

Utilization of Unmanned System Technology in Transportation Engineering

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Overview

- Unmanned Systems
 - Laws
 - Capabilities
 - Future
- Transportation Engineering Uses
 - Parking Study
 - Accumulation Graphs
 - Cost Effectiveness



Unmanned Systems



Unmanned Systems

- Fleet at ISU
 - Phantom 4 Pro
- Capabilities
 - Flight time 28 minutes
 - Max Service Ceiling 20,000 feet
 - Max Wind Speed Resistance 22 mph
 - Programmable flight paths
 - Range over 4 miles
 - Object tracking
- Cost of each drone
 - \$3000 to \$5000

Federal Aviation Administration

- Small Unmanned Aircraft Rule (Part 107), 21 June 2016
- Visual Line-of-sight (VLOS) only
- Maximum altitude of 400 feet above ground level (AGL)
- Minimum visibility of 3 statute miles

Federal Aviation Administration

- Air Traffic Control (ATC) permission required in Class D airspace
 - Airports that have an operating air traffic control tower
 - Notification is required when operating inside 5 statute miles
- Require a part 107 certification for operating in a controlled airspace
- Airspace Authorization
 - Available through internet request
 - 3-4 month wait
- Must yield right of way to other aircraft

Federal Aviation Administration

- Requires Preflight inspection prior to every flight
- No operation over moving vehicles
- May not operate over any persons
- Restrictions may be lifted in near future

Local Restrictions

- Must notify University Police
- Must follow FAA flight rules

Unmanned Uses Within Limitations

- Parking
 - Inventory
 - Accumulation/Occupancy
- Before and after traffic queues
 - Signal timing
 - Other improvements
- Work zone
 - Inspections
 - Traffic monitoring

Parking Study Objectives

- Parking inventory
 - Count the number of spaces in each lot
- Parking accumulation
 - One hour increments on all campus lots
 - Use unmanned systems if possible to collect data
 - Compare cost of traditional vs. unmanned system
 - Create bar graphs showing parking trends in each campus lot vs capacity

Indiana State University

- Terre Haute, Indiana
 - 60,000 Residents
- Indiana State University
 - Enrollment 14,000
 - Campus 435 acres
 - 5 Colleges
 - 30 parking lots
 - 1 parking garage



Campus Map

The image displays an interactive campus map of Indiana State University. The map is a top-down view showing various buildings, parking lots, and green spaces. A sidebar on the left contains a search bar and a list of categories with checkboxes and expand/collapse icons. The categories include Buildings, Parking (with sub-options for Faculty/Staff, Handicapped, Remote, Staff/Student, and Visitors' Pay Lots), Services, and Transit. At the bottom of the sidebar, contact information for the Office of Communications and Marketing is provided. The map itself shows streets such as Elm St, Lafayette St, N 1st St, Canal St, N 2nd St, Sycamore St, Penn St, N 9 1/2 St, N 10th St, N 10th 1/2 St, Wabash Ave, and Nut St. Highway markers for 41 and 150 are also visible. The text 'Terre Haute' is centered at the bottom of the map area.

Search... Search

- > Buildings
- ▼ Parking
 - > Faculty/Staff Parking
 - > Handicapped Parking
 - > Remote Parking
 - > Staff/Student Parking
 - > Student Parking
 - > Visitors' Pay Lots
- Cherry Street Parking Garage
- Welcome Center Parking
- > Services
- > Transit

Indiana State University
Office of Communications and Marketing
102 Gillum Hall, Terre Haute, IN 47809
web@indstate.edu
(812) 237-3773

Terre Haute

Parking Inventory

- Determine spaces on campus by type
 - Regular Spaces
 - Handicapped
 - Parking Meters
 - Service
 - Motorcycle



Parking Inventory with Unmanned Systems

- Count in off peak times
- Striping and signage visible



Parking Lots

- 6 Staff
 - 740 Total Spaces
 - 691 Regular
- 6 Student
 - 960 Total Spaces
 - 921 Regular
- 10 Staff/Student
 - 1594 Total Spaces
 - 1552 Regular
- 8 Remote
 - 1605 Total Spaces
 - 1587 Regular
- 1 Parking Garage
 - 590 Total Spaces
 - 572 Regular
- Total Spaces 5498

Parking Inventory Results

- Discrepancies
 - Most lots were off by 2 to 5 regular spaces
 - No accurate count for several years

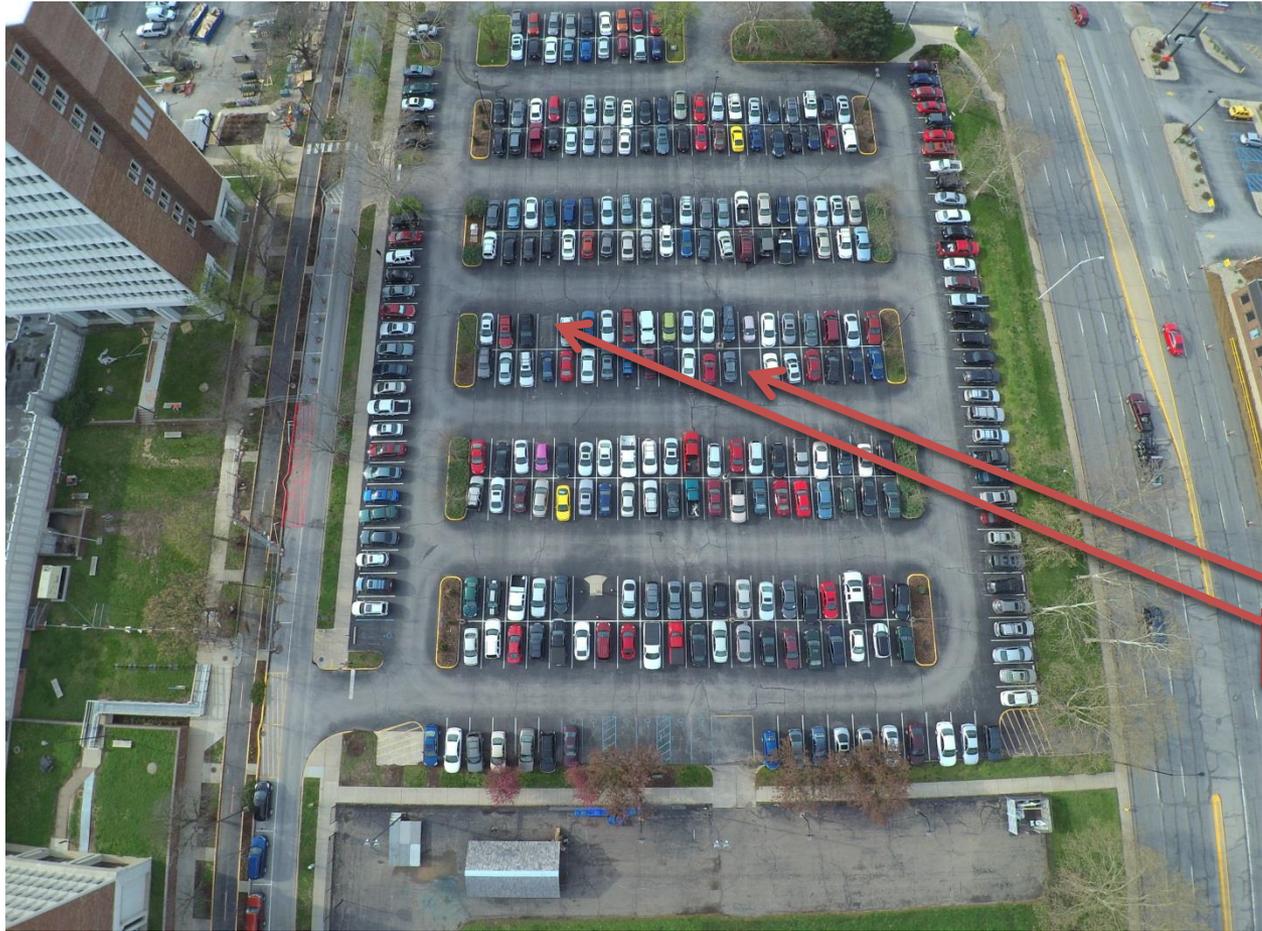
Parking Accumulation

- Defined: total number of vehicles parked at any given time
- Establish the distribution of parking accumulation over time
- Determine the peak accumulation and when it occurs
- Determine space availability
- Collect vehicle occupancy each hour
- Due to the nature of arrival patterns
 - 7:30 am to 3:30 pm
 - Class schedule
 - Faculty hours

Parking Accumulation

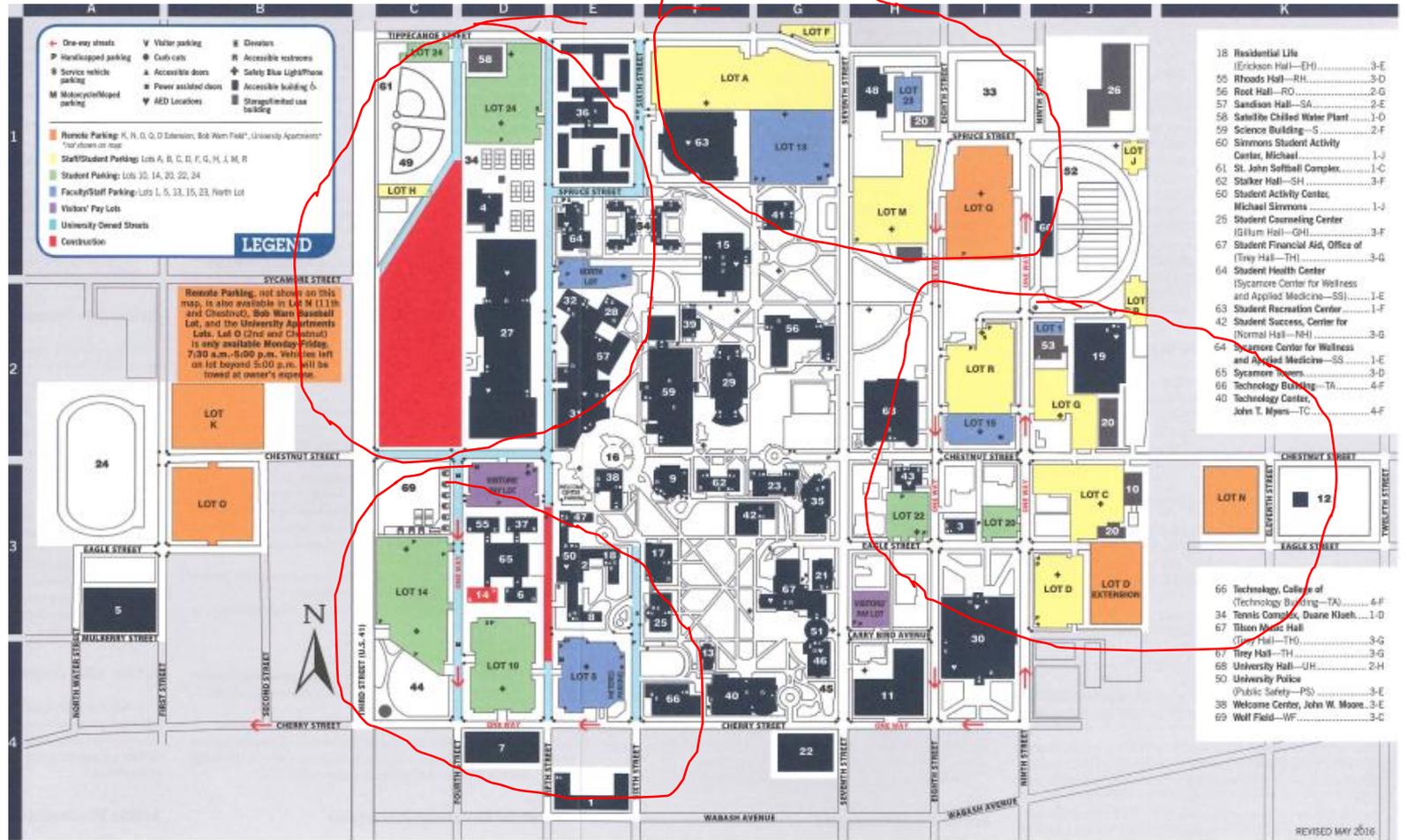
- Preliminary Analysis
 - Always open spaces
 - Handicapped
 - Parking Meters
 - Service
 - Motorcycle
 - Spaces full
 - Regular Spaces

Drone Data



Open Spaces

Campus Map



Parking Garage

- Not accessible via drone
- Manual counts



Cost Effectiveness

- Wages
 - \$12 per student
- Hours
 - Large lots require full day counts
 - Drone capture multiple lots per flight
- Drone Cost
 - \$3000

Cost Effectiveness

Method	Hours	Weeks	Cost
Traditional Method 4 Students	512	12.8	\$ 6,144.00
Drone Study Student	40	1	\$ 3,480.00
Drone Study reduced cost by 56.7 percent or 92.2 percent when cost of drone is recouped			

Lesson Learned

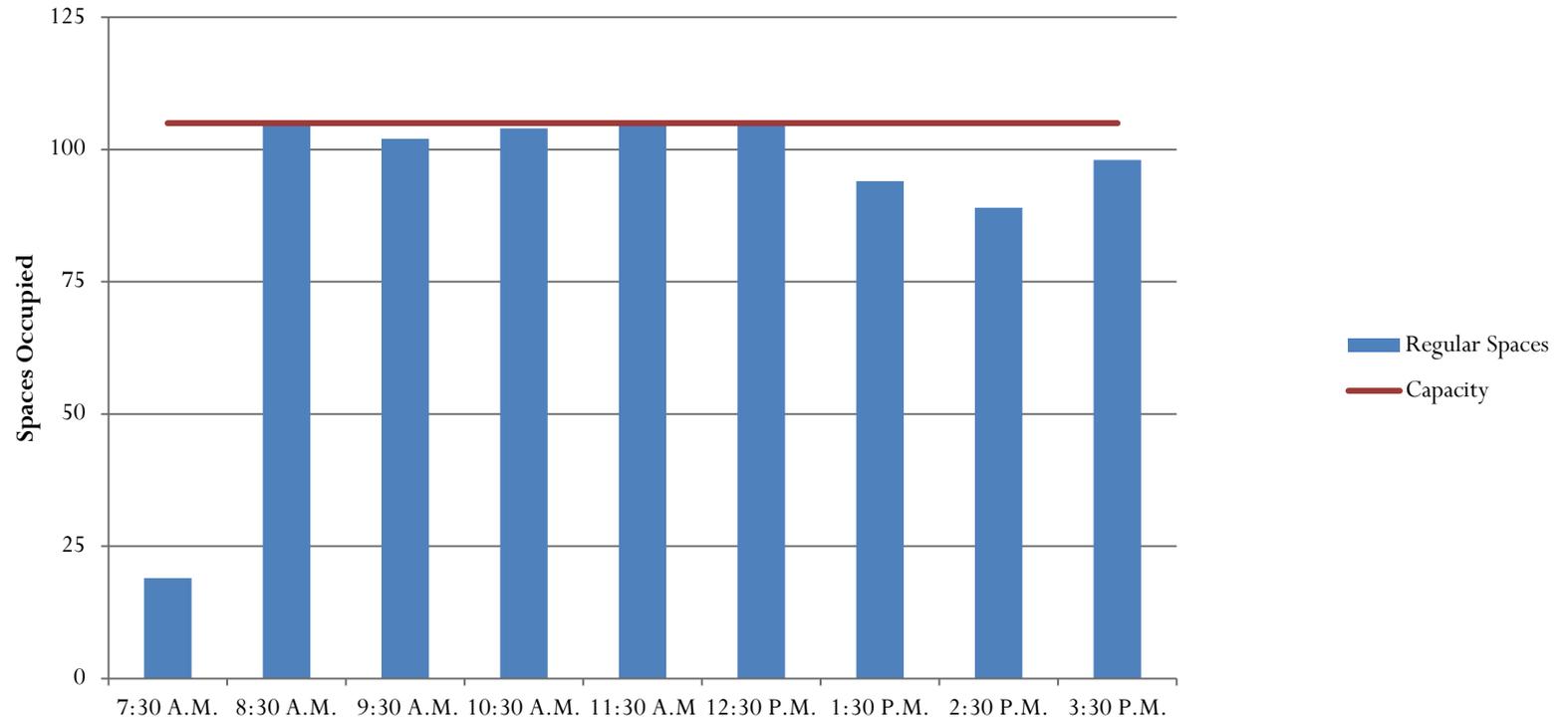
- Labeling the pictures
 - Date
 - Time
 - Parking lot(s)
- Multi lots per picture
 - Reducing flights
- Sun angles
 - Shadows
 - Glare
- Drone capabilities
 - Battery efficiency
 - Data storage
- Weather
 - Including wind

Deliverable

- Accumulation graphs
- All parking lots on campus
- Assist travelers in choosing parking based on time of day

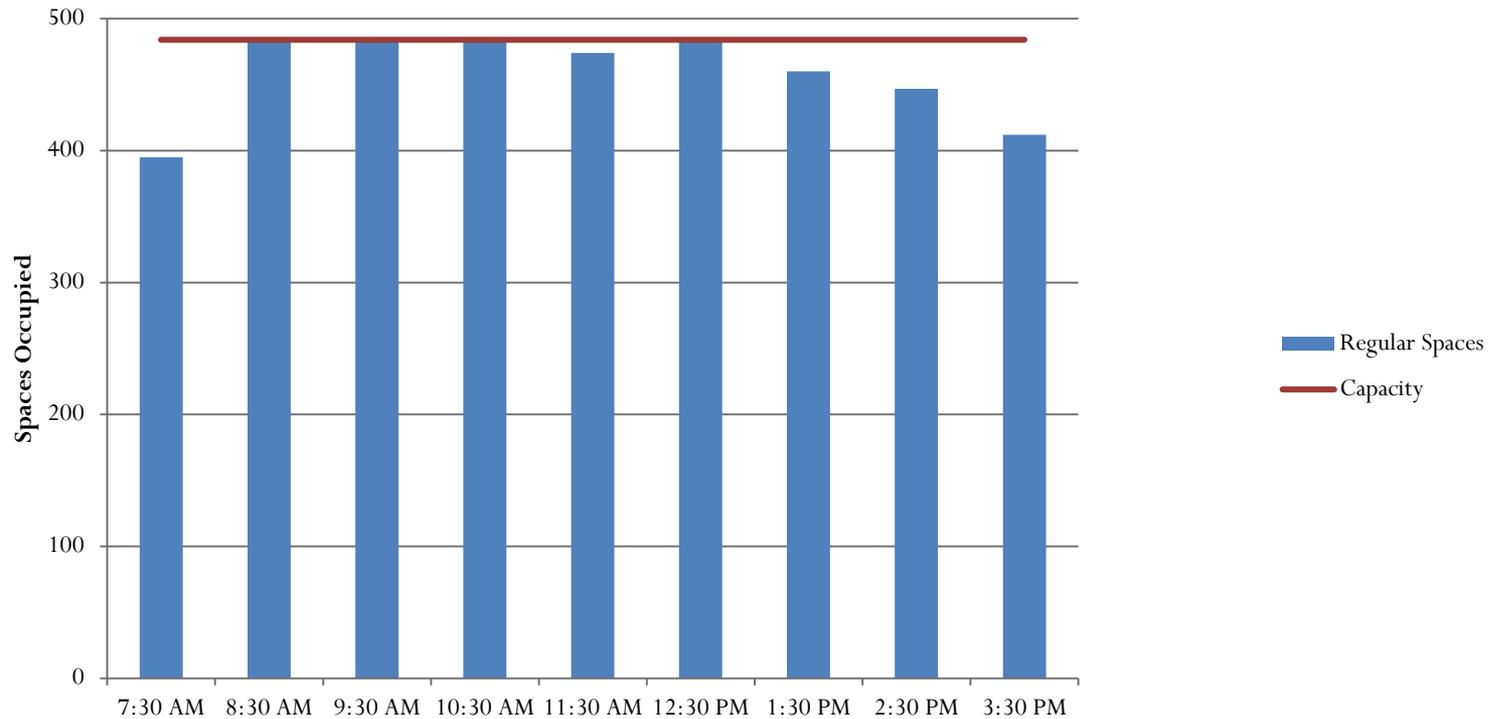
Bar Graphs

FACULTY/STAFF LOT 15



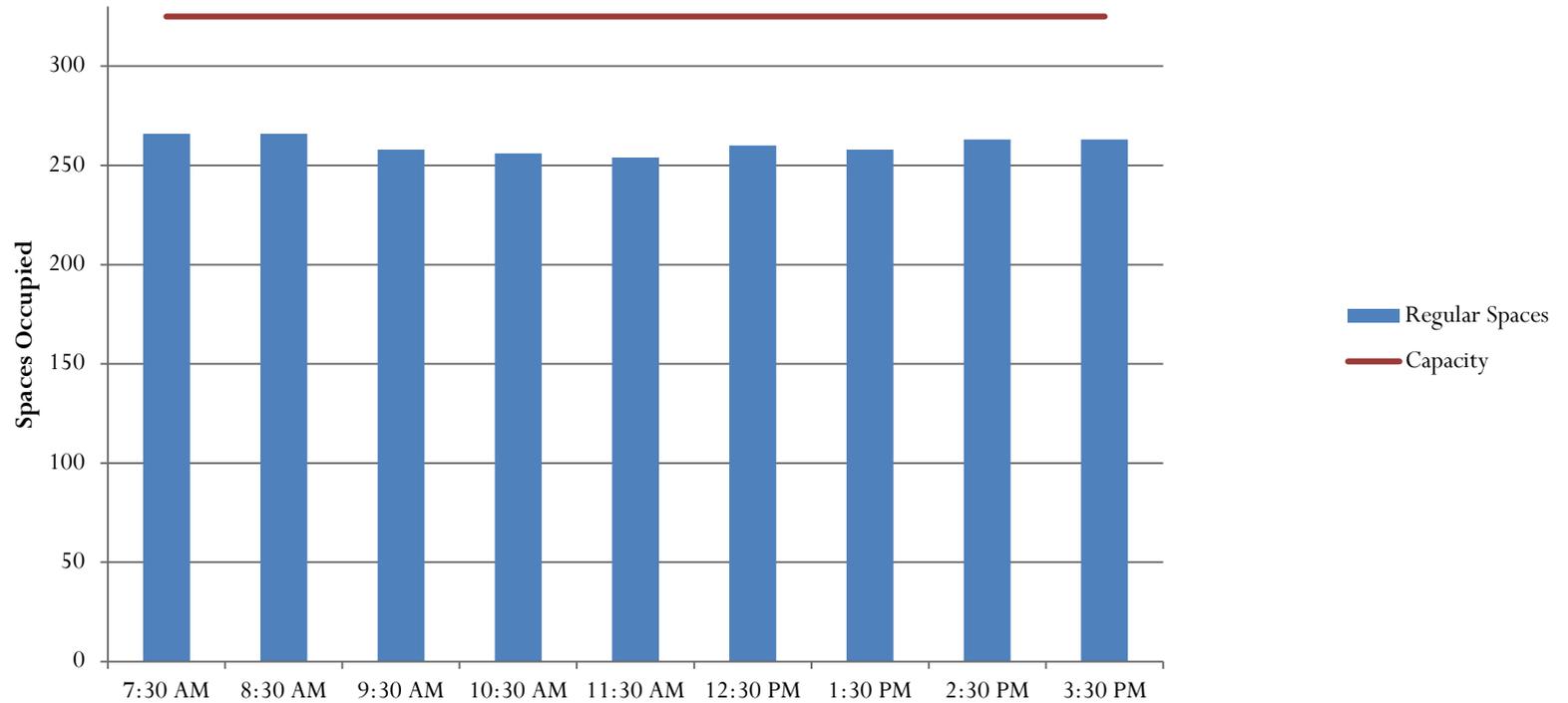
Bar Graphs

STAFF/STUDENT LOT A



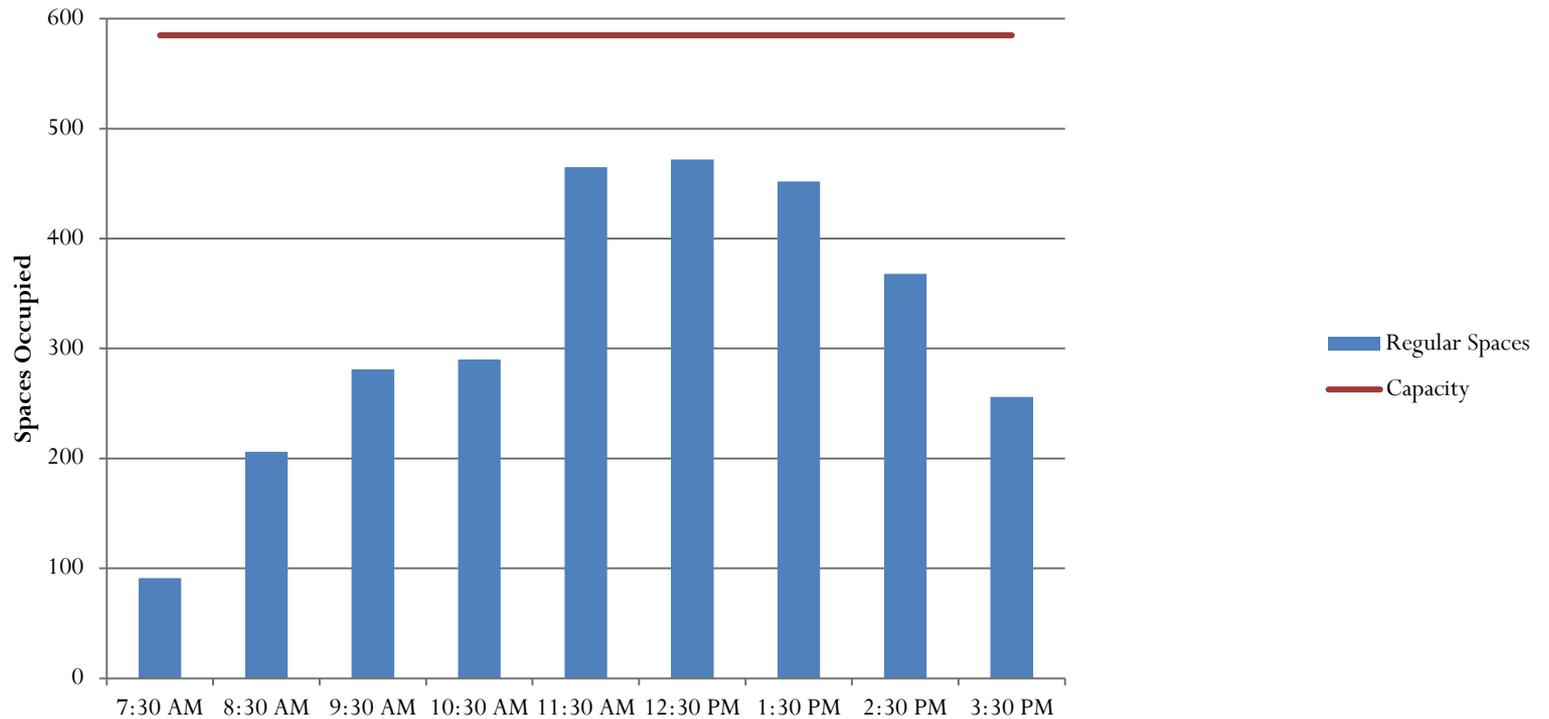
Bar Graphs

STUDENT LOT 24



Bar Graphs

PARKING GARAGE



Future use with Software

- OpenALPR
 - Plate detection system
- Compatible with most cameras
- Create flight plan to collect data
 - Issue tickets as necessary
 - Conduct studies on:
 - Duration
 - Turnover rate



id	Lot	Plate_Number	Confidence
1	15	CE MW 1	78.48
2	15	NR 1967	74.51
3	15	KE 4932	86.46
4	15	TKY 3939	78.54
5	15	BCEM 29	95.45

Contact Information

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