Articulated Bus Project:
Existing Conditions Report
Written By: Alexandria Jones

Figure 1: Santa Cruz Metro Articulated Bus

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Executive Summary:

This study draws attention to the fact that in recent years bus overcrowding has become a prominent issue with Santa Cruz Metro buses that service UCSC routes. During class blocks, these UCSC route buses are becoming prematurely full at the beginning of their routes and are passing by many students who are trying to get to campus for class. To reduce this issue of bus overcrowding, articulated buses were introduced as a way to increase capacity and also reduce the amount of people passed by.

This report provides an analysis and evaluation of the utilization and on time performance of the Santa Cruz Metro articulated buses. Methods of analysis included gathering passenger data and on-time performance data through point counts and onboard surveys. Results of data analyzed show that articulated buses are carrying less people onboard than the non-articulated buses. There are several factors that may contribute to the relatively small loads, but one factor presented in this report is the misalignment of UCSC class schedules with the schedule of the articulated buses. It was also found in this report that the extra passenger capacity of the articulated buses is affecting its on-time performance on the UCSC campus. In particular, the articulated buses have slower running times at heavily utilized bus stops due to the extra passenger capacity. In short, articulated buses have good on-time performance when load factors are low, and thus there is no benefit to the extra capacity. When the extra capacity is utilized, this negatively affects on-time performance.

This report finds that the articulated buses are not being utilized to their full potential but, with a few adjustments they have the possibility to perform ideally. The major areas of weakness such as the slow dwell times and schedule misalignment should be further investigated by the Santa Cruz Metro administration. Recommendations discussed include: adjusting articulated bus running times, reducing articulated bus dwell time, and future research.

Introduction:

Bus overcrowding has become a growing problem with Santa Cruz Metro and to the UCSC campus. This issue has become a major point of contention to many UCSC students, who live off campus, because students are unable to catch the bus when they need to get to class. One reason why bus overcrowding has become an issue is due to the housing displacement on the UCSC campus. Due to limited housing on campus, many students who do not have guaranteed housing are being pushed off campus because of the increasing enrollments. Many of these students who then move off campus are also unable to find housing close to the campus. This can be attributed to a number of factors including the Santa Cruz housing shortage and housing unaffordability (No Place Like Home 2017).

And as a result, these students, who cannot locate housing near the campus, turn to living in cheaper areas with more housing availability, such as: Live Oak, Twin Lakes, and Capitola. These areas are further from campus and therefore require students who do not have cars to take the bus to get to the university. When going to school, students who live in these areas typically bus from their homes to the Metro Center, and transfer to a UCSC route to the campus. Consequently, a large number of students board at the Metro Center and this creates a dynamic where the buses going up to campus become overcrowded one or two bus stops after the Metro Center. Due to this problem, a significant number of students who wait at the bus stops following the Metro Center are passed by and are unable to catch a bus to campus. This premature overcrowding of the bus usually occurs during several peak hours, primarily in between class blocks.

In the interest of resolving the bus overcrowding issue, Santa Cruz Metro and UCSC Transportation and Parking Services have introduced articulated buses to reduce bus overcrowding. Three articulated buses that serve several UCSC routes were fully introduced to the campus as a

pilot program in January of 2018. The pilot was launched because articulated buses have the potential to supply more capacity, pick up more students, reduce the amount of passbys, and reduce overall bus overcrowding. This report was generated as an evaluation of the introduced articulated buses to find out:

(1) If articulated buses are effectively picking up more students than the non-articulated buses

(2) At what times of day the articulated buses are most effective and where they can be improved

(3) The impacts of large buses on running times.

With the data collected, this report will present charts and graphs to illustrate the findings of this research.

Methods:

Passenger data and on-time performance data were collected at Bay and Mission and on the UCSC campus for 8 days over the course of 2 weeks from (February 6th - February 16th). During Week 1 of data collection, manual point counts of 4 bus stops with high passenger demand were recorded, with a focus on peak hours (SCCRTC 2017). Data collected for point counts included (Figure 2): bus route, departure and arrival times, boardings and alightings, and passbys.

Week 1 data collection times:
- [Bay and Mission] from (3:30-5:30 pm) on [2/6]
- RCC/Porter] from (7:30-9:00 am) on [2/7]
- [RCC/Porter] from (3:30-5:00 pm) on [2/7]
- [Cowell/Stevenson] from (7:30-9:30 am) on [2/8]
- [Cowell/Stevenson] from (3:30-5:30 pm) on [2/8]
- [Science Hill/Engineering] from (3:30-5:00 pm) on [2/9]
- [Bay and Mission] from (7:30-9:30 am) on [2/9]

During Week 2 of data collection, on-board surveys were collected for 15 bus trips. Trips using articulated buses on routes 15, 16, and 20D were surveyed and compared to trips using non-

articulated buses on routes 15, 16, and 20. The articulated trips were paired with non-articulated trips of similar routes and departure times to serve as the "control" trips of the study. Week 2 data collection times were chosen because they represent peak boarding times (Lipschutz & Hahm 2015). Data collected for onboard surveys included: bus stop description, scheduled stop time, departure and arrival times, boardings and alightings, and sources of delay (Figure 2a):

Week 2 data collection times:
M/F
- [15A], dep. Metro Center at 7:45 am on [2/12]
- [15A], dep. Metro Center at 8:45 am on [2/12]
- [16A], dep. Metro Center at 2:52 pm on [2/12]
- [16R], dep. Metro Center at 7:37 am on [2/16]
- [16R], dep. Metro Center at 8:37 am on [2/16]
- [15R], dep. Metro Center at 2:00 pm on [2/16]
- [16R], dep. Metro Center at 2:52 pm on [2/16]

T/TH

- [20DA], dep. Delaware&Swift at 9:20 am on [2/13]
- [20DA], dep. Delaware&Swift at 10:20 am on [2/13]
- [20DA], dep. Delaware&Swift at 3:20 pm on [2/13]
- [20DA], dep. Delaware&Swift at 5:20 pm on [2/13]
- [20R], dep. Delaware&Swift at 9:30 am on [2/15]
- [20R], dep. Delaware&Swift at 10:30 am on [2/15]
- [20R], dep. Delaware&Swift at 3:30 pm on [2/15]
- [20R], dep. Delaware&Swift at 4:30 pm on [2/1]

Figure 2. Point Counts at [Science Hill/Engineering] from (3:30-5:00 pm) on [2/8]

Survey Date	Rte	Arrive Time	Depart Time	Ons (F)	Ons (B)	Offs (F)	Offs (B)	Passbys
2/8/2018	Loop	7:32	7:34	1	1	8	5	0
2/8/2018	UC	7:34	7:34	0	0	1	6	0
2/8/2018	10R	7:38	7:40	3	2	5	11	0
2/8/2018	16R	7:38	7:40	0	0	3	11	0
2/8/2018	20D	7:40	7:41	2	0	3	6	0
2/8/2018	Loop	7:42	7:42	0	4	9	8	0
2/8/2018	20R	7:48	7:49	11	0	5	13	0
2/8/2018	UC	7:49	7:50	3	5	3	9	0
2/8/2018	Loop	7:53	7:54	4	2	6	14	0
2/8/2018	16R	7:58	7:59	4	2	11	14	0
2/8/2018	UC	8:03	8:04	3	1	2	2	0
2/8/2018	Loop	8:04	8:04	0	0	7	8	0
2/8/2018	10R	8:12	8:13	9	0	3	11	0
2/8/2018	16R	8:14	8:14	2	0	0	5	0
2/8/2018	Loop	8:15	8:15	0	6	0	5	0
2/8/2018	UC	8:17	8:17	0	2	2	0	0
2/8/2018	22R	8:24	8:25	3	0	2	9	0
2/8/2018	16R	8:25	8:26	3	0	5	10	0
2/8/2018	Loop	8:25	8:26	1	1	0	6	0
2/8/2018	UC	8:33	8:34	0	4	0	3	0
2/8/2018	Loop	8:35	8:36	0	2	0	0	0
2/8/2018	20DA	8:36	8:36	1	0	1	2	0
2/8/2018	10R	8:37	8:37	0	0	4	4	0

Figure 2a. Example of on-board survey of the articulated 20D, departing Delaware&Swift at 9:20 am on [2/13]

Rte	Stop ID	Stop Description	Stop Time	Stops	Arrive Time	Depart Time	Ons (F)	Ons (B)	Ons All	Offs (F)	Offs (B)	Offs All	Onboard	Survey Date	Other Sources of Delay
20D	2330	(TIMEPOINT: Delaware	9:20:00	7	9:18	9:18	0	0	0	0	0	0	14	2/13/2018	
20D	2718	Natural Bridges Dr & De	9:22:00	8	0	0	0	0	0	0	0	0	14	2/13/2018	
20D	2726	Natural Bridges Dr & Mi	9:23:00	9	9:20	9:21	2	0	2	0	0	0	16	2/13/2018	
20D	2344	Western Dr & Beachview	9:24:00	10	9:22	9:23	5	0	5	0	0	0	21	2/13/2018	
20D	1907	Western Dr & Flower	9:25:00	11	9:24	9:24	11	0	11	0	0	0	32	2/13/2018	Stoplight
20D	2593	Western Dr & Western C	9:26:00	12	9:25	9:26	1	0	1	0	0	0	33	2/13/2018	bike on board
20D	1909	Western Dr & Monarch	9:26:00	13	0	0	0	0	0	0	0	0	33	2/13/2018	stop sign
20D	1910	Western Dr & Meder	9:27:00	14	9:26	9:27	1	0	1	1	1	2	32	2/13/2018	stop sign
20D	1510	High & Western Dr	9:29:00	15	9:28	9:28	0	0	0	0	0	0	32	2/13/2018	taking bike off rack
20D	1341	(TIMEPOINT: Bay Dr & H	9:30:00	16	9:30	9:31	3	0	3	0	0	0	35	2/13/2018	
20D	1342	Coolidge Dr & Hagar Ct	9:32:00	17	9:32	9:32	6	0	6	0	0	0	41	2/13/2018	5 passbys
20D	2660	Hagar Dr & Village Rd (L	9:33:00	18	9:34	9:34	10	0	10	0	0	0	51	2/13/2018	stop sign with traffic
20D	1501	Hagar Dr (UCSC - East Re	9:35:00	19	9:35	9:37	37	0	37	0	0	0	88	2/13/2018	peds at stop sign
20D	2101	Hagar Dr (UCSC - East Fi	9:36:00	20	9:37	9:38	2	0	2	1	0	1	89	2/13/2018	
20D	2102	Hagar Dr (UCSC - Bookst	9:37:00	21	9:40	9:41	17	0	17	1	11	13	93	2/13/2018	peds crossing street
20D	1617	McLaughlin Dr (UCSC - C	9:38:00	22	9:42	9:43	7	0	7	10	4	14	86	2/13/2018	
20D	1616	McLaughlin Dr (UCSC - C	9:39:00	23	9:44	9:45	3	0	3	9	10	19	70	2/13/2018	
20D	1615	(TIMEPOINT: Science Hil	9:40:00	24	9:46	9:47	2	0	2	10	13	23	49	2/13/2018	
20D	1509	Heller Dr & McLaughlin S	9:40:00	25	9:48	9:48	0	0	0	22	3	25	24	2/13/2018	
20D	2448	Heller Dr (UCSC - Rachel	9:42:00	26	9:50	9:50	1	0	1	2	7	9	16	2/13/2018	
20D	2516	Heller Dr (UCSC - Family	9:42:00	27	0	0	0	0	0	4	0	4	12	2/13/2018	
20D	1505	Heller Dr (UCSC - Oakes	9:43:00	28	9:51	9:52	1	0	1	0	0	0	13	2/13/2018	
20D	2328	Empire Grade (UCSC - Ar	9:45:00	29	0	0	0	0	0	0	0	0	13	2/13/2018	
20D	2759	High (Tosca Terrace)	9:46:00	30	0	0	0	0	0	0	0	0	13	2/13/2018	
20D	2659	Western Dr & Meder	9:47:00	31	9:55	9:55	0	0	0	1	0	1	12	2/13/2018	
20D	2660	Western Dr & Monarch	9:48:00	32	0	0	0	0	0	0	0	0	12	2/13/2018	
20D	2661	Western Dr & Western C	9:48:00	33	9:56	9:56	0	0	0	1	0	1	11	2/13/2018	
20D	2662	Western Dr & Cypress Pa	9:49:00	34	0	0	0	0	0	0	0	0	11	2/13/2018	
20D	2663	Western Dr & Flower	9:49:00	35	9:57	9:57	0	0	0	1	0	1	10	2/13/2018	
20D	2715	Natural Bridges Dr & Mi	9:51:00	36	9:59	10:00	0	0	0	0	0	0	10	2/13/2018	
20D	2717	Natural Bridges Dr & De	9:51:00	37	10:01	10:01	0	0	0	2	1	3	7	2/13/2018	
20D	1351	(TIMEPOINT: Delaware	9:53:00	38	10:02	10:03	0	0	0	2	2	4	3	2/13/2018	

Results:

Summary of All Onboard Surveys

Out of the 15 trips surveyed, the articulated buses on average had 18 total passengers onboard, while the non-articulated buses had 22 passengers onboard (Figure 3). However, the mean values do not reflect the large number of outliers. The median number of passengers onboard

the articulated buses was 10 while the median value for the non-articulated buses was 21 (Figure 3 & Figure 3a). This passenger data reveals that out of the 15 trips surveyed, the articulated buses did not carry as many passengers as the non-articulated buses. Even though there were not as many passengers boarding the articulated buses on average, however, there is a significant difference between the maximum number of passengers onboard the articulated vs. non-articulated buses. The maximum number of passengers recorded onboard the articulated bus was 93 whereas the maximum for the non-articulated was 67 (Figure 3). These maximums demonstrate that although the articulated buses do have the capacity to board more students, there may be other factors contributing to the relatively lower averages and median values.

Since this study only surveyed 15 trips, which is a small sample size, it was compared to the Santa Cruz Metro Transit Department's (SCMTD) ridership data from 2 weeks in January (see Appendix A). This data provides complete coverage (545 trips surveyed) of articulated vs. non-articulated bus ridership, and finds a slightly higher number of boardings on articulated buses. However, the differences are small – the median, 75th percentile and maximum number of boardings per trip are only three people higher for articulated buses, again indicating that the additional capacity is not being used to its full potential. The differences between the datasets could be due to the small sample size of the surveys, or because of the focus of these surveys on higher-demand times of day.
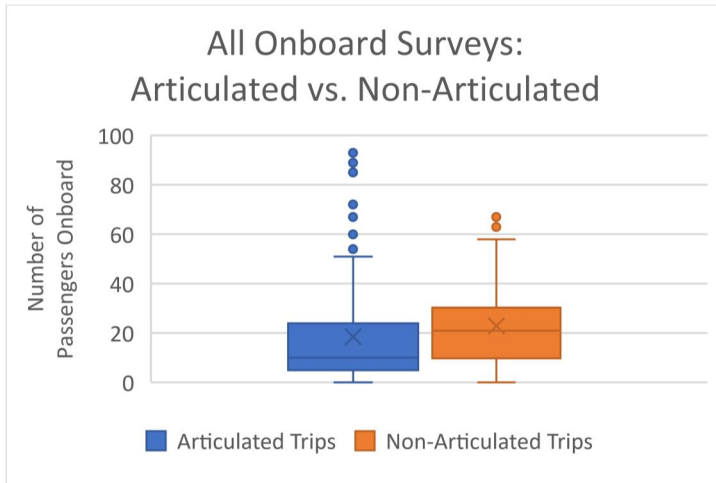
Figure 3a. Number of Passengers Onboard per stop (All Surveys) Articulated Vs. Non-Articulated

	Arc	Non-Arc
Min	0	0
Q1	5	10
Median	10	21
Q3	24	30
Max	93	67
Mean	18.4747	22.8894
Range	93	67

Figure 3. Number of Passengers Onboard the Articulated Buses vs. Non-Articulated Buses

Route Evaluations

Using the data gathered from this report, comparisons were made between the number of passengers onboard for matched pairs of articulated and non-articulated (control) bus routes. The data presented represents the number of passengers onboard (per stop) for each sampled Route 20 articulated and non-articulated bus (Figure 5). Three of the four surveyed articulated 20s (10:20am, 3:20pm, 5:23pm) had a maximum of less than 25 passengers onboard while all surveyed non-articulated 20s (9:30am, 10:30am, 3:30pm, 4:30pm) had a maximum of more than 25 passengers onboard. The data also illustrates that the articulated Route 20 bus running from 9:18-10:03 am on 2/13 had the most passengers onboard at 93 passengers (Figure 5). The next comparable maximum onboard size is the non-articulated Route 20 bus running from 4:36-5:20 pm on 2/15. The onboard maximum for this trip was 58 passengers. This indicates that the crowded articulated 20 carried on board a maximum of 35 more passengers than the crowded non-articulated 20 (Figure 5). In other words, while on average the articulated buses are serving lower-demand trips, they are extremely effective on certain occasions.

Additional comparisons were made between the articulated and non-articulated Route 15 and 16. Finding comparable control trips were more difficult for these routes because there are very few non-articulated Route 15 buses and the articulated 16 only begins running in the afternoon. Out of the 3 articulated Route 15s surveyed, only one had a maximum of over 24 passengers onboard while the 2 articulated route 16s had a maximum of 49 and 50 passengers onboard. The one surveyed non-articulated 15 had a maximum of 20 passengers on board, while the two non-articulated route 16s both had a maximum between 40 and 55 passengers onboard. This data also depicts that the maximum number of passengers onboard, among all 15 and 16 routes, was the Articulated 15 running from 8:45-9:32 am on 2/12 (Figure 6). This bus carried onboard 26 more passengers than the next comparable maximum onboard: the non-articulated Route 16 bus running from 8:39-9:21 am on 2/16, which carried 67 passengers onboard (Figure 6). A similar conclusion is evident as for the Route 20 buses: while on average the articulated buses are serving lower-demand trips, they are extremely effective on certain occasions.
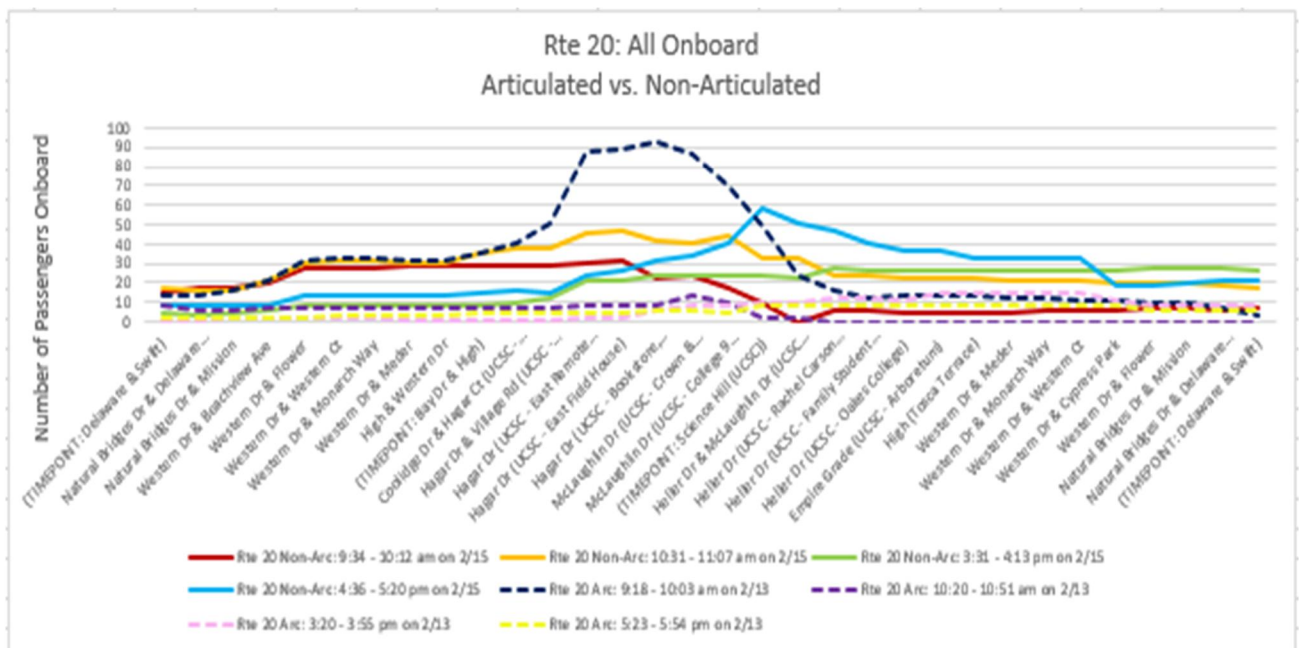
Figure 5. Number of Passengers onboard per stop vs all surveyed Route 20 articulated and non-articulated buses
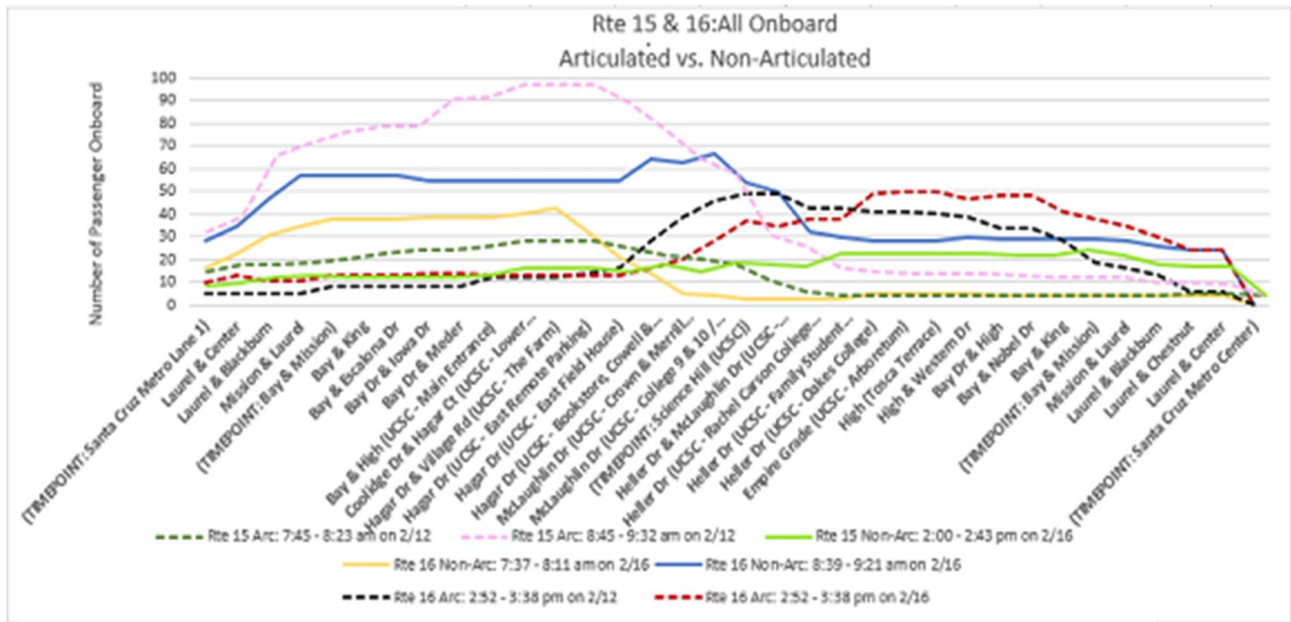
Figure 6. Number of Passengers onboard per stop vs all surveyed Route 15 and 16 articulated and non-articulated buses

Class Schedule versus Boardings

As previously mentioned it is noteworthy to analyze UCSC class schedule times against articulated bus departure times to determine if misalignment of the schedules is a factor contributing to why there are relatively less passengers onboard the articulated buses per stop versus the non-articulated buses. Analysis was done between the T/TH afternoon class schedule times and the articulated 20D arrival and boarding times.

These figures display the number of boardings against the arrival time of the bus (red dots) compared to the corresponding class block that it should fall in (green rectangles) (Figures 7&8). This comparison reveals that the articulated 20D that leaves Delaware and Swift at 3:20 pm is not aligned with the 3:20 pm class block (Figure 5 & Figure 7). In other words, Figure 7 shows that

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the articulated 20D boarded a maximum of 5 passengers at any stop during the 3:20-4:55 pm class block. Since most students choose to take the bus 20-30 minutes before class, it is not effective for the 3:20 pm articulated bus to reach the UCSC campus 10 minutes after the 3:20 class begins. Additionally, the articulated bus boardings during the 5:20 – 6:55 pm class block reveals the same schedule misalignment. The articulated 20D that leaves Delaware & Swift at 5:20 pm boarded a maximum of 4 passengers during this afternoon class block.

On the contrary, after comparing the same T/TH afternoon class schedule with the non-articulated 20 routes, it is clear that the non-articulated 20 running from Delaware & Swift at 4:30 was able to board more passengers than the articulated bus that ran an hour prior (Figure 6&8). The 4:30 pm Route 20 bus picked up students who got out of their 3:20-4:55 classes. Due to this alignment of the 3:20 class schedule and the 4:30 bus, the non-articulated bus was able to board 17 more passengers than the 3:20 articulated bus.
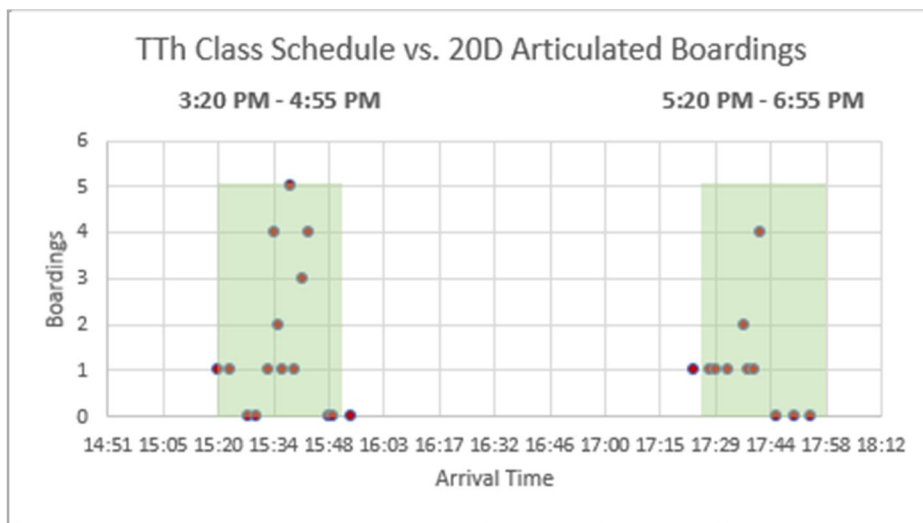
Figure 7. T/TH Class Schedule vs. 3:20 pm and 5:23 pm Articulated 20 D arrival and boardings
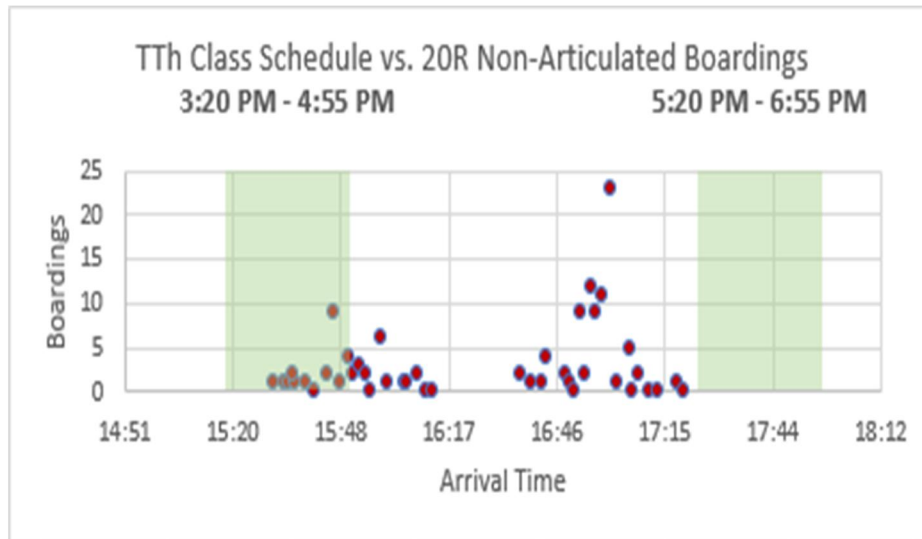
Figure 8. T/TH Class Schedule vs. 3:30 pm and 4:30 pm Non-Articulated 20 arrival and boardings

Running Time

The running times of the articulate buses were evaluated to determine if the extra passenger capacity on the articulated bus is affecting their on-time performance. The following data represents time behind schedule of the bus for each surveyed articulated and non-articulated bus. Figure 9 demonstrates the minutes behind schedule of all surveyed Route 20 buses. 'Minutes behind Schedule' was calculated by subtracting the actual bus arrival time from its scheduled arrival time. This data shows that the buses with the highest schedule delay were the non-articulated Route 20 buses. Out of the 4 surveyed non-articulated Route 20s, 3 of them remained 6 or more minutes behind schedule for at least half of its trip, while only 1 out of 4 articulated Route 20 remained behind schedule for this same duration. A majority of the surveyed 20s were the most behind schedule while on the UCSC campus. Figure 9 shows that minutes behind schedule increases from the East Field House bus stop to the RCC bus stop and then plateaus once the bus is back off campus.

Figure 10 demonstrates the minutes behind schedule of all surveyed Route 15 and 16 buses. This data shows that the buses with the highest schedule delay were the articulated Route 15 and 16 buses. Out of the 4 surveyed articulated buses, 3 of them remained 6 or more minutes behind schedule for at least half of its trips, while only 1 non-articulated Route 16 bus remained behind schedule for this same duration. Like the Route 20s, a majority of the Route 15s and 16s were the most behind schedule while on the UCSC campus. Figure 10 shows that the minutes behind schedule increases after the High and Bay bus stop and then the time delay starts to plateau after leaving the campus. By the time all the buses reach Laurel and Center the minutes behind schedule has already decreased to 4 or less.

The articulated Route 20 buses remained relatively on time with its expected schedule (Figure 9). On reason for this could be attributed to the misalignment of the articulated Route 20 running times with the UCSC class times. Since these buses are picking up people at the wrong time, there are only a few people boarding the bus at each stop. Therefore, increased passenger capacity of the articulated buses is not causing slower running times. On the other hand, the articulated Route 15s and 16s had the highest schedule delays (Figure 10). This may be because the articulated Route 15 and 16s were more aligned with the class schedule and therefore they were able to pick up more passengers.

*The minutes behind schedule may also be affected by other factors including: construction, traffic on the road, and pedestrians in the streets. These were not accounted for in this study.
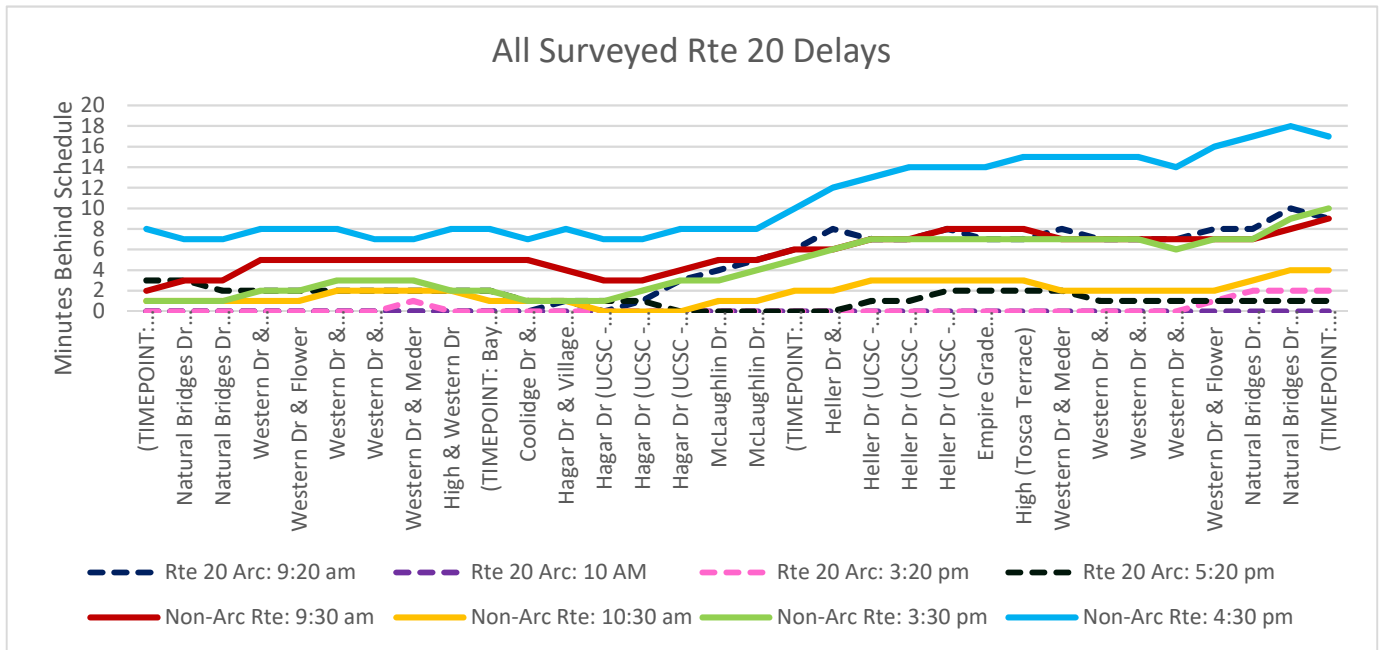

Figure 9. Minutes behind schedule (Expected-Actual) vs. All Surveyed Rte 20s
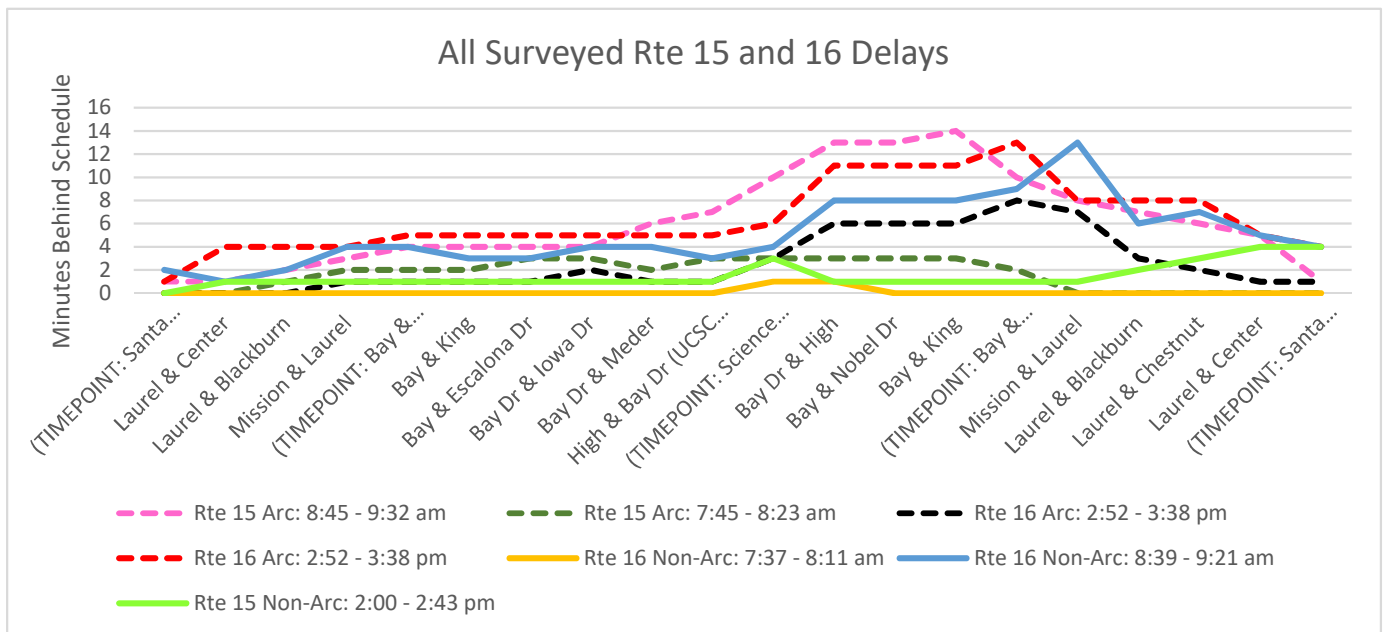

Figure 10. Minutes behind schedule (Expected-Actual) vs. All Surveyed Rte 15 and 16s

<u>Sources of Delay</u>

One reason why there is an increased slowdown for the buses is due to the time it takes to board all passengers. An analysis was completed of the time in seconds it takes to board each passenger compared to the total number of boardings and alightings of the articulated and non-articulated buses. Data collected demonstrates that it takes on average 3 seconds to board 1 passenger (from the time the doors open to the time the passenger steps onto the bus). Time to board was calculated by (3 x Number of Boardings). Figure 11 depicts the time in seconds it took for the 9:20 am articulated bus to reach near maximum onboard. At the East Remote Parking Lot, the 9:20 am articulated bus reached its highest time to board. This bus boarded 37 passengers while having 51 people already onboard (Figure 11). The high volume of students getting on the bus significantly slowed down the articulated bus because it took 111 seconds or 2 minutes and 25 seconds to board all passengers (Figure 11).

This data coincides with expected vs. actual on time performance data found on Figure 9. Comparatively, the 4:30 pm non-articulated 20 reached its highest time to board and near maximum capacity at the Science Hill bus (Figure 12). This bus boarded 23 people at once while having 40 people onboard and took 69 seconds to load all passengers (Figure 12). The articulated bus took 42 seconds longer than the non-articulated bus to board passengers at its highest time to board. The time it takes to board a high volume of passengers can attribute to the slowdown of the articulated bus running times.

*The 9:20 am and 4:30 pm articulated buses were chosen because they comparably represent the time it takes to board passengers near their respective maximum capacity.
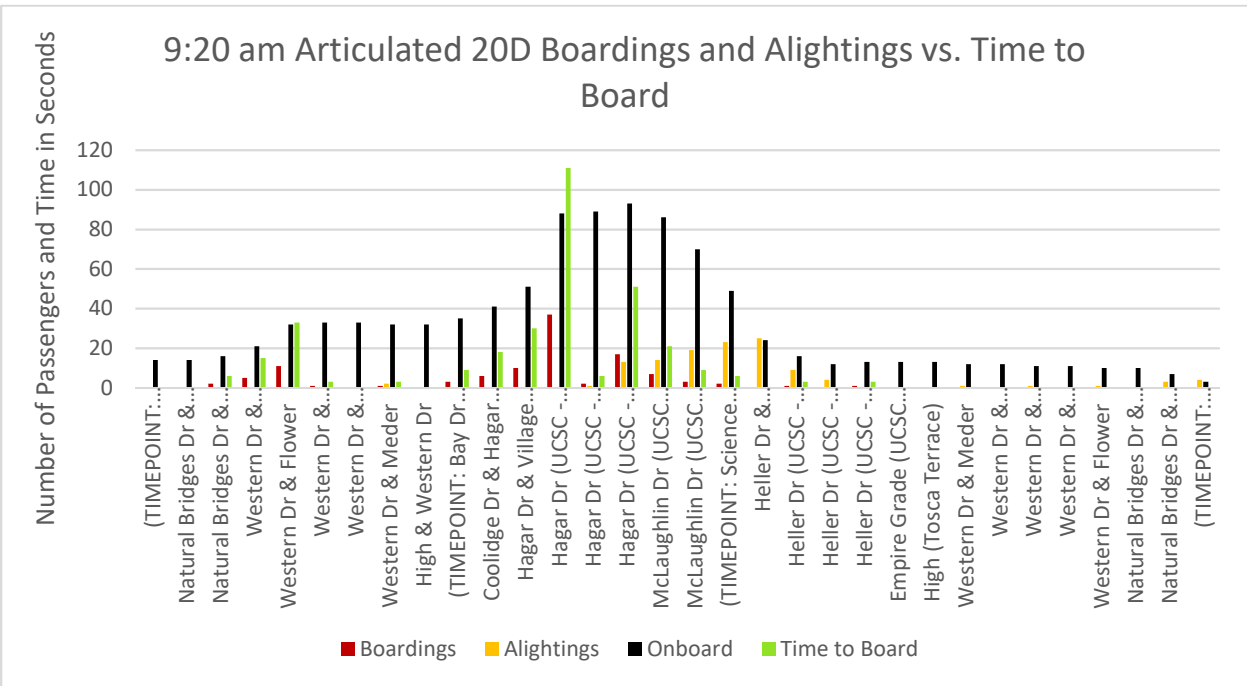
Figure 11. Number of Passenger and Time in Seconds vs. 9:20am Arcticulated 20D Boardings and Alightings vs. Time to Board
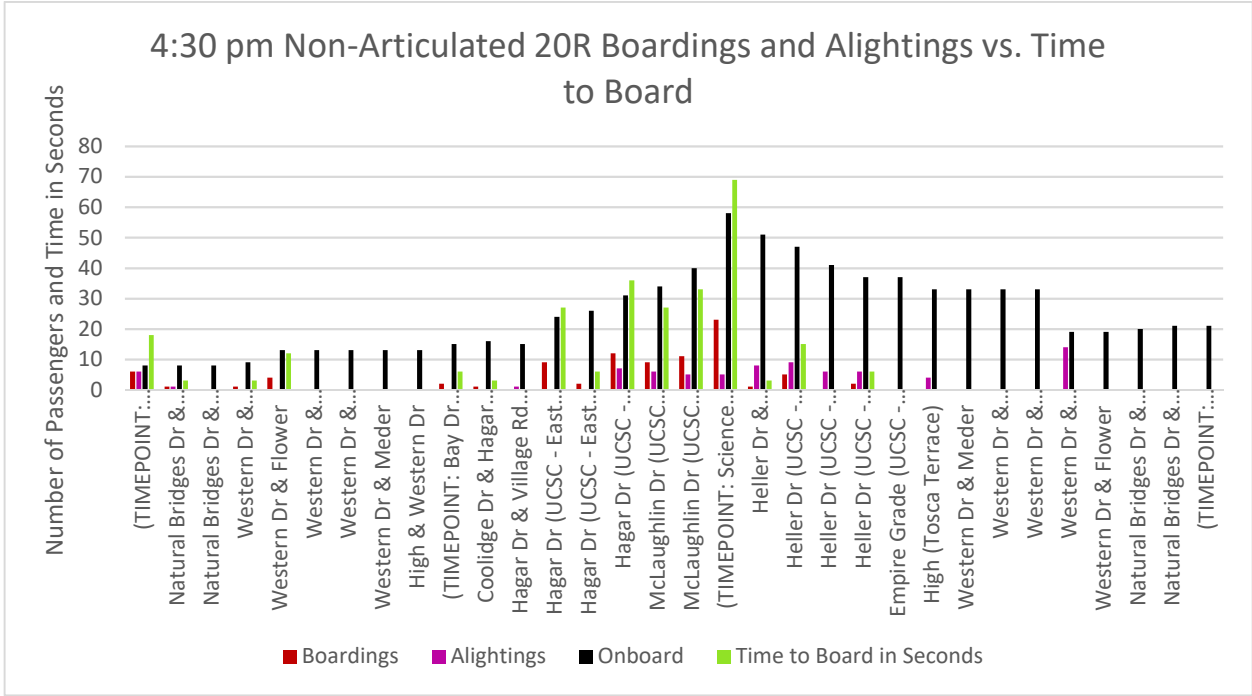

Figure 12. Number of Passenger and Time in Seconds vs. 4:30 p Arcticulated 20D Boardings and Alightings vs. Time to Board

Recommendations

Schedule Recommendations

- The articulated bus running times should be adjusted to better align with UCSC classes during peak boarding times
- Articulated buses can be used as a supplemental service, instead of running all day, so that they will only be used during peak passenger boarding times.
  - Alternatively, articulated buses could potentially be used as UCSC loops instead of Metro buses.

Dwell Time Recommendations

- After all cameras are installed on articulated buses, introduce all-door boarding in order to speed up dwell time
  - Alternatively, another way to introduce all door boarding would be to use UCSC staff to check IDs on the back door of the articulated bus
- TAPS can send out a PSA insisting all students take the loops when they are only riding the bus for a few stops on campus.
- Another way to potentially speed up dwell times would be to place images of hands pushing the back door to signify how to open the door.

Future Research

- This research should be expanded upon next quarter so that more data can be used to accurately examine the performance of the articulated buses.
  - In the future, more data should be collected on other sources of delay that may contribute to slow dwell times.
  - Additionally, an online survey should be created for articulated bus riders so that more information can be used to examine the performance of the buses.

References

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Appendix A

In this data, the average ridership for the articulated buses was 57 versus 49 for the non-articulated buses (Figure A1). The median values for the articulated buses were also higher than the values for the non-articulated, 46 versus 43 respectively (Figure A2). When more surveys are included, the articulated buses do have a higher ridership than the non-articulated buses.
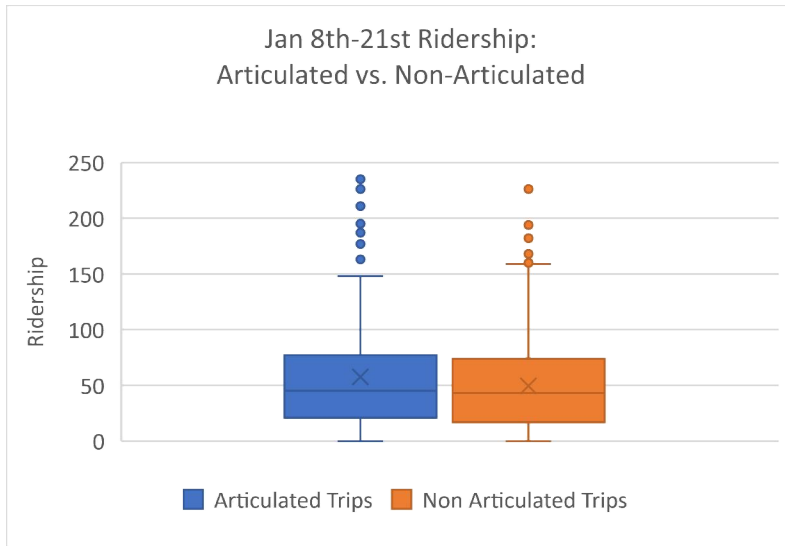

Figure A1. January ridership, Articulated Buses vs. Non-Articulated Buses SCMTD January data

	Articulated	Non-Arc
Min	0	0
Q1	22	17
Median	46	43
Q3	77	74
Max	235	232
Mean	57.63612	49.5692
Range	235	232

Figure A2. Ridership, Articulated Buses vs. Non-Articulated Buses SCMTD January data.

In the Santa Cruz Metro Ridership data, the average Fall quarter ridership for the articulated buses was 63 vs. 50 for the non-articulated buses in the Fall (Figure B2). In Winter quarter, the average ridership for the articulated buses was 64 vs. 52 for the non-articulated buses in the Winter B2). These averages demonstrate that ridership for both articulated and non-articulated buses has slightly increased from the Fall to Winter. Additionally, the median values for both Fall and Winter quarter show the same increase in ridership.

The data also signifies that, in both Fall and Winter quarter, the articulated bus has on average higher ridership than the non-articulated buses (Figure B1). The articulated bus average ridership has slightly increased from Fall to Winter, 63 to 64 respectively. Similarly, the non-articulated bus average ridership has increased from 50 to 52. The overall increase in ridership from Fall to Winter could be contributed to increased student enrollment on campus.
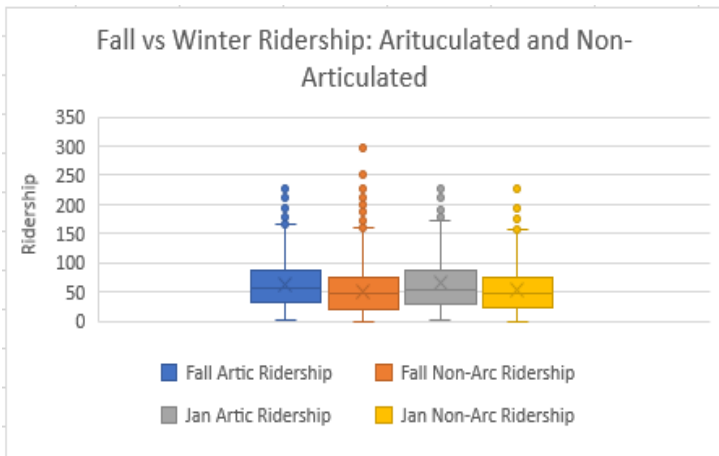

Figure B1. Fall (9/28-10/12) vs. Winter (1/8-1/21) ridership, Articulated Buses vs. Non-Articulated Buses

	F Arc R	F N-Arc R	W Arc R	W N-Arc R
Min	1	0	1	0
Q1	33	19	29.25	22
Median	56	47	53	46
Q3	86	75	87	76
Max	235	297	235	232
Mean	63.58532	50.83746	64.75385	52.3819
Range	234	297	234	232

Figure B2. Ridership, (Fall vs. Winter) Articulated Buses vs. Non-Articulated Buses SCMTD January data.