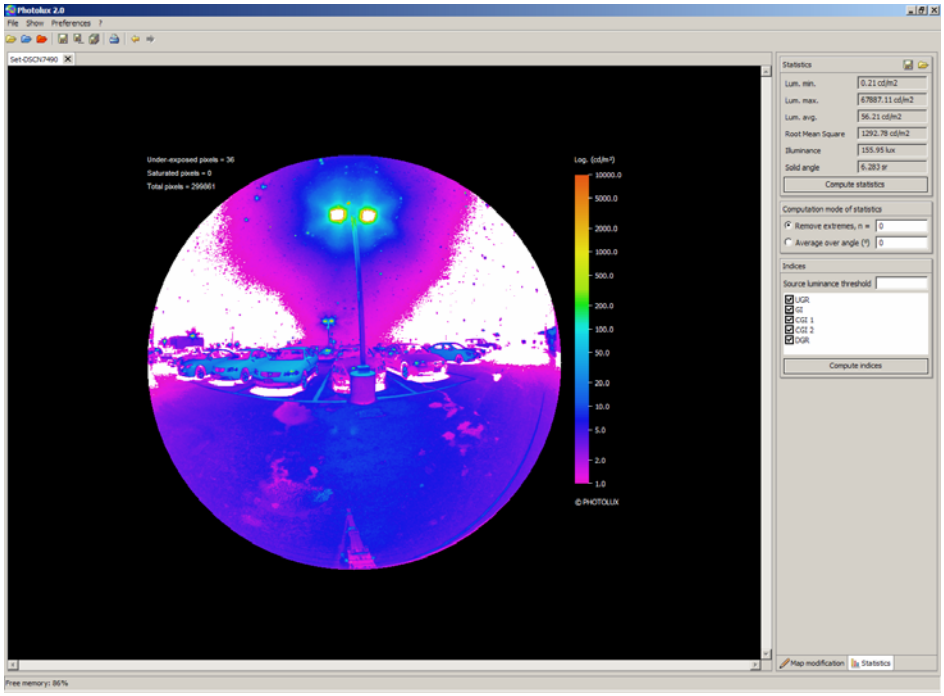

Figure 7: Luminance Measurements (cd/m^2) of 2-200 watt induction ©. This system resulted in a maximum luminance of 68,000 cd/m^2 (the lowest of the three systems).

Illuminance readings could not be taken because the cars had been returned to their original places on the back lot once the night surveys were completed. When the researchers returned a few days later to take representative readings, the lighting system experiment was no longer set up. Intuitively, it is accepted that System A has higher light levels than System B and System B has higher light levels than System C because of the higher lumen lamps.

1.2 Background

Car dealerships are typically designed to meet target maintained illuminance levels with recommended uniformities shown in Table 2. Illuminating Engineers Society of North America RP-2-01, Appendix H (IESNA, 2001) discusses the issues in outdoor merchandising.

> "Outdoor merchandising areas are governed by the same concerns as indoor retail spaces. Provided that sufficient minimum task and evaluation luminance can b e achieved, luminance ratios between the lighted retail area and its surroundings should not exceed 20:1. Increasing the lighting level does not add to merchandise attraction, and may create a hazard to motorists on adjacent roadways or a nuisance for neighbors. A value of ten times the average surrounding task luminance is the maximum that should be utilized for the focus merchandise. This will provide merchandise appeal without producing hazards or creating conflicts with other nighttime events."

TYPE OF MERCHANDISE	AREA TO ILLUMINATE	DESCRIPTION	ILLUMINANCE IN FOOTCANDLES OF SURROUNDING AREA – TARGET MAINTAINED LEVELS		
			HIGH	MEDIUM	LOW
Auto Dealerships	CIRCULATION	Area not used for merchandise sales or display, also approach and parking area	10	7	5
	MERCHANDISE	General auto sales or area of merchandise presentation	50	30	20
	FEATURE DISPLAYS	Front row presentation and or autos on feature stands	75	50	35

Table 2: IESNA RP-2-01 Table H1: Recommended Illuminances for Outdoor (Exterior) Merchandising Environments .

The illuminance level recommendations have been derived by a consensus process in accordance with IESNA committee procedures. Values are typically determined based on committee members' experience with retail lighting including attracting customers to the site, brightness expectations and franchise design standards.

One purpose of this survey is to evaluate these illuminance level recommendations and test their validity through subjective surveys taken by a reasonably representation of the population in terms of age, gender and income. This is very important since the higher the illuminance level, the more energy is consumed.

It was felt that if illuminance levels were lower than RP-2-01 recommendations, then the quality of the lighting system needed to be higher. Quality issues include better color rendering for the cars and less glare reflecting off the cars. An induction lamp was chosen for these increased quality issues with an additional benefit of very long lamp life reducing the dealership's maintenance. The system power consumption is less than half of the standard 1000 watt metal halide system which will lower operating costs for the customer.

1.3 Project Goals and Objectives

The existing technology uses a standard 1,000 watt metal halide lamp with fair color rendition properties. This lamp is typically used in order to achieve the higher illuminance levels with minimal amount of luminaires. The forward throw luminaires are pole mounted at an approximate 1:2 spacing height ratio.

The proposed retrofit modification replaces the one 1,000 watt metal halide lamp with two 165 or 200 watt induction lamps.

This retrofit decreases glare, improves color recognition, saves over 50% of the energy and lower maintenance costs.

Since the induction lamp has less mercury than the metal halide lamp, and the induction lamp lasts up to four times longer, the overall mercury amount is greatly reduced. Environmental benefits from less energy consumption are also realized.

1.4 Market Potential

The market potential shown in Table 3 can be applied to car dealerships and expanded into other high lighting level areas using the 1,000 or 750 watt metal halide lamp. Since the induction lamp is also instant on/off, it is an ideal lamp source for motion sensors. Induction lamp dimming is also available offering even more energy saving opportunities especially during late night curfew hours.

System (nominal W)	Connected kW	Avg $/kWh	Dusk-dawn oper. hrs	Annual $ spent	Annual $ saved (1000W base)	Dusk-dawn w/ motion	Annual $ spent	Annual $ saved (1000W base)
1000 MH	1.08	0.14	4,130	624	0	3,200	484	141
750 PSMH	0.818	0.14	4,130	473	151	3,200	366	258
400 (2x200) Induction FL	0.408	0.14	4,130	236	389	3,200	183	442

Table 3: Market Potential

Initial cost is a market barrier. Induction lamps with power generator are currently around $200 more per lamp than the conventional metal halide system. If two induction lamps are required to replace one 1,000 watt metal halide, this would increase to approximately $400 per luminaire. The life cycle costs in reduced energy and maintenance will favor the induction lamp. Like all new technologies, when induction lamps are more prevalent, their price should drop.

Another market barrier is the luminaire design. Induction lamps can fail if the heat from the system is not dissipated. Fortunately, the 1,000 watt luminaires are large and heat is easily dissipated. Ideally, luminaires should be designed and UL rated for the specific lamp wattage. The lamps are not point sources so the optimum reflector design is more difficult. Many manufacturers are just now adding induction lamps as options to their luminaires.

Past practice and perception is also a market barrier. Many car dealership owners and designers may be hesitant to install a lighting system that delivers less light than the IESNA

RP-2-01 recommendations. High lighting levels are also associated with the perception better security. Lowering lighting levels compared to surrounding competitors may lead to the fear of loosing market share.

These survey results are the beginning step in evaluating the impact of lighting levels with marketing and security perceptions. If lighting levels can be lowered while other quality benefits increase, then there is a large energy saving potential. This could also influence IESNA recommendations for car dealership exterior display lighting.

The primary instrumentation was the survey tool in developing subjective opinions from a population representation. Luminance readings were obtained with a Nikon E5400. These were used to evaluate consistency with the question on glare and actual measurements.

2.0 Test Procedures

2.1 Survey Design

The goal of the survey was to gauge perceptions of the different lighting systems. The Clanton Team developed a questionnaire based upon the survey instrument that was used for the subjective assessment portion of the PIER CA Outdoor Lighting Baseline Assessment Study (RLW, 2003). The survey was altered to allow for scaled responses on a 1 to 5 scale instead of yes/no responses. Respondents were asked to rate their perceptions of each lighting system with respect to glare, brightness, color rendition, security, etc. Demographic questions were also asked which included respondent age and gender. The full instrument is included in the appendix.

Sampling

A diverse set of 100 respondents was targeted to capture a general perception of the various lighting systems. Respondents were recruited through a variety of sources: local non-profits, churches, Craigslist, etc. Each respondent was paid an incentive of $50-75 to participate in the research project. RLW compared the age and gender distributions to the Census 2000 percentages for California and they were generally in line with the Census. Each respondent completed a short survey for each of the set ups. A total of 104 respondents ultimately completed the survey.

Experiment Dates and Location

Time and Date: 7pm – 9:30pm on Wed., October 11, and Sat., October 14

Nissan Motors (back lot), 1665 Industrial Park Ave., Redlands, CA 92374

2.2 Data Collection / Monitoring

The study team marked each of the lighting system areas with the letters A, B, and C to identify the different systems for the respondents. Additionally, the team ensured that the area directly beneath the front pole for each system had the same color cars displayed. Whenever possible the same model of the car was used. This was important to ensure that the respondents were evaluating the different lighting systems relative to the same products and that bias was not introduced by the cars displayed under each system.

The study team had four staff at the experiment location during the survey implementation. There was one main station where all respondents checked in and checked out. At check in, they were asked to provide their name and number and were given the survey and a short

instruction. They were each assigned a random order in which to visit each set up to ensure that the respondents were not systematically biased by the order of the set up visits. Each respondent responded to the same 19-question survey for each set up. One facilitator was stationed at each set up to assist with directing the respondents to the appropriate location from which to view the cars and to answer any questions.

2.3 Experiment Setup

The three types of lamps used in the study are specified in Table 4 below.

System	Description	Watts/ Lamp	Fixtures	Total Lamp Watts	Total Lamp + Ballast/ Generator Watts
A	Metal Halide Lamps	1,000	4	4,000	4,320
B	Pulse Start Metal Halide Lamps	750	4	3,000	3,280
C	Induction Fluorescent Lamps	400	4	1,600	1,632

Table 4: System descriptions

Figure 8 shows the Metro Nissan As-Built Lighting Plans and the experiment set-up in the back lot of the dealership. Lighting systems A, B, and C were separated by lighting fixtures that were turned off during the experiment to create separation between the systems. There are a few key issues with the experiment setup that should be pointed out that could have affected the results of the study:

- Note the car repair warehouse location and it's proximity to system C. This was a large repair facility that blocked out any conventional lighting from the dealership. This building could also have affected the general atmosphere of the surrounding area, possibly creating a feeling of more darkness and less safety.
- System C also had two dark areas surrounding it on both sides.
- System B had the advantage of slight amounts of spillover of conventional lighting from the mid-lot area of the Nissan dealership.
- System A had a wall separating the lot from another bright car dealership lot and a parking lot.
- System C is the induction lighting system. From all observations, position C was the most disadvantaged, both in terms of possible spillover lighting and from possible safety concerns caused by the large adjacent warehouse. Therefore, the researchers conclude that if anything, the reactions to the induction lighting system may have been biased negatively by the positioning of the system in the most disadvantageous of the three locations.

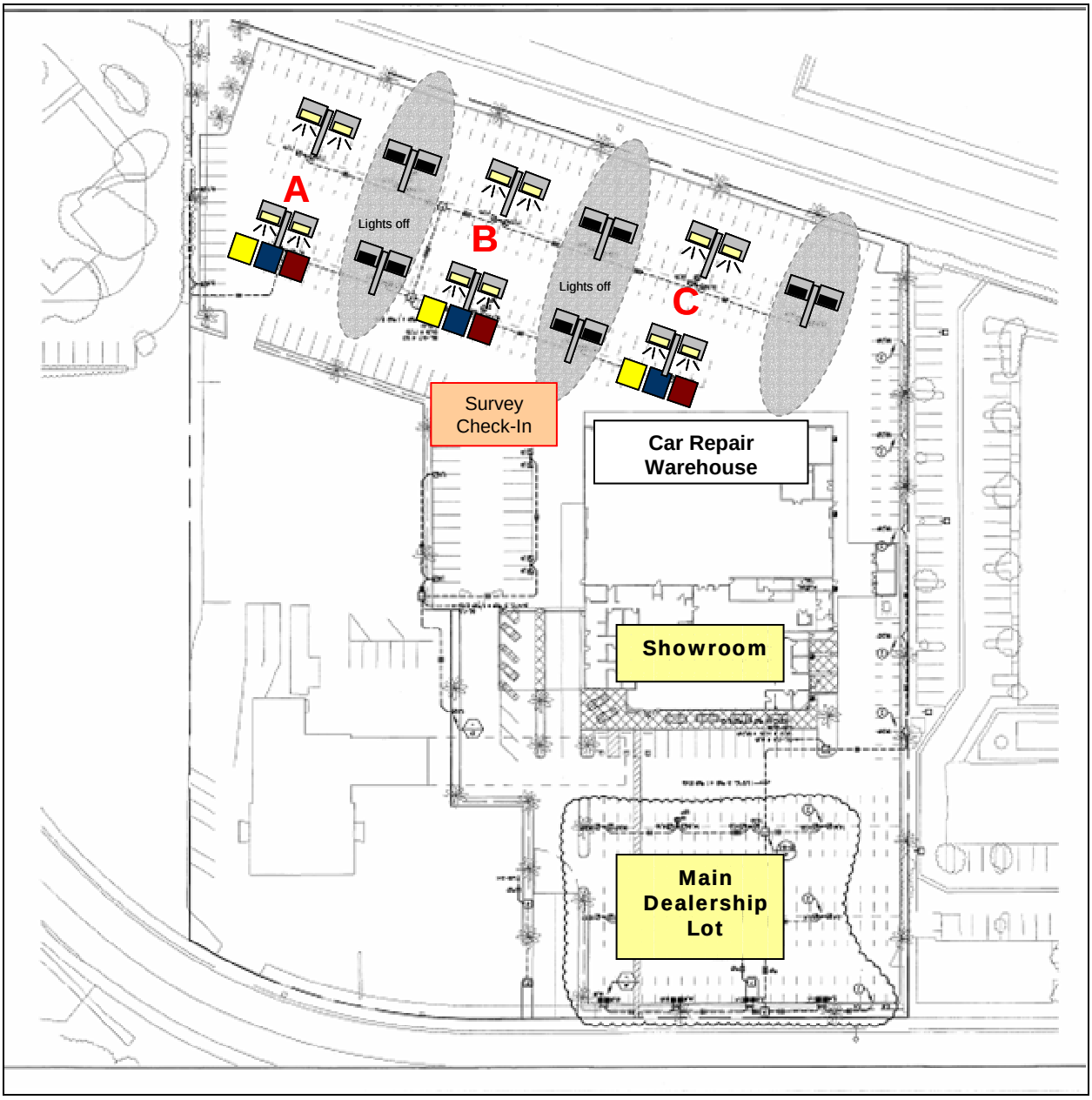

Figure 8: Experiment Set-Up

2.4 Photos

The team took some photos of the experiment area (Figure 9) on the night of the 11th. This picture shows an overall view of the back lot from position A. The check-in tent can be seen in the far right background and the maintenance garage is behind the tent.

Figure 9: Overall View of Back Lot from Position A

Figure 10 shows the check-in tent where participants were given the survey and instructions.

Figure 10: Check-In Tent

Figure 11 shows the set up for system A.

Figure 11: System A – 1,000 W Metal Halide - Day

Figure 12 shows the set up for system B during the evening.

Figure 12: System B – 750 W Metal Halide – Night

Figure 13 shows the set up for system C during the evening.

Figure 13: System A – 400 W Induction - Night

3.0 Results

RLW analyzed the survey data using SAS[1] and Excel and provide sample means, frequencies, and inspected cross-tabulations where applicable. Each respondent answered the same 19 questions for each lighting system. The responses to these 19 questions are summarized by system in this section. The qualitative question on the survey was also analyzed to obtain some anecdotes that SCE may find useful to support the technology. The three types of lamps used in the study are specified in Table 4.

System A – 1,000 watt metal halide lamps are the de facto standard used in car dealership outdoor lighting. There were 104 respondents over two test days: 48 respondents on Oct 11, and 56 on Oct 14, 2006. Exactly half the respondents were men and half women, 52 of each. Unfortunately system C had a lamp failure on Oct 11, and system B had a lamp failure on Oct 14.2 Therefore, the results presented in this chapter only use responses from the Oct 14 test -- when systems A and C were both fully functional.

Additional results, from Oct 11 and the combined results from both test days are shown in the appendix. These results are informative as the survey responses are consistent with the non-performance of the lamps on different systems and days. This is valuable as it serves as a qualitative verification of the survey methodology.

3.1 Overall Results

Generally the results of the Oct 14 survey **did not show** that the 1,600W induction lighting system (C) was significantly different from the standard 4,000W metal halide system (A), or in other words, the mean ratings of the systems were not statistically different.

A "statistically significant difference" (e.g., difference between two sample means) means there is a small probability (less than 10% in this study) that the differences observed in samples occurred by pure chance when no differences exist in the populations from which the samples were drawn. Note that it is also possible to *not* observe statistically significant differences when real differences in populations *do* exist.

Two exceptions, where the results for systems A and C were *significantly* different are below:

- System A was "too bright" (statement 5) more often than C (mean A=2.6, mean C=1.8)
- System A was "glaring" (statement 8) more often than C (mean A=3.0, mean C=1.8)

Other differences in survey responses, although not statistically significant, showed system C was generally darker, but possibly better at showing true colors and possibly more comfortable to some viewers.

Table 5 shows the full list of 19 questions asked of each respondent for all three lighting systems. The two questions where survey responses indicate significant differences between system A and C are highlighted in yellow (statements 5 and 8). The respondents rated the induction lamps significantly less bright and glaring than the system A metal halide lamps.

[1] SAS is a statistical software package with data management and analysis capabilities that is widely used in market and load research.

[2] The failed lamps seem to be a case of extreme bad luck. Changing out failed lamps mid-survey was not possible for a variety of reasons including the necessity of long warm-up times. Future field testing may benefit from a failed-lamp contingency plan.

#	Statements/Questions	Significant Difference?	Comments
1	It would be safe to walk here, alone, **during the day**.	No	
2	It would be safe to walk here, alone, at night.	No	
3	The lighting is comfortable.	No	
4	This is a good example of security lighting.	No	
5	**The lighting is too bright.**	**Yes**	**A was considered too bright significantly more than C.**
6	The lighting is too dark.	No	
7	The lighting is uneven (patchy).	No	
8	**The lighting is glaring.**	**Yes**	**A was considered significantly more glaring than C.**
9	The lighting is too limited in area.	No	
10	The lighting is poorly matched to the site.	No	
11	I cannot tell the colors of things due to the lighting.	No	
12	I can easily read the sticker information.	No	
13	All features of the cars are easily visible in this lighting.	No	
14	The lighting presents the car colors well.	No	
15	The color of the red car **closely resembles** true red.	No	
16	The color of the blue car **closely resembles** true blue.	No	
17	The color of the yellow car **closely resembles** true yellow.	No	
18	Please rate your impression of the overall quality of the light on a scale of 1 to 5, with 1 being very low quality and 5 being very high quality.	No	
19	How does the lighting in this area compare with the lighting at similar dealerships at night?	No	

Table 5: Oct 14 significant differences in responses between systems A and C.[3]

[3] One lamp on system B was out on Oct 14, so it can not be compared to C.

Figure 14 shows a sample of the graphical display format that is used to present the means and confidence intervals in subsequent figures. The means are denoted by the blue diamonds, and the 95% confidence levels are denoted by the black bars around the means. Significant differences for responses to systems A and C are determined by comparing confidence intervals. When the bars do not overlap vertically, the difference is considered statistically significant at the 95% confidence level.[4]

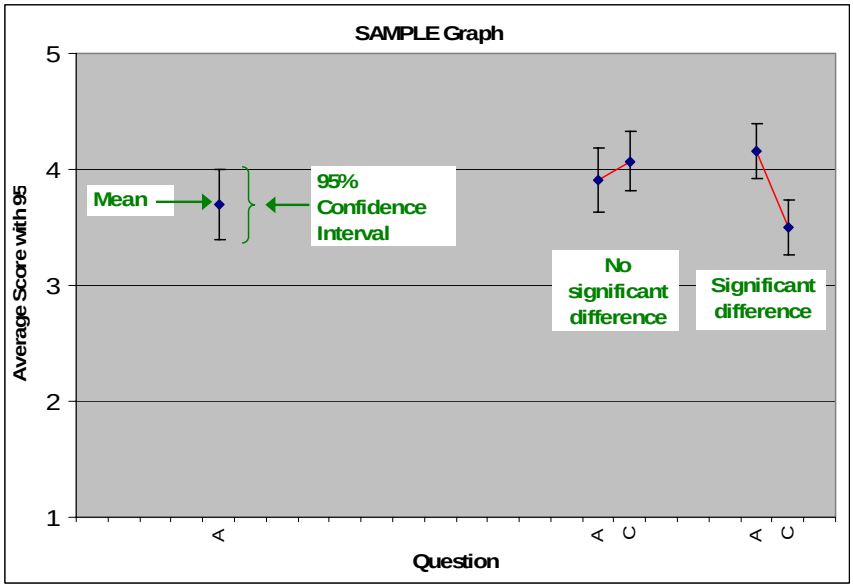

Figure 14: Sample Graphical Display of Means and Confidence Intervals

[4] Section 3.1 discusses the interpretation of these results.

Figure 15 and Figure 16 show that for 17 of the 19 questions asked, the respondents did not identify a significant difference between systems A and C. It can be seen below that only for questions 5 and 8 are there significant differences between A and C, where for #5, the mean of A=2.6 and the mean of C=1.8, and for #8, the mean of A=3.0 and the mean of C=1.8. System B is not compared to C since system B was not fully operational.

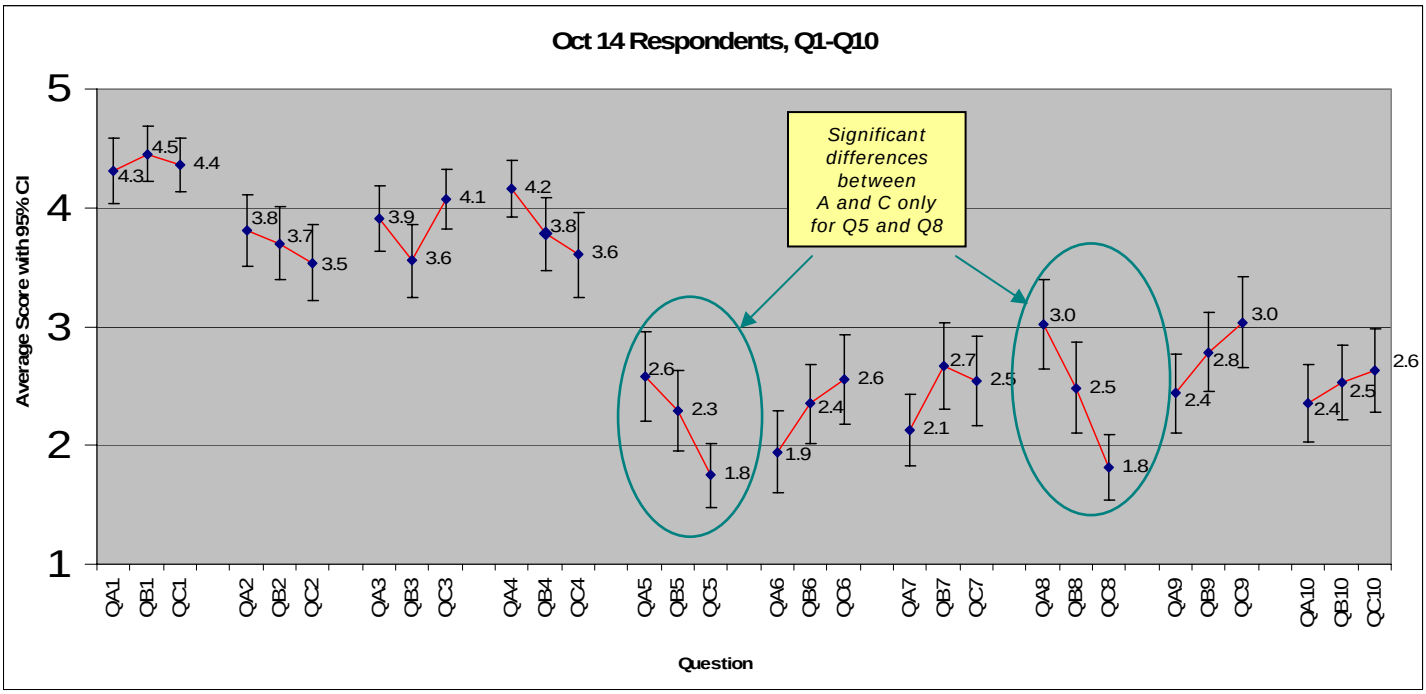

Figure 15: October 14th mean and 95% confidence intervals of survey responses, Q1-Q10.

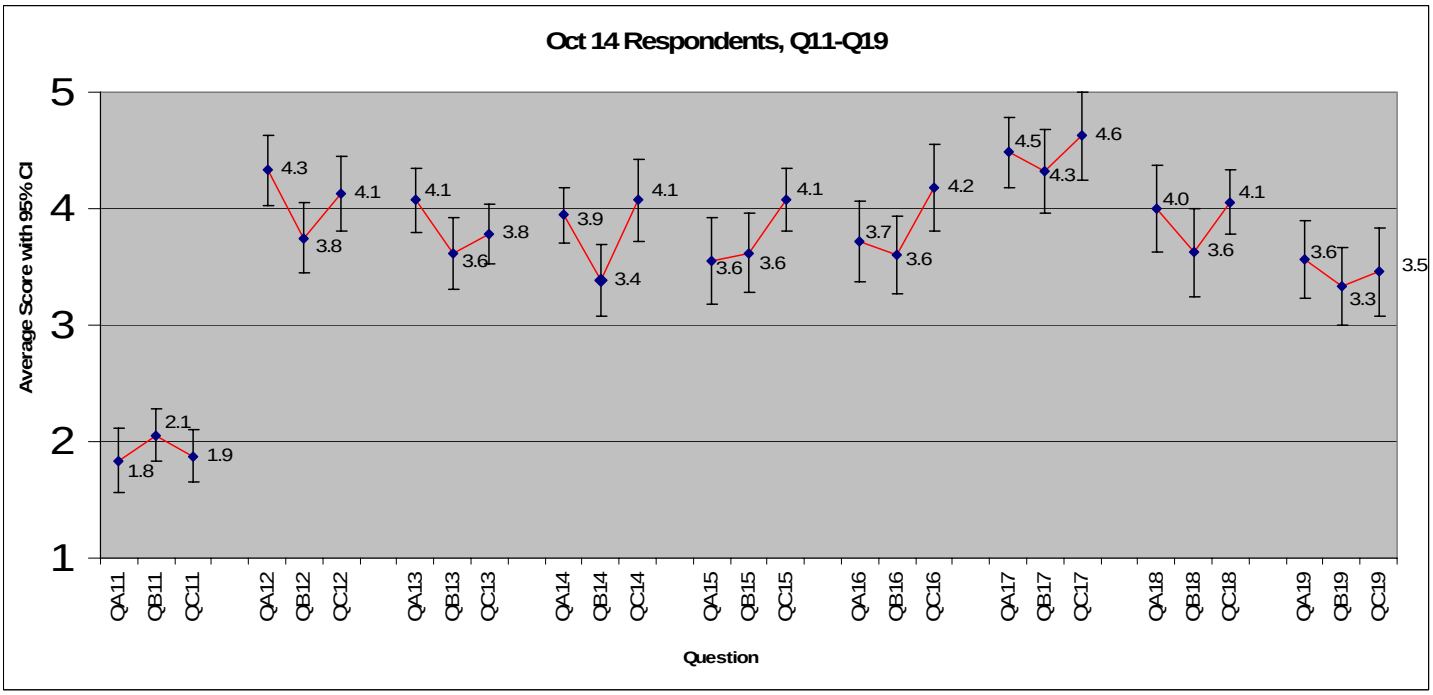

Figure 16: October 14th mean and 95% confidence intervals of survey responses, Q11-Q19.

Table 6 shows the Oct 14 survey results statistics from which Figure 15 and Figure 16 are created. Note that n, the number of responses to each question, varies slightly due to occasional non-responses or "don't know" responses.

#	System	Statement/Question (1=stongly disagree, 3=neutral, 5=strongly agree)	n	Mean	Standard Deviation	95% Margin of Error
Q1	A	It would be safe to walk here, alone, during the day.	55	4.31	1.05	0.28
	B		55	4.45	0.86	0.23
	C		55	4.36	0.85	0.22
Q2	A	It would be safe to walk here, alone, at night.	56	3.80	1.15	0.30
	B		56	3.70	1.17	0.31
	C		54	3.54	1.19	0.32
Q3	A	The lighting is comfortable.	56	3.91	1.05	0.27
	B		56	3.55	1.17	0.31
	C		56	4.07	0.97	0.25
Q4	A	This is a good example of security lighting.	55	4.16	0.90	0.24
	B		54	3.78	1.14	0.31
	C		53	3.60	1.32	0.36
Q5	A	The lighting is too bright.	55	2.58	1.41	0.37
	B		55	2.29	1.29	0.34
	C		56	1.75	1.03	0.27
Q6	A	The lighting is too dark.	52	1.94	1.27	0.35
	B		54	2.35	1.25	0.33
	C		56	2.55	1.44	0.38
Q7	A	The lighting is uneven (patchy).	55	2.13	1.12	0.30
	B		54	2.67	1.35	0.36
	C		55	2.55	1.42	0.38
Q8	A	The lighting is glaring.	55	3.02	1.42	0.38
	B		56	2.48	1.45	0.38
	C		55	1.82	1.04	0.27
Q9	A	The lighting is too limited in area.	55	2.44	1.24	0.33
	B		55	2.78	1.26	0.33
	C		55	3.04	1.44	0.38
Q10	A	The lighting is poorly matched to the site.	56	2.36	1.26	0.33
	B		55	2.53	1.18	0.31
	C		56	2.63	1.34	0.35
Q11	A	I cannot tell the colors of things due to the lighting.	55	1.84	1.20	0.32
	B		56	2.05	1.20	0.31
	C		56	1.88	1.16	0.30
Q12	A	I can easily read the sticker information.	55	4.33	0.94	0.25
	B		56	3.75	1.30	0.34
	C		56	4.13	1.24	0.32
Q13	A	All features of the cars are easily visible in this lighting.	56	4.07	0.99	0.26
	B		55	3.62	1.11	0.29
	C		56	3.79	1.23	0.32
Q14	A	The lighting presents the car colors well.	56	3.95	1.02	0.27
	B		55	3.38	1.28	0.34
	C		56	4.07	1.04	0.27
Q15	A	The color of the red car closely resembles true red.	56	3.55	1.40	0.37
	B		55	3.62	1.33	0.35
	C		56	4.07	1.31	0.34
Q16	A	The color of the blue car closely resembles true blue.	56	3.71	1.28	0.33
	B		56	3.61	1.25	0.33
	C		56	4.18	1.19	0.31
Q17	A	The color of the yellow car closely resembles true yellow.	56	4.48	0.97	0.25
	B		56	4.32	1.08	0.28
	C		56	4.63	0.86	0.23
Q18	A	Please rate your impression of the overall quality of the light on a scale of 1 to 5, with 1 being very low quality and 5 being very high quality.	56	4.00	0.91	0.24
	B		56	3.63	0.93	0.24
	C		55	4.05	0.93	0.25
Q19	A	How does the lighting in this area compare with the lighting at similar dealerships at night?	48	3.56	1.01	0.29
	B		48	3.33	0.88	0.25
	C		48	3.46	1.11	0.31

Table 6: October 14th Survey Results Statistics

3.2 Overall Quality of Lighting Systems

Perhaps the two most important questions on the survey were Questions #18 and #19, which asked directly about the overall quality of the lighting systems. The frequency distribution of the responses is shown in Table 7 and Figure 17.

Response	QA18	QB18	QC18	QA19	QB19	QC19
1	1	1	0	0	1	3
2	1	4	4	8	5	5
3	14	20	10	15	24	16
4	21	21	20	15	13	15
5	19	10	21	10	5	9
Total	56	56	55	48	48	48

Table 7: Frequency of responses for question #18 and #19 on Oct 14

Question #18 asked respondents to rate their impression of the overall quality of the light. When viewed as a frequency distribution or when viewed by comparing the 95% confidence intervals, no significant difference between the answers to question 18 with respect to systems A and C was observed. Figure 17 shows that similar numbers of respondents rated systems A and C for each level 1 through 5. This indicates that in general, respondents were similarly impressed with the overall quality of the light from systems A and C.

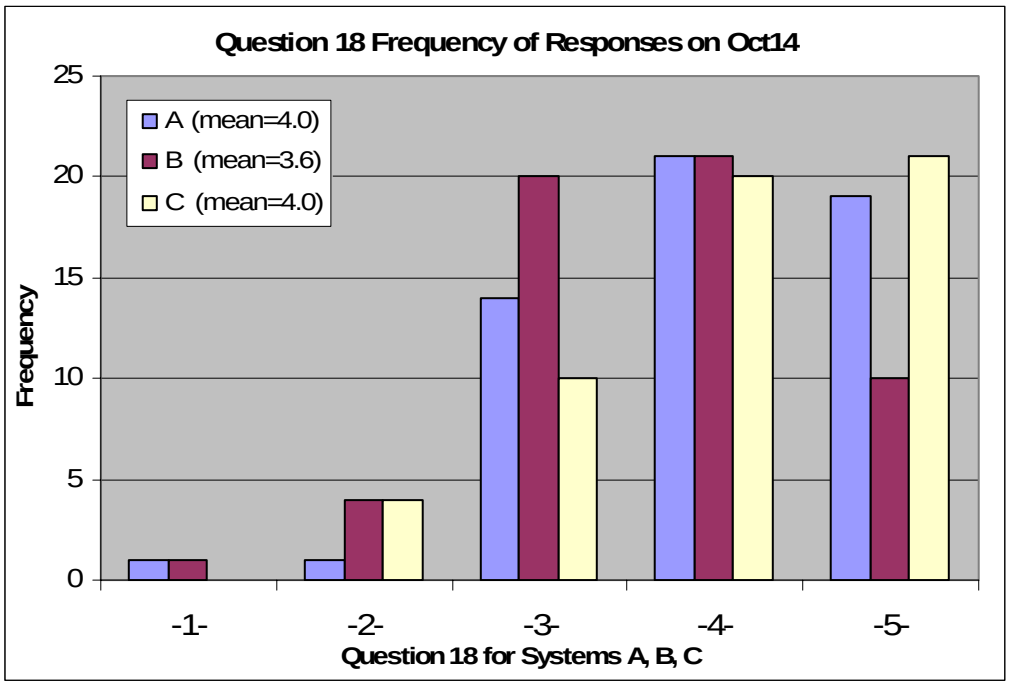

Figure 17: Frequency distribution of responses to Question18, "Please rate your impression of the overall quality of the light on a scale of 1 to 5, with 1 being very low quality and 5 being very high quality."

Question #19 which asks,

> *"How does the lighting in this area compare with the lighting at similar dealerships at night?"*

received eight fewer responses overall (48 vs. 56) (see Figure 18). This is due to the fact that several people had not recently been to other car dealerships and therefore had no basis on which to make the comparison. When viewed as a frequency distribution or when viewed by comparing the 95% confidence intervals, no significant difference between the answers to question 19 with respect to systems A and C was observed. This indicates that in general, respondents thought that the lighting in areas served by both systems A and C was similar to lighting at similar dealerships at night.

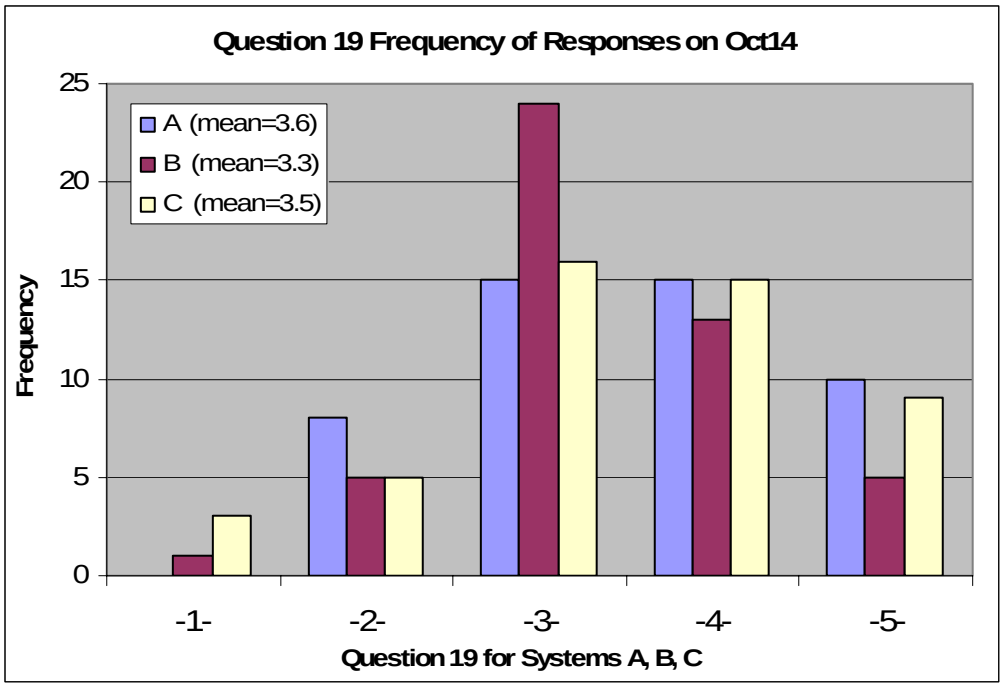

Figure 18: Frequency distribution of responses to Question 19 "How does the lighting in this area compare with the lighting at similar dealerships at night?"

3.3 Qualitative Question Summary

The final question of the survey (F1) asks,

> *"Please write down any general comments on the quality of the different lighting systems. This can include any final thoughts on how the three systems compare, which is preferable and why, etc."*

The responses were summarized into positive, negative, and neutral categories, and a keyword search was conducted with consideration to context and usage. Again, system B is mostly ignored since it had a failed lamp on Oct 14.

Overall the text comments shown in Table 8 are consistent with the numerical findings comparing systems A and C. They scored almost the same in terms of positive and negative comments. System A is viewed as brighter (10 mentions) and safe/security (8), while system C is seen as darker (5), the three most frequently mentioned keywords.

System	Positive	Neutral	Negative	Total
A	23	21	12	56
B	11	32	13	56
C	20	23	13	56

Table 8: Oct 14 summary of text responses categorized by system

Another observation from the text responses, shown in Table 9, is that glare and reflections seem to be more of a problem for individuals wearing glasses or contact lenses. Future studies may want to develop a sample design with specific consideration to those classes of people.

System	PROS (# mentions)	CONS (# mentions)
A	bright (10) comfortable (4) security (3) see colors better (4) safe (5) warmer (1)	glare (3) harsh (3) yellow looking (1)
B	bright (4) see colors better (1)	glare (4) patchy (1) car colors appeared dark (3)
C	comfortable (3) pleasing (1) softer (2) sharp (1)	dark (5) dim (1) difficult to see sticker (1) patchy (1) dead (1)

Table 9: Oct 14 Summary of Qualitative Keyword Responses and Counts

Additional conclusions are harder to draw from the text answers, so Table 10 has been included which contains the complete set of responses from each of the 56 participants on Oct 14. The reader can attempt to gain his/her own insights from the responses.

10/14/2006 Responses	Question F1: Please write down any general comments on the quality of the different lighting systems. This can include any final thought on how the three systems compare, which is preferable and why, etc.
1	C - is too soft of a light. A - I feel is the best. B - has too much of a glare.
2	A - had a high glare to those with glasses or contacts.. C - a bit too dark in the back. B - best of all.
3	Section B was the best for me. I thought the light in all three sections was comforting in that you could walk through the cars and not worry about someone hiding. The sticker was hard to read at station B, but in section A it was very clear.
4	A - Excellent lighting. B- neutral. C - too dim.
5	their features.
6	I think the lighting can be improved all over.
7	I preferred C & B over A .They were brighter.
8	I felt all three were basically similar on how it presents the cars
9	the red).
10	I liked C best but the radius of the light is not wide enough. A had the best radius but was too bright.
11	A & B ARE GOOD LIGHTING WHILE C DOES NOT LIGHT UP AS WELL. IT IS DIFFICULT TO SEE THE STICKER ON C.
12	B SEEMS BRIGHTER A DARKER C WAS DARKEST
13	where you were at. All the lights are well lit.
14	The quality of the lighting was great. Some lighting was a little soft. I like the brightness.
15	C - comfortable. I can walk around and not notice it. B - Too much glare. I can't look up. A - Glarey, but I can see things.
16	Section C felt the most comforable as far as strength of light. Section B had most complete coverage. All sections had less illuminated areas that are harder to see stickers and cars and are less secure.
17	I prefer the B lighting. Although the lighting was good, ideal at night, I found it all glaring.
18	The lights at C were softer to the eyes and more coverage, so I could see all around the site as well as the cars.
19	A & B were very glaring, but certainly lit the area. I didn't think any of the red cars were true red.
20	A is very bad. B is ok bad. C is the best.
21	I much preferred C to any of the other lights. Much easier on the eyes. A was harsh, B was not enough. It appeared that all of the yellow, blue and red were not the true colors. Yellow was almost a school bus color, Blue was too dark.
22	glaring. Also, the car colors are very vivid in the C light.
23	I believe lighting system B to be preferable. A was too harsh, while C was too dark.
24	B & C wasn't as much.
25	Even though A was very glary, I liked it the most in terms of how well it lit up the entire area. Area C makes the cars look sharp, but looks like any other dealership would look using fluorescents. Has a dead look to it.
26	I like C the best.
27	safer.
28	Section A lighting is the best. The other two B & C are moderate, whatlyou would see normally at car dealerships at night.
29	A is best-more bright. Felt more comfortable walking in area. Able to see more cars at a time. B was just bright enough to see cars. C somewhat darker. Was to focus on the 3 cars felt somewhat enclosed.
30	The lighting at B seemed darker, dingier. Of the 3 stations, I prefer A. Not sure why. It seems warmer somehow.
31	A is just too bright. B & C are about the same. The brighter the better at night A.
32	The lighting in some areas was less accomodating than others. Area B felt less safe than area A or C.
33	I prefer A. The lighting was bright enough that I felt secure to walk around and the cars looked good under the light. B was really bright and glared off my glasses. C I felt wasn't bright enough.
34	C is better for features and comfort to see the cars without a glare.
35	were not lit enough doesn't' show the color well.
36	definitely feel safe "night car" shopping in area A.
37	They all seem to be equal.
38	bright and made glare on the windows.
39	Lighting in A is better; it has no glare.
40	I think lighting A has the better lighting. Car lot should be bright so you can see everything about the car you want to see.
41	A - most comfortable. C- next. B- least.
42	A lot was the best, much better to see. Colors on all 3 vehicles were vibrant. Felt a lot safer!
43	I think I like section B best colors seem to be most clear. Section C was the worst
44	also brought out the car colors, but area A's lights seem a bit yellow, not as clean looking & didn't show red as true as the other areas. (Or the sample car isn't same shade as the otheres.)
45	The rain presented a problem of visability.
46	polar opposite of A. My eyes felt adjusted to the overall ambience but would seem that there were too many shadows cast B I felt was overall the best out of the 3 in ambience & reduced glare. The lighting still seemed a little bit too bright but it wasn't uncomfortable.
47	A - Too bright w/ blue tint makes me squint; red is burgandy. B - Also bright w/ yellow tint; again squinting; blue is green & red is burgandy. C - Bright but not hurting eyes; all colors are clear.
48	C was a little weak in patches
49	A seemed brighter but showed car colors less true. C showed car colors best.
50	Site A resembled an operating room. Too bright - overpowering.
51	Light A was noticably better and appeared closer to daylight conditions.
52	The three lighting systems are about the same although, I found B to be a little patchy.
53	or the A light.
54	For A - they seemed roughly the same. None preferable.
55	I liked C the best, it was not as bright, but I could still see very good.
56	I work security, so from that standpoint I think that system A is by far the better of the three systems but from a customer's perspective. System C is the most pleasing and comfortable. I find system B to be lacking in comparison to the others.

Table 10: Oct 14 qualitative responses to "general quality of lighting" question

3.4 Data Analysis

The data analysis consisted of four main steps that follow generally accepted analysis methods and are described below:

(1) Quality control of the raw data (responses) - During quality control, the survey response database was tested for missing values, inappropriate values, logic errors, and data entry errors. These quality control methods found and corrected for multiple data errors.

(2) Analysis of the sample - The sample was tested and found to be reasonably representative of the population in terms of age, gender, and income.

(3) Study methodology consideration - Bias is always a concern in all types of research and analysis. One potential area of bias was the order in which the lighting systems were viewed. To minimize potential "order" bias, respondents were assigned to take the surveys in all six possible sequences (ABC, ACB, BAC, BCA, CAB, CBA) in approximately equally numbers. As such, no order-specific analysis was deemed necessary.

Another obvious source of bias was the failed lamps in both systems B and C on different nights. For this reason the primary data used for analysis was from Oct 14, when both systems A and C were fully functional.

Potential sources of bias are a critical concern in evaluating results. Unfortunately, it is usually extremely difficult to objectively quantify the magnitude of the bias or even its direction. Generally, the best the users of an evaluation study can do is to look for certain aspects of the implementation of the study that could increase the risk of bias. In this study there were several sources of potential bias that were considered in the implementation and analysis: bias due to lamp failures, the possibility of a non-representative sample, and the order of viewing the three systems. Other potential sources of bias include survey wording, language interpretation, sample self-selection, and others.

As an example, Figure 19 shows how the sample of all participants was compared to the population to examine if the sample was reasonably representative by age, and indeed it was. Had the sample not been representative by age it is unknown what affect (bias), if any, it would have had on the results.

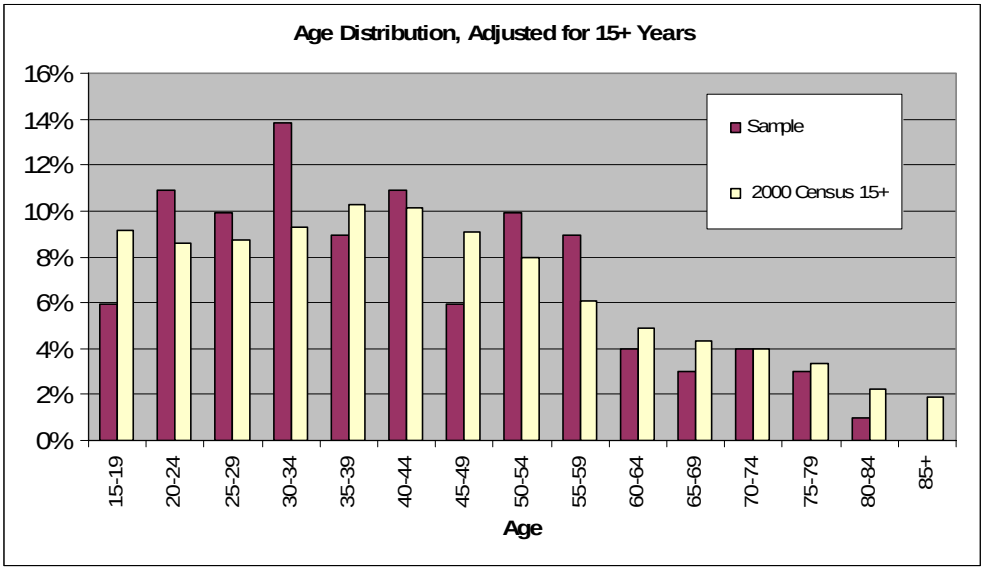

Figure 19: Age distribution of sample vs. adjusted US 2000 Census

(4) Statistical analysis - The main analysis method of the responses was to compute the mean and 95% confidence interval for each question as shown in Figure 15 and Figure 16 and to examine where significant difference in answers occurred. Significant differences for responses to systems A and C are determined by comparing confidence intervals. When the bars do not overlap vertically, the difference is considered statistically significant at the 95% confidence level. The analysis method for the text answers is described in the previous section along with the results.

In estimation the researchers like to obtain both a point estimate and an interval estimate of a parameter. The point estimate (mean) is the best guess of the true value of the parameter, while the interval estimate (confidence interval) gives a measure of accuracy of that point estimate and provides a range of plausible values for the true parameter. It is important to note that a 95% confidence interval is statistically based, but can also be misleading if bias enters the study.

3.5 Discussion

Generally the results of the Oct 14 survey **did not show** that the 1600W induction lighting system (C) was significantly different from the standard 4000W metal halide system (A). Two exceptions, where the results were *significantly* different, showed system A was "too bright" (statement 5) and "glaring" (statement 8) more often than system C. Other differences in survey responses, although *not statistically significant*, showed system C was generally darker, but possibly better at showing true colors and possibly more comfortable to some viewers. These findings are consistent with the write-in responses on Question F1, and consistent with comments heard by staffers during the test periods.

3.6 What does it all mean?

While it may be reasonable to conclude that systems A and C performed similarly for many qualities of the lights from the perspective of the respondents, it is not possible to make definitive statements about specific performance characteristics of each system due to the fact that this study was planned as an *exploratory* market research study, not a rigidly controlled scientific experiment.

Many variables could not be controlled, including changing weather (light rain and varying cloud cover), time of day, non-identical system set-ups (non-functioning lamps, car models and car locations), varying surroundings (and light levels), and other variables. While the results are meaningful and compelling, they can not be considered absolutely conclusive. It is left to the reader to determine if the study's level of rigor is sufficient for their particular needs.

For the purposes of deciding whether to pursue additional research on induction lighting, the fact that this exploratory research *did not* find significant differences in how people rated the *overall* quality of the lighting systems does suggest that additional research to further examine the differences in the perceived lighting quality would be beneficial. In particular, it will be valuable to understand the effect the improved color and the lack of glare produced by the induction lamps have on human visual comfort and performance.

Given that there is very little difference shown in how the Metal Halide lamps and the Induction lamps were perceived in this study, it is recommended that the induction lamps be included as a viable option for lighting retrofits and new construction applications as part of SCE's Energy Efficiency portfolio. The one caution is to make sure the end user has installed test fixtures and is confident that the induction system will provide the levels of lighting needed both for human safety and for the specific tasks being performed.

3.7 Future Research Recommendations (Phase II)

An attempt will be made to partner with a major automobile manufacturer who has multiple dealerships located in SCE's service territory. These dealerships, ideally, will be selected based on the following criteria:

- Similar front lot size
- Similar sales history
- Been in operation at least 5 years
- Willing to participate in a long term study
    - Access to site for metering and measurement
    - Access to sales records and buyer traffic
- Ensure that all lamps are fully functional for duration of the experiment

The Phase II study should be designed in the following manner:

- Each dealership will have the complete front lot lighted with new fixtures
  - 1000W Metal Halide for Dealership A
  - 750W Pulse Start Metal Halide for Dealership B
  - 400W – 450W Induction (specific fixture and lamps to be determined) for Dealership C
- Each Dealership should conduct "business as usual" for the duration of the study
- Ensure that proper reflectors and fixtures are used for each lamp type
- Perform all lighting measurements using IESNA standards and best practices
- Increase the size and frequency of the survey sample
  - Survey conducted when the lighting systems are new
  - Survey conducted half-way through the study
  - Survey conducted at end of study

3.8 Prior Work

To the best of the researchers' knowledge there has not been any similar market research conducted of induction lighting. The Clanton Team developed the questionnaire based upon the survey instrument that was used for the subjective assessment portion of the PIER CA Outdoor Lighting Baseline Assessment Study.

4.0 Conclusions

1. Generally the results of the Oct 14 survey *did not show* that the 1,600W induction lighting system (C) was significantly different from the standard 4,000W metal halide system (A). Two exceptions, where the results were significantly different, showed System A was "too bright" (statement 5) and "glaring" (statement 8) more often than system C. Other differences in survey responses, although not statistically significant, showed system C was generally darker, but possibly better at showing true colors and possibly more comfortable to some viewers.
2. These findings are consistent with the write-in responses on Question F1, and consistent with comments heard by staffers during the test periods.
3. Additional results, from Oct 11 and the combined results from both test days are shown in the Appendix. These results <u>*are*</u> instructive as the survey responses are consistent with the failed lamps on different systems and days. This is valuable as it serves as a qualitative verification of the entire survey methodology.
4. Given that there is very little difference shown in how the Metal Halide lamps and the Induction lamps were perceived in this study, it is recommended that the induction lamps be included as a viable option for lighting retrofits and new construction applications as part of SCE's Energy Efficiency portfolio. It is important to make sure the end user has installed test fixtures and is confident that the induction system will provide the levels of lighting needed both for human safety and for the specific tasks being performed.

5.0 References

IESNA Merchandise Lighting Committee. 2001. IESNA RP-2-01 Table H1: Recommended Illuminances for Outdoor (Exterior) Merchandising Environments." Illuminating Engineering Society of North America, New York, New York.

RLW Analytics, Inc. October 2003. "PIER CA Outdoor Lighting Baseline Assessment Study P500-03-082-A-18." California Energy Commission, CA and New Buildings Institute, White Salmon, Washington.

6.0 Conclusions

5. Generally the results of the Oct 14 survey *did not show* that the 1600W induction lighting system (C) was significantly different from the standard 4000W metal halide system (A). Two exceptions, where the results were significantly different, showed System A was "too bright" (statement 5) and "glaring" (statement 8) more often than system C. Other differences in survey responses, although not statistically significant, showed system C was generally darker, but possibly better at showing true colors and possibly more comfortable to some viewers.
6. These findings are consistent with the write-in responses on Question F1, and consistent with comments heard by staffers during the test periods.
7. Additional results, from Oct 11 and the combined results from both test days are shown in the Appendix. These results *are* instructive as the survey responses are consistent with the failed lamps on different systems and days. This is valuable as it serves as a qualitative verification of the entire survey methodology.

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RLW Analytics, Inc. October 2003. "PIER CA Outdoor Lighting Baseline Assessment Study P500-03-082-A-18." California Energy Commission, CA and New Buildings Institute, White Salmon, Washington.

8.0 Appendices

Figure 20, Figure 21, Table 11, and Table 12 all show additional results not used in primary analysis.

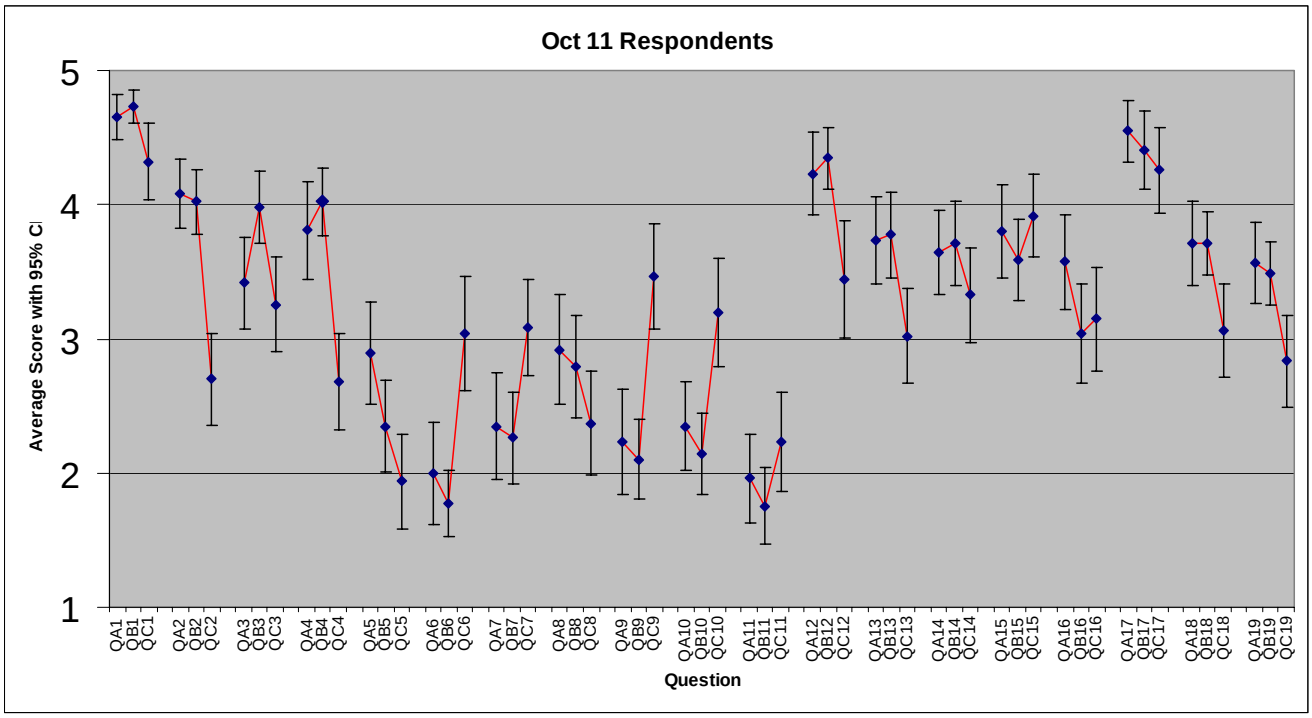

Figure 20: Mean and 95% confidence intervals of all questions for survey respondents on October 11th.

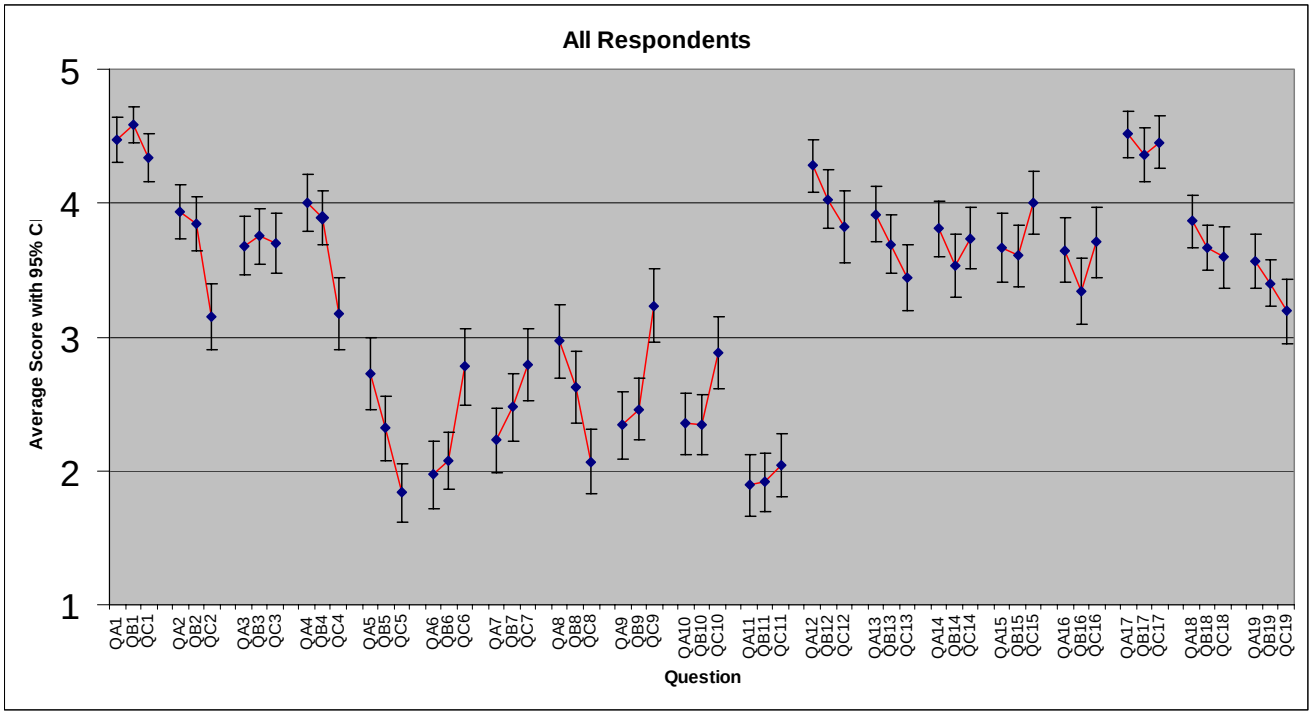

Figure 21: Mean and 95% confidence intervals of all questions for ALL survey respondents.

#	System	Statement/Question (1=stongly disagree, 3=neutral, 5=strongly agree)	n	Mean	Standard Deviation	95% Margin of Error
Q1	A	It would be safe to walk here, alone, during the day.	49	4.65	0.60	0.17
	B		49	4.73	0.45	0.12
	C		47	4.32	1.00	0.29
Q2	A	It would be safe to walk here, alone, at night.	49	4.08	0.91	0.25
	B		49	4.02	0.85	0.24
	C		47	2.70	1.20	0.34
Q3	A	The lighting is comfortable.	48	3.42	1.20	0.34
	B		49	3.98	0.97	0.27
	C		47	3.26	1.24	0.36
Q4	A	This is a good example of security lighting.	47	3.81	1.26	0.36
	B		48	4.02	0.89	0.25
	C		47	2.68	1.27	0.36
Q5	A	The lighting is too bright.	48	2.90	1.34	0.38
	B		49	2.35	1.22	0.34
	C		47	1.94	1.24	0.35
Q6	A	The lighting is too dark.	48	2.00	1.34	0.38
	B		49	1.78	0.87	0.24
	C		47	3.04	1.49	0.43
Q7	A	The lighting is uneven (patchy).	46	2.35	1.37	0.40
	B		49	2.27	1.22	0.34
	C		46	3.09	1.24	0.36
Q8	A	The lighting is glaring.	49	2.92	1.46	0.41
	B		49	2.80	1.35	0.38
	C		46	2.37	1.34	0.39
Q9	A	The lighting is too limited in area.	48	2.23	1.39	0.39
	B		49	2.10	1.07	0.30
	C		47	3.47	1.36	0.39
Q10	A	The lighting is poorly matched to the site.	49	2.35	1.18	0.33
	B		49	2.14	1.10	0.31
	C		46	3.20	1.39	0.40
Q11	A	I cannot tell the colors of things due to the lighting.	48	1.96	1.17	0.33
	B		49	1.76	1.01	0.28
	C		47	2.23	1.29	0.37
Q12	A	I can easily read the sticker information.	48	4.23	1.10	0.31
	B		49	4.35	0.83	0.23
	C		45	3.44	1.50	0.44
Q13	A	All features of the cars are easily visible in this lighting.	49	3.73	1.17	0.33
	B		49	3.78	1.14	0.32
	C		45	3.02	1.22	0.36
Q14	A	The lighting presents the car colors well.	48	3.65	1.12	0.32
	B		48	3.71	1.11	0.31
	C		46	3.33	1.21	0.35
Q15	A	The color of the red car closely resembles true red.	49	3.80	1.24	0.35
	B		49	3.59	1.08	0.30
	C		47	3.91	1.08	0.31
Q16	A	The color of the blue car closely resembles true blue.	49	3.57	1.24	0.35
	B		49	3.04	1.31	0.37
	C		47	3.15	1.35	0.39
Q17	A	The color of the yellow car closely resembles true yellow.	49	4.55	0.82	0.23
	B		49	4.41	1.04	0.29
	C		47	4.26	1.11	0.32
Q18	A	Please rate your impression of the overall quality of the light on a scale of 1 to 5, with 1 being very low quality and 5 being very high quality.	48	3.71	1.11	0.31
	B		48	3.71	0.82	0.23
	C		47	3.06	1.22	0.35
Q19	A	How does the lighting in this area compare with the lighting at similar dealerships at night?	37	3.57	0.93	0.30
	B		37	3.49	0.73	0.24
	C		36	2.83	1.06	0.34

Table 11: Oct 11 Survey Results Statistics

#	System	Statement/Question (1=stongly disagree, 3=neutral, 5=strongly agree)	n	Mean	Standard Deviation	95% Margin of Error
Q1	A	It would be safe to walk here, alone, during the day.	104	4.47	0.88	0.17
	B		104	4.59	0.71	0.14
	C		102	4.34	0.92	0.18
Q2	A	It would be safe to walk here, alone, at night.	105	3.93	1.05	0.20
	B		105	3.85	1.04	0.20
	C		101	3.15	1.26	0.25
Q3	A	The lighting is comfortable.	104	3.68	1.14	0.22
	B		105	3.75	1.10	0.21
	C		103	3.70	1.17	0.23
Q4	A	This is a good example of security lighting.	102	4.00	1.09	0.21
	B		102	3.89	1.03	0.20
	C		100	3.17	1.37	0.27
Q5	A	The lighting is too bright.	103	2.73	1.38	0.27
	B		104	2.32	1.25	0.24
	C		103	1.83	1.13	0.22
Q6	A	The lighting is too dark.	100	1.97	1.30	0.25
	B		103	2.08	1.12	0.22
	C		103	2.78	1.47	0.28
Q7	A	The lighting is uneven (patchy).	101	2.23	1.24	0.24
	B		103	2.48	1.30	0.25
	C		101	2.79	1.37	0.27
Q8	A	The lighting is glaring.	104	2.97	1.43	0.28
	B		105	2.63	1.41	0.27
	C		101	2.07	1.21	0.24
Q9	A	The lighting is too limited in area.	103	2.34	1.31	0.25
	B		104	2.46	1.21	0.23
	C		102	3.24	1.42	0.27
Q10	A	The lighting is poorly matched to the site.	105	2.35	1.22	0.23
	B		104	2.35	1.16	0.22
	C		102	2.88	1.39	0.27
Q11	A	I cannot tell the colors of things due to the lighting.	103	1.89	1.18	0.23
	B		105	1.91	1.12	0.21
	C		103	2.04	1.23	0.24
Q12	A	I can easily read the sticker information.	103	4.28	1.01	0.20
	B		105	4.03	1.14	0.22
	C		101	3.82	1.40	0.27
Q13	A	All features of the cars are easily visible in this lighting.	105	3.91	1.08	0.21
	B		104	3.69	1.12	0.22
	C		101	3.45	1.28	0.25
Q14	A	The lighting presents the car colors well.	104	3.81	1.07	0.21
	B		103	3.53	1.21	0.23
	C		102	3.74	1.18	0.23
Q15	A	The color of the red car closely resembles true red.	105	3.67	1.33	0.25
	B		104	3.61	1.21	0.23
	C		103	4.00	1.20	0.23
Q16	A	The color of the blue car closely resembles true blue.	105	3.65	1.26	0.24
	B		105	3.34	1.30	0.25
	C		103	3.71	1.36	0.26
Q17	A	The color of the yellow car closely resembles true yellow.	105	4.51	0.90	0.17
	B		105	4.36	1.06	0.20
	C		103	4.46	1.00	0.19
Q18	A	Please rate your impression of the overall quality of the light on a scale of 1 to 5, with 1 being very low quality and 5 being very high quality.	104	3.87	1.02	0.20
	B		104	3.66	0.88	0.17
	C		102	3.60	1.18	0.23
Q19	A	How does the lighting in this area compare with the lighting at similar dealerships at night?	85	3.56	0.97	0.21
	B		85	3.40	0.82	0.17
	C		84	3.19	1.12	0.24

Table 12: All Survey Results Statistics