Strategic Scheduling Opportunities at Portland Community College (PCC)

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STRATEGIC SCHEDULING OPPORTUNITIES AT PCC

INTRODUCTION

Higher educational institutions are trying to keep their tuition affordable while managing costly and aging facilities. District-wide space and resource management have become a key strategy for energy, time, and money-saving in today's financially strapped educational institutions. Maximizing the effort to increase efficiency is a requirement to stay competitive with other institutions, balancing between expenditure and funding without increasing the tuition. In a typical business, up to 30% of energy is wasted, according to the U.S. Department of Energy. That is equal to 17,483,153 kW of Portland Community College's (PCC) total energy consumption and can save $1.748,315; reduce 12,361 metric tons of CO2. This equivalent to 30,673,172 miles driven by an average passenger vehicle. (16)

However, applying specific saving strategies can reduce wasted energy even more. (1) According to Streamside Solutions, by integrating room and HVAC scheduling based on building usage can reduce 20-40% of energy usage by returning HVAC to unoccupied settings between events. Case studies show that adopting such a strategy can reduce energy costs by an average of $0.50 per square foot annually. If adopted by PCC that will save about $1,249,110 districtwide. (2)

This paper explores possible opportunities to optimize scheduling. It starts with a brief introduction to PCC campuses and centers. Then it explores the role of occupancy scheduling in saving time, cost, and energy via aligning the HVAC-setback occupancy schedule, Light occupancy schedule, and Cafeteria Scheduling with the event provider platform. The current status and the process of class scheduling at PCC will be reviewed. Then an analysis of the importance of optimizing class scheduling via analyzing space

utilization, utilization, and demand over time, demand over time, and room vs. seat utilization.

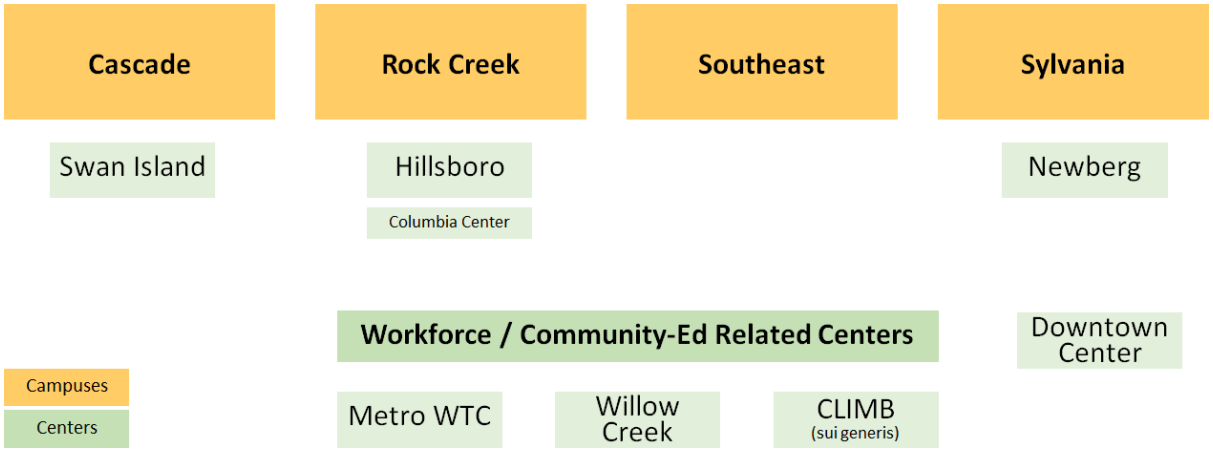
Afterward, it demonstrates the process of shutting down the college and its role in saving time, energy, cost, and the lifespan of the equipment. From that, it draws the path to a centralized scheduling platform which is the backbone of strategic scheduling. Lastly, it presents the final recommendations and required actions to achieve strategic scheduling opportunities.

The main goal of strategic scheduling, in addition to saving time, money, and energy is to make more spaces available, leading to more efficient use of space, increase Facilities Management Services (FMS) staff productivity, and align with PCC's Climate Action Plan goals to reduce Greenhouse Gas emissions (GHG). Strategic scheduling also aims to increase student's enrolment and maximize events generating revenue by outside organizations and visitors.

PCC's CAMPUSES AND CENTERS

PCC consists of four campuses (Cascade, Rock Creek, Southeast, and Sylvania) and eight centers (Newberg, Hillsboro, Swan Island, Metro, Willow Creek, CLIMB, and Downtown, and Columbia Centers). The Downtown Center has only one classroom and offers a limited number of courses, Columbia Center has only one course, while the other six have significant activities. Figure 1 describes the relationships among campuses and centers. The instructional spaces at the campuses and their affiliated centers' host credit classes and other instructional-based activities. While CLIMB, Portland Metro, and Willow Creek function more independently. Types of activities vary widely and include credit and non-credit classes, workforce training activities, community education and other community-based events, administrative meetings associated with PCC, and a range of other activities.

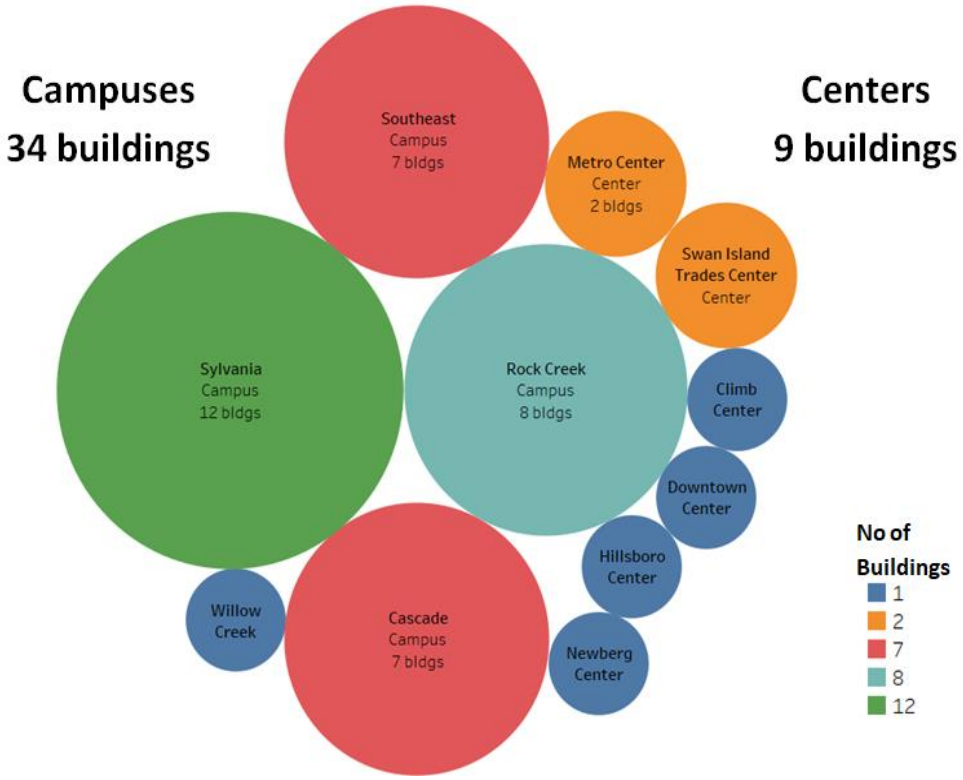
Figure 1. Relationship of Campuses and Centers



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure 2. shows Buildings by Campus and Center. There are 34 buildings with instructional spaces on the 4 campuses; and 9 buildings across the 7 centers.

Figure 2. Buildings by Campus and Center



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

STRATEGIC SCHEDULING OPPORTUNITIES

Because of the complexity of this project this part was divided into three sections, each section has its own goals and benefits:

I. Occupancy Scheduling
II. Optimizing Class Scheduling
III. District-wide shutdown

SECTION I: OCCUPANCY SCHEDULING

Occupancy scheduling, defined as the system will operate only if the zone/rooms are occupied.

The main goal of occupancy scheduling is to save energy, money, resources, and reducing the carbon footprint. Savings can be demonstrated through:

1. Integrating room and HVAC scheduling based on building usage can reduce 20-40% of energy usage by returning HVAC to unoccupied settings between events. This is equivalent to:
    a. 11,655,435 kW-23,310,871 kW
    b. $1,165,543-$2,33,1087
    c. 8241-16481 Metric Tons of Carbon Dioxide Equivalent, about 13-26% of PCC's total carbon emissions.

    Case Study: Western Carolina University saved about $23,110 with the 28,444 square feet controlled by spending $5,013 on the Events2HVAC software, with the return of investment (ROI) in only two months. If PCC controlled the total of its 2,486,843 square feet, it can save about $2,020,494. (9).
2. Cafeteria scheduling will add extra savings by integrating dining scheduling with resource management to reduce food waste and optimize other resource usages.

This section has three components:

i. HVAC-setback* occupancy schedule

ii. Light occupancy schedule

iii. Cafeteria scheduling

i- HVAC-setback* occupancy schedule

Setback: when a building temperature is lowered from 70-75 degrees to 50-55 degrees during holidays, weekends, or when buildings are not occupied.

Heating or cooling should be scheduled only when spaces are occupied. When no events/classes are being held the HVAC system should be set back to 55°F. Integrating room and HVAC scheduling based on building usage and using a centralized web-based platform campus-wide will save energy from heating and cooling. Having all schedules posted on the same platform will facilitate the programming of the HVAC system to shut down when space is not occupied. Having all schedules posted on one platform, along with an automated data analytical system that gives real-time recommendations will best utilize the space/building to eliminate energy waste and increase efficiency.

Case study: The University of North Carolina Chapel Hill saved 33.13% electricity on cooling and 16.69% electricity on heating in a specific space when they integrated their scheduling platform with Johnson Controls MSEA Interface using Events2HVAC software to operate the heating and cooling only in occupied spaces. (10)

PROBLEMS AND SOLUTIONS

To optimize the efficiency HVAC occupancy schedule, PCC needs to address these problems and consider possible solutions:

A. Problem: Several buildings are not equipped with the BAS operating platform, and few buildings are divided into zones.

Solution: Making sure that all new buildings are equipped with a BAS. Also, allocate a budget for building renovation and make sure that each building is divided into zones to optimize the HVAC schedule. HVAC zoning creates customized temperature zones throughout the building and increases efficiency. Having a building without BAS that contains multiple HVAC zones will result in an inability to automatically customize temperature by rooms. Also, the HVAC system operates throughout the entire building and results in energy loss even if the building was unoccupied. Overall, the HVAC zoning provides better control over energy consumption throughout the building as well as helping to avoid heating or cooling empty rooms, saving energy and money, and increasing air quality and comfort.

The primary function of BAS is to monitor heating and cooling demand and usage. According to Intel, the deployment of traditional BAS costs between $2.50-$7.50 per square foot. However, the return on investment will take up to four years to recover. BAS can save 0.20 - 0.40 cents per square foot. (3) Creating a benefit-cost analysis of upgrading older buildings to be equipped with the BAS operating platform can help to facilitate making such decisions.

B. Primary room schedulers each week send a scheduling report to the HVAC manager and he makes sure to update the HVAC scheduling manually. PCC's room scheduling and HVAC scheduling operate independently. The FMS HVAC scheduler downloads the schedule from Live25 and coordinates with PCC's schedules manually. The FMS team spends hours manually entering the HVAC schedule to align with building schedules. Also, there is a lack of coordination between the event planners and the FMS HVAC scheduler.

Solution: use event automation software such as EVENTS2HVAC (Johnson Controls MSEA Interface). EVENTS2HVAC is a software application, serving as a linkage between

room schedules and HVAC schedules, it is a robust interface between scheduling tools like 25Live and the district's various BAS operating platforms. Events2HVAC takes room scheduling/reservations and translates the BAS operating platform to a setback or turn on/off HVAC systems. Avoiding heating, cooling, and lighting empty rooms and running systems only in rooms that are occupied will save energy and money. For more information about Events2HVAC see Figure A1, A2, and A3 which explains how Events2HVAC works. Also, see the benefits and features of Events2HVAC software in Appendix B.

Case study: In 2014 University of North Carolina Chapel Hill decided to automate their schedules by adopting Events2HVAC software. This adoption integrated space schedules and HVAC schedules by getting data from the event scheduling platform and sending commands to buildings' automation systems, HVAC controls, and security systems to automate space conditions per scheduled use. The results of syncing space scheduling platforms and Events2HVAC to one-third of the total rooms of the *Frank Porter Graham Student Union at the University of North Carolina Chapel Hill* increased the efficiency of the HVAC system and saved $10,000 in an eight-month period (see Figure A10 in appendix D) While Minnesota State University Moorhead saves 45-55 cents per square foot; $1 million in savings per year by using Events2HVAC. (6)

C. Problem: Some old buildings do not have a compatible HVAC system with Events2HVAC.

Solution: Hardware upgrades or add-ons to the HVAC control system to these buildings will do the job. To determine if any hardware upgrades or add-ons are needed and estimate the cost, contact Tonya Russell, Streamside Solutions, Sales & Marketing Manager, trussell@streamsidesolutions.com, (970) 237-4382.

D. Problem: Unexpected change in the building schedule

Solution: Syncing scheduling platforms with Events2HVAC will make any unexpected changes in building schedules automatically.

E. Problem: Schedulers are not familiar with the HVAC zoning layout.

Solution: Provide schedulers with HVAC zoning maps that can help them book spaces that are in the same zone. For example, in Building 2 on the Rock Creek campus the rooms 117, 117E, and 129 are in one zone (zone A) while rooms 108, 110,111,114, and 115 (zone B) are in another zone. If three classes are needed to be scheduled on the same day it is better to schedule the classes in zone A, instead of zone B since there are more rooms in zone B and it is required more energy to operate the HVAC system. The total square feet of the zone need to be considered as well.

Consider asking 25Live developers to build features to the software that make the Optimizer runs to fill location based on their HVAC zone. HVAC zoning creates customized temperature zones throughout the building and increased efficiency. Having a building without BAS that contains multiple HVAC zones will result in an inability to automatically customize temperature by rooms. Also, the HVAC system operates throughout the entire building and results in energy loss even if one is occupied. Overall, the HVAC zoning provides better control over energy consumption throughout the building as well as helping to avoid heating or cooling empty rooms, saving energy and money, and increasing air quality and comfort. See the link to the Google folder for the HVAC zoning maps for all campuses in Appendix E.

ii- LIGHT OCCUPANCY SCHEDULE

According to the United States Department of Energy, lighting in commercial buildings accounts for 20% of energy consumption. Having all buildings equipped with BAS and integrated light scheduling with 25Live using EventsHVAC software will improve the efficiency of the light schedule. (4).

Campuses across the country are installing occupancy sensors, resulting in obvious benefits such as lights that automatically turn off and on, accurately controlled temperature and ventilation, and in general, help create more comfortable rooms with more energy efficiency. There are several rooms and corridors not equipped with light sensors at PCC. The optimal solution is installing occupancy light sensors. However, installing occupancy light sensors district-wide might take several years. Upgrading to LED lighting can save up to 30% of electricity consumption. (5) In the meantime, it is critical to tie the light systems to a scheduling platform to ensure that lights are only operated when rooms are occupied.

iii- CAFETERIA SCHEDULING

Scheduling and resource management platforms can inform the dining service's needs. Integrating the event scheduling platform into the dining schedule to know when to operate and how much food is needed will help to reduce food waste and optimize other resource usages. It can predict the daily potential customers which can minimize food waste and determine the required number of foodservice staff per shift. Using the web-based master planning system, X25 can facilitate the prediction of such future trends.

SECTION II: OPTIMIZING CLASS SCHEDULING

Objective:

Classrooms are one of PCC's most important and scarce resources. Space management is one of the most challenging issues facing PCC. The main goal of optimizing the class schedule is to save energy, money, and reducing the carbon footprint. Along with increasing student enrollment and maximizing events generating revenue by outside organizations and visitors.

BACKGROUND

EVENTS AT PCC

"Events" is a term that refers to two categories:

1. "Formal Instruction" for academic credit. Unlike "Other Activities and Events" it has a Course Record Number (CRN) code, except for Portland Metro, some events have CRN "Formal Instruction" is split into:
    a. "Classroom-Based Instruction", in-person at all times,
    b. "CLWeb", hybrid classes, some portions held on-campus, and some online.
    c. "WEB Classes", distance learning.
2. "Other Activities and Events":
    a. Non-credit classes
    b. Workforce-related training activities
    c. Continuing education activities
    d. Tutoring sessions
    e. District meetings
    f. Student group meetings
    g. Meetings sponsored by external organizations
    h. Other

LOCATIONS AT PCC

Any event at PCC is associated with:

- "Physical Locations", the actual classroom, or space.
- "Administrative Locations", effectively the "campus of record", indicates the administrative responsibility for the event. Any event might occur in a physical location such as Rock Creek Campus and might be affiliated with another campus's administration such as Sylvania.

ROOMS AT PCC

PCC has a wide range of room types, including:

- General-purpose classrooms (seminar spaces, classrooms, lecture halls, auditoria)

- Special Purpose Room/Teaching Lab (biology or chemistry labs, studio spaces, video conferencing) Those spaces are not readily adaptable to other instructional functions.
- Computer labs, instructional spaces equipped with computers, printers, specialized software, etc.
- Studios and other specialty spaces
- Conference rooms
- Other unspecified rooms

EVENTS-RELATED SOFTWARE AT PCC

PCC uses two software programs for recording information about activities occurring in instructional spaces:

1. Banner software (a student information system), only contains formally scheduled courses and has CRN codes, all non-credit / non-course activities do not have CRNs and are not recorded in Banner.
2. Series 25 products, a scheduling and event management system by CollegeNet. Series 25 products include Schedule25 (S25), R25 software, and 25Live used for scheduling and tracking courses and events. The college already started to migrate to 25Live to schedule academic courses, however, several campuses are still scheduling academic courses via R25 and S25. Some campuses have shifted to 25Live to schedule non-course events.

   Non-credit / non-course activities are recorded using the software. Note that not all of them are recorded in the system. However, CollegeNet offers a 25Live, cloud-based system, that is gradually replacing S25 and R25. The biggest issue is that Series25 products are not used district-wide. Series 25 offers another product that is not used by PCC, it is called X25, a web-based master planning system that provides graphs and analytic data to identify and correct inefficiencies in your space allocation.

The data can help PCC to make informed scheduling decisions and ensure the effective allocation of buildings and classrooms.

The biggest issue with X25 that it is not built into the software and schedulers or data analyst will have to examine the data to make predictions. However, using this data can inform the algorithm used by the Schedule25 Optimizer (commonly known as the Optimizer), to optimize energy saving. The Optimizer algorithm plays a great role in maximizing the number of placements, space utilization, and organizational satisfaction with placements when placing events. However, the Optimizer algorithm does not have a built-in algorithm that optimizes energy-saving and integrates the HVAC zoning map to it.

CURRENT STATUS OF CLASS SCHEDULING AT PCC

The size of PCC and its various campuses and centers hinder allocating responsibilities for managing and scheduling classrooms. Classrooms (“Formal Instruction” for academic credit) are scheduled in the 25Live scheduling platform by Room Schedulers except for some computer labs, teaching labs, or other special use space. While other rooms are fully controlled by a department’s “Division Schedulers”, they are responsible for scheduling specific physical locations for “Other Activities and Events” in their department and those are not scheduled in the 25Live scheduling platform. There are two types of Live25 users:

- “Requester”, the person who requests space reservation via Live25. Any faculty, student, and staff can request physical locations.
- “Scheduler", the person who approves the requester’s space reservation request. Room schedulers are the only one who approves the request.

Giving “Division Schedulers” the privilege to be “Scheduler" (in Live25) for specific rooms that they already control in their department is an important step toward using a

centralized scheduling platform. 25Live gives the option of having a default scheduler, in which one person is responsible for a specific space, or an office scheduler in which more than one person is responsible for that space.

THE PROCESS OF CLASS SCHEDULING AT PCC

The scheduling timeline starts with the rollover done a year before. The faculty department chair receives the schedule along with the administrative assistants, then the administrative assistants work in Banner to ensure that all classes are entered properly, and the rollover is done correctly. Then, the “Blackout” occurs, all the classes entered into Banner are turned over to the campus primary schedulers and they schedule any remaining classes in unused time slots. During the “Blackout” the Instructuioal Admstartive Assistant (IAA) is not allowed to touch the classes for one week. This transfers the control and management over class schedules from the division schedulers (IAA) to the primary room schedulers. Admins of different departments give rooms to schedulers credit and noncredit classes, then the Programmer/Analyst II, Mark Wilson, takes the information from Banner and transfers it to 25Live.

The Optimizer reads the input data that describe locations and classes, builds a model of this configuration in memory, and then quickly assigns where the events should be placed. And then the classes get scheduled. Some classes have priority classrooms in which they get assigned rooms because it has the required equipment, while general-purpose classrooms have no priority. During the blackout time, schedulers take everybody's information and verify that all classes are in the right space and there are no issues. The majority of classes are scheduled from 10 am-2 pm (prime class time) and the scheduler makes sure that all classes are placed in the preferred times. Many classes do not fit in the prime class time. Administrative assistances give schedulers a list of preferred classes in the priority rooms and a list of the orphan classes, classes that do not fit in their priority scheduling room. The

orphan classes occur when the department has used all the space they want. The biggest issue is that instructors prefer to teach between 9:00 am - 2:00 pm, Monday-Thursday.

The scheduler then puts the orphan classes in the empty general-purpose classrooms. After all credits (including ABE, GED, and pre-college program, future connect, and link) get scheduled by the room scheduler, the community education classes get scheduled. Then the room schedulers send whatever classes that do not fit the IAA, offering them a different time. Then the negotiation process starts. See Figure A12. for more information about typical event placement and the assignment process.

i- SPACE UTILIZATION ANALYSIS

Data from the PCC Space Utilization Analyses were used from the Facilities Plan Technical Reports. It will focus on formal instructional academic activities since they have been recorded in the Banner system and are scheduled (or at least recorded) in the 25Live scheduling platform, like non-academic events, which do not have consistent and systematic ways to record these events district-wide.

ROOM INVENTORIES, COURSES, AND SECTIONS

The schedulers at PCC provided data for the academic year 2016 (Fall 2015 and Spring 2016), however, Fall 2015 data were used in analyses because of the heavier volume of scheduling activity in comparison to spring.

Only instructional classes with physical meetings are included in this analysis. Only the rooms that have at least one section meeting in the Fall term are included in the space utilization analyses. (See Figure 3)

There was an inconsistency between the set of rooms included in the room inventory (master room database) versus rooms in the course database (rooms that included a course). The room inventory database has 396 on four campuses; the course database included 474 rooms. Only 360 rooms were included in both the course and room databases.

Figure 3. Comparison of Full Course Inventory vs. Inventory for Utilization Analyses.

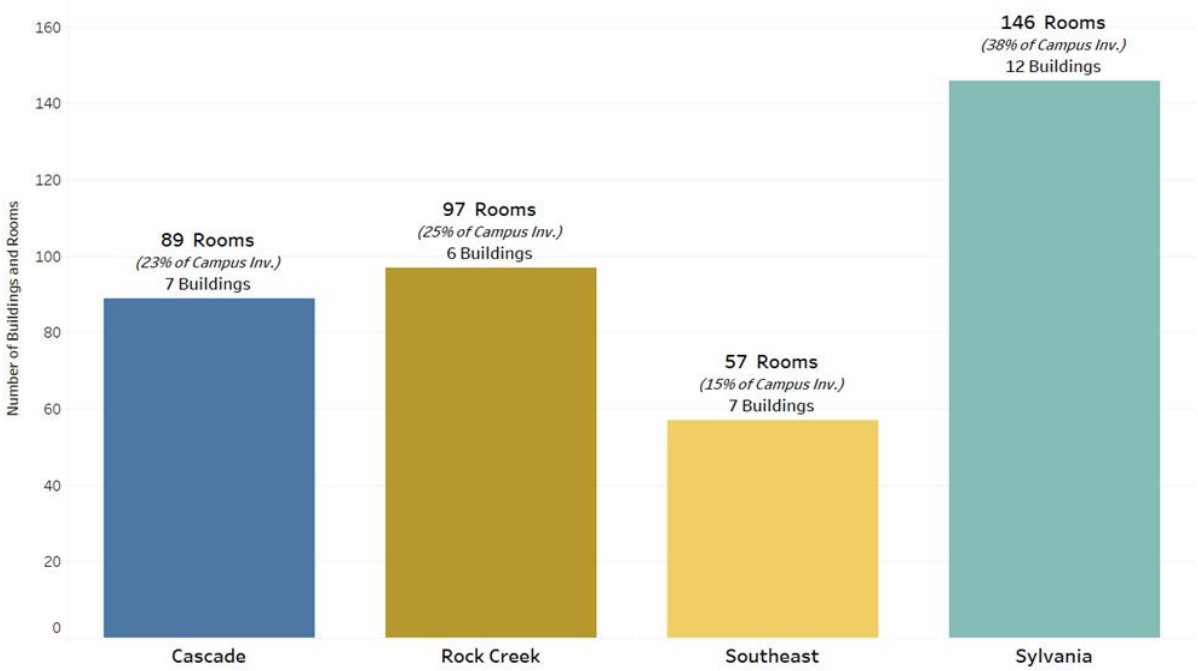
Room Type	Rooms [1] Full Course Inventory	[2] Scheduled in Fall Term Only		[4] = [3] - [1] Difference (Full vs. Fall)
		No.	Pct.	
General Purpose Rooms	195	186	48%	(9)
Computer Labs	38	37	10%	(1)
Special Purpose / Teaching Labs	128	111	29%	(17)
Unspecified	113	55	14%	(58)
Total	474	**389**	100%	(85)

Note: Biggest reductions are in (1) special purpose rooms in Sylvania, and (2) unspecified rooms in Cascades and Rock Creek.

Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

In Fall 2015, 389 rooms were scheduled on the four campuses for "Classroom-Based Instruction". Sylvania campus had the largest inventory 38% of the four-campus inventory, Rock Creek 25%, Cascade 23%, and Southeast 15%. (See Figure 4)

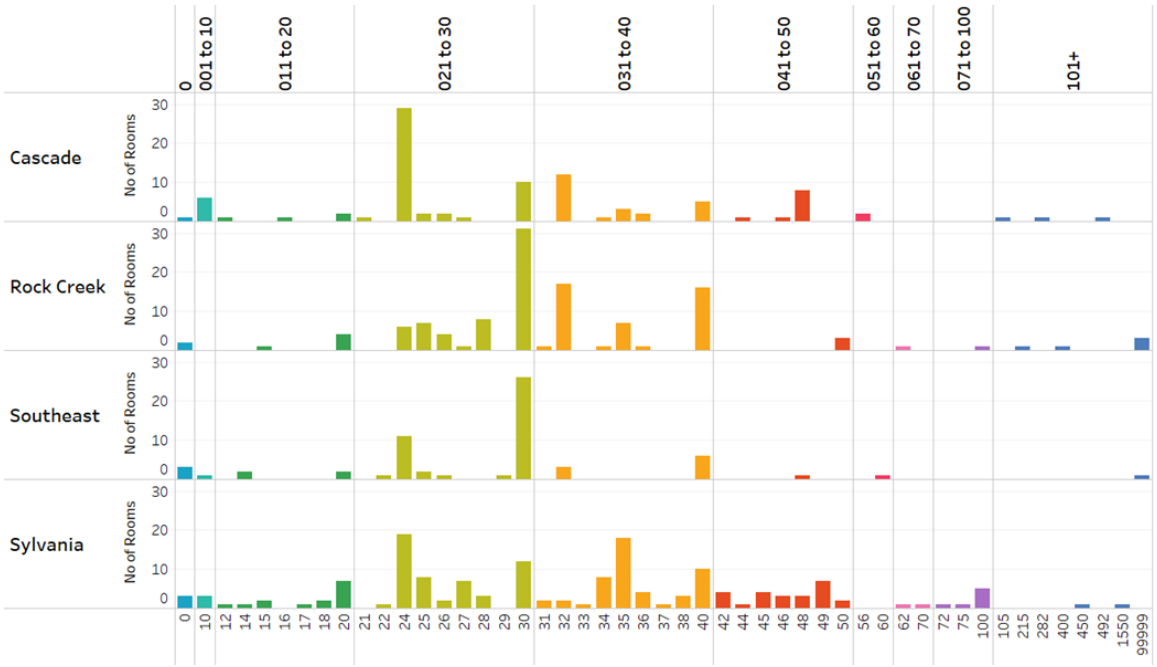
Figure 4. The Fall Inventory



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure 5. Shows Room Distribution by Seat Capacity and Campus. The majority of rooms on all campuses have between 20-30 seats. The second-highest percentage of rooms has 30-40 seats, while there fewer rooms have either 10-20 or 40-50 seats. More than 50 seats are even smaller.

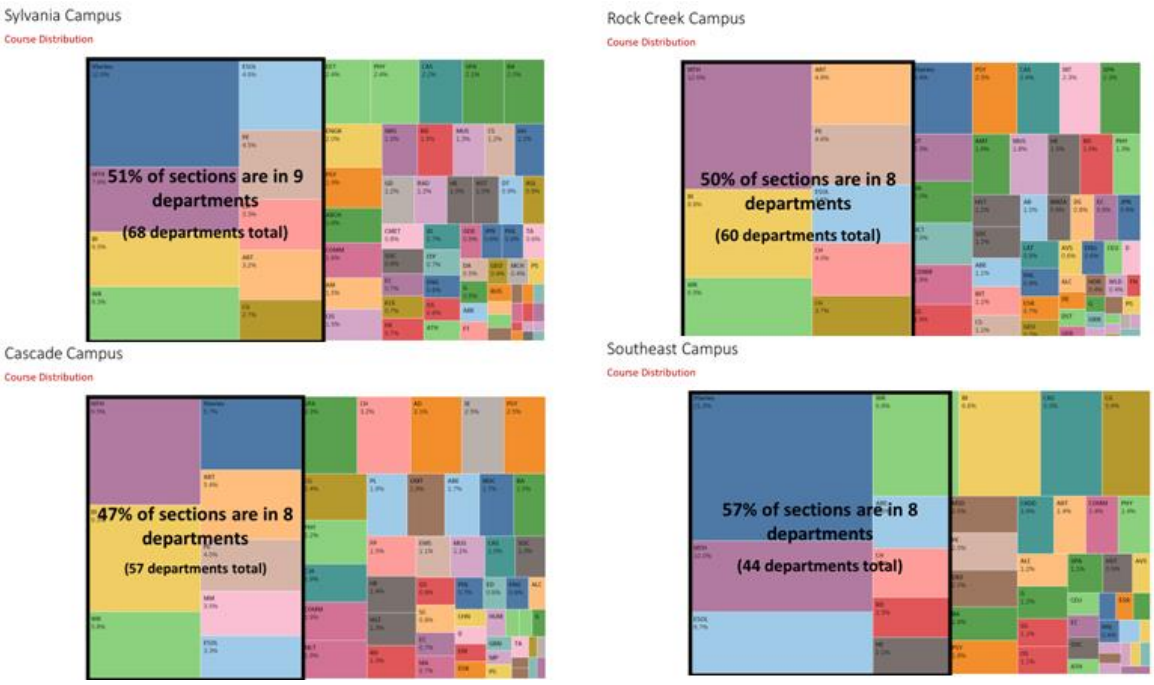
Figure 5. Room Distribution by Seat Capacity and Campus



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure 6 can influence which department should PCC start with to optimize space utilization. Since it shows that eight departments at four campuses account for about 50% of sections.

Figure 6. Percentage of Sections by Department at Each Campus



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

UTILIZATION, AND DEMAND OVER TIME ANALYSIS

The main focus for this section will be to analyze room utilization, seat utilization, and supply vs. demand across all campuses and centers. The analyses will evaluate the room and seat utilization, and how the existing supply of instructional space responds to the demand.

ROOM UTILIZATION

Room utilization determines the frequency of a room being scheduled during the week; it measures the percentage of available room hours that a room is used for instruction. Ideally, rooms would have high room utilization.

Figure 7 represents the summary room utilization for all rooms (general-purpose, computer labs, special-purpose / teaching labs), and general-purpose rooms for four campuses during two different periods 8 am to 5 pm and 5 pm to 10 pm. Utilization rates are reported to three groups: four-day week (MTWR); Friday; and Saturday.

Room utilization from 8 am to 5 pm during the four-day week is about 50% or more for all campuses; while “general-purpose rooms” is higher than “all rooms” since “all rooms” include space that is allocated courses such as computer labs, special-purpose / teaching labs.

Having this limitation on the ability to schedule these classes by general-purpose rooms creates a big obstacle toward optimizing class schedules. Those spaces are owned and should be controlled by the college. The idea of owning the space by the department and the limitation that it can create might decrease enrollment since classes are scheduled by departments considering instructors' preference, not students' needs.

General-purpose classes are the most flexible and can play a major role in optimizing class schedules. This flexibility can allow schedulers to move them around and facilitate

choosing the optimal space, unlike computer labs, special purpose/teaching labs which have more restrictions on their physical space.

Room utilization is lower on Fridays and Saturdays. This is expected since there is a national trend in having classes in two sections a week, either MW or TR, while Friday and Saturday "Other Activities and Events" occur. Overall, the analyses show that room utilization is good across all campuses between 8 am and 5 pm from Monday - Thursday. Room utilization on Friday and Saturday is low for four campuses and affiliated centers. (see Figure 7 below).

Figure 7. Overview of Room Utilization

Overview of Room Utilization

Campus		All Rooms 8am to 5pm	All Rooms 5pm to 10pm	General Purpose Rooms 8am to 5pm	General Purpose Rooms 5pm to 10pm
Cascade	MTWR	48%	33%	55%	33%
	F	22%	24%	20%	24%
	S	21%	8%	21%	8%
Rock Creek	MTWR	58%	39%	69%	41%
	F	21%	20%	19%	22%
	S	27%	3%	24%	3%
Southeast	MTWR	51%	42%	59%	44%
	F	17%	24%	18%	29%
	S	19%	0%	20%	0%
Sylvania	MTWR	53%	33%	60%	31%
	F	18%	30%	14%	40%
	S	21%	8%	16%	0%

Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

SEAT UTILIZATION

Seat utilization determines the percentage of seats filled per room. Ideally, rooms would have high seat utilization. Figure 8 represents an overview of seat utilization, which has similar parameters and outlines.

Seat utilization is high on all campuses except in the evenings on Friday and Saturday with some exceptions. However, the patterns show a great match between class sizes and room sizes.

Figure 8. Overview of Seat Utilization

Overview of Seat Utilization

Campus		All Rooms 8am to 5pm	All Rooms 5pm to 10pm	General Purpose Rooms 8am to 5pm	General Purpose Rooms 5pm to 10pm
Cascade	MTWR	72%	67%	66%	58%
	F	67%	71%	63%	69%
	S	71%	29%	53%	29%
Rock Creek	MTWR	68%	65%	71%	66%
	F	64%	32%	63%	38%
	S	58%	55%	63%	55%
Southeast	MTWR	72%	68%	78%	68%
	F	63%	66%	74%	77%
	S	70%	0%	70%	0%
Sylvania	MTWR	67%	65%	65%	60%
	F	65%	45%	55%	30%
	S	53%	74%	38%	0%

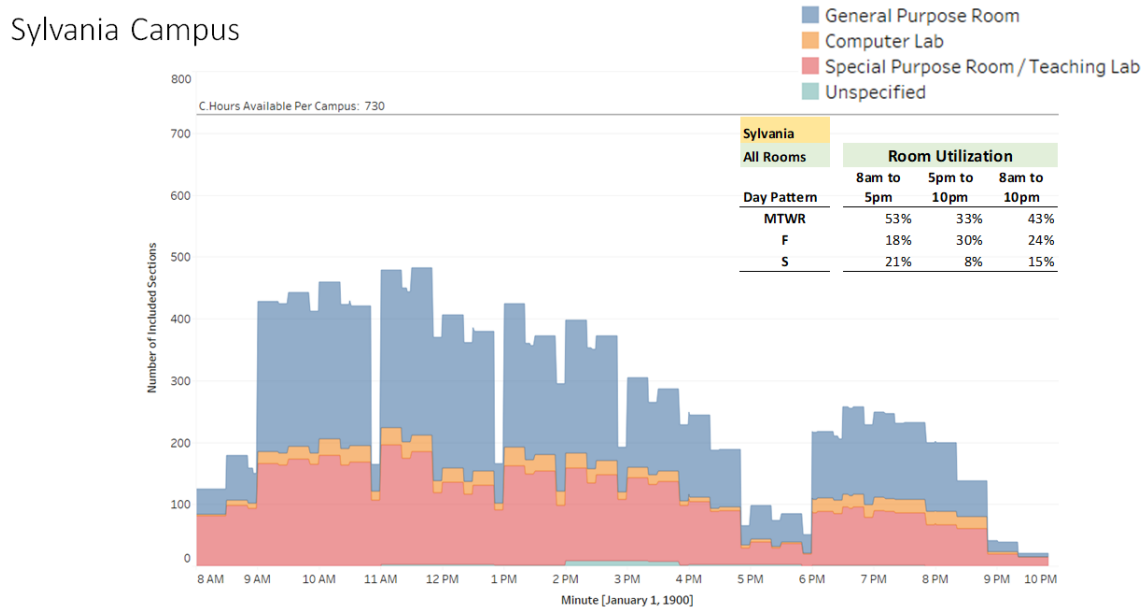
Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

DEMAND OVER TIME AND ROOM VS. SEAT UTILIZATION

This analysis shows periods of peak use and the "unused capacity" to identify opportunities where the campus could schedule more classes or allocate physical space to optimize HVAC zoning usage. Figure 9 demonstrates the demand for overtime for all instructional spaces on the Sylvania campus, with room type (general purpose room, computer lab, special purpose room/teaching lab, and unspecified). It demonstrates the amount of time that is scheduled at each hour from Monday - Friday. To further illustrate demand over time a table shows the room utilization rates for three different day patterns MTWR, F, and S, over three time frames 8 am to 5 pm, 5 pm to 10 pm, and 8 am to 10 pm. In

Figure 9 the scheduling in Sylvania campus reaches its peak from 9 am to mid-afternoon, then it drops with fluctuation in the late afternoon and keeps dropping till 6 pm. The period 9 am - 3 pm has the highest demand over time as well as the highest room utilization since most instructors do not prefer to teach so early or stay late.

Figure 9. Sylvania: Demand over Time: Monday through Friday – All Rooms (146 Rooms)



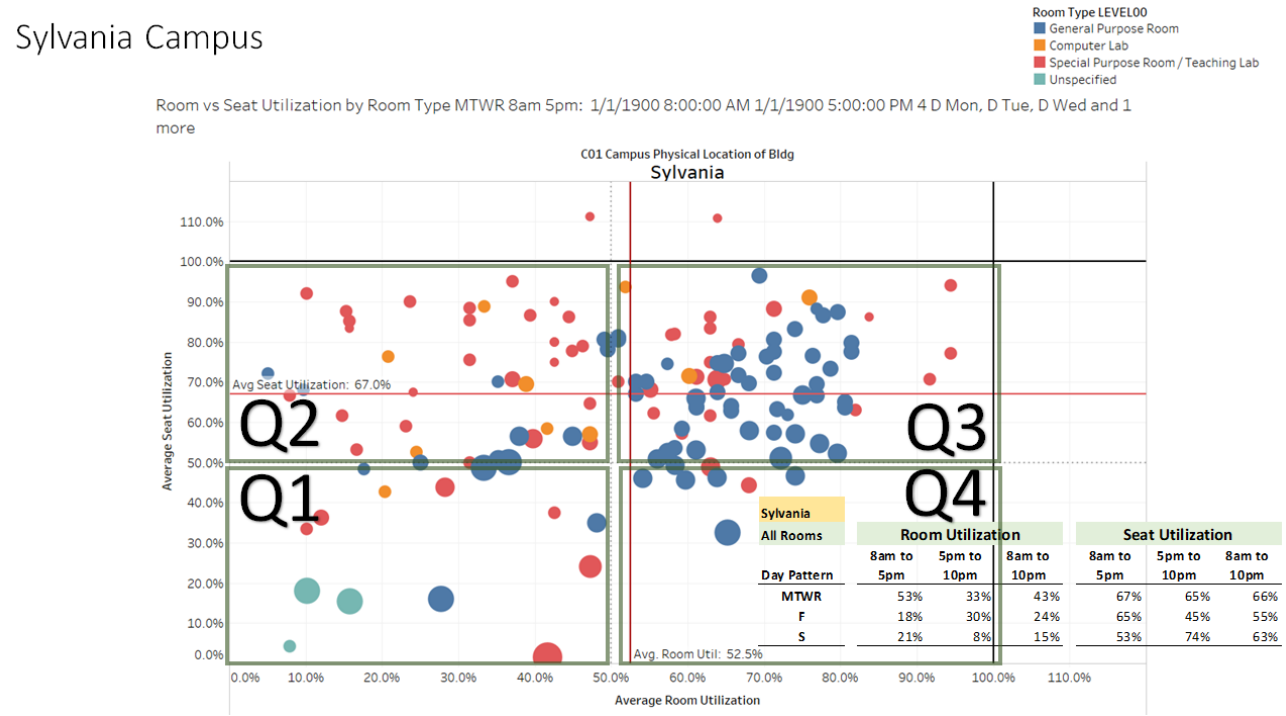
Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure 10 represents the average room utilization versus average seat utilization on the Sylvania campus by room type (general purpose room, computer lab, special purpose room/teaching lab, and unspecified). The size of the dots demonstrates the relative number of seats in the room. While the red lines on the graph show the average room and average seat utilization. Figure 10 divides into four equal quadrants (inside the green boxes):

- Quadrant 1 (lower left): low room (<50%) and low seat (<50%) utilization
- Quadrant 2 (upper left): low room (<50%) and high seat (>50%) utilization
- Quadrant 3 (upper right): high room (>50%) and high seat (>50%) utilization
- Quadrant 4 (lower right): high room (>50%) and low seat (<50%) utilization.

Out of all campuses, Sylvania has the largest number of rooms. Figure 10 indicates that most general-purpose classrooms are in quadrant 3 or 4 which indicates high room utilization, the number of general-purpose classrooms in quadrant 3 is higher which indicates a high seat utilization. Special purpose rooms are mostly in quadrants 1 and 2, however, many have good seat utilization in quadrants 2. See Figures A4-A9 in Appendix C, to learn about the demand over time and the comparison between the room and seat utilization for Rock Creek, Cascade, and Southeast campuses.

Figure 10. Sylvania: Room vs. Seat Utilization MTWR 8 am to 5 pm All Rooms (146 Rooms)



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

GUIDE FOR OPTIMIZING CLASS SCHEDULING

Optimizing class scheduling by organizing classes in a few buildings instead of keeping all buildings operating to reduce energy usage and resources. Optimizing the class schedule is important to make sure that PCC's space is being used as efficiently as possible.

Applying the optimizing class scheduling will result in using fewer spaces for the same number of classes.

Things to consider before booking a space:

1. Provide strategic scheduling training and education to room schedulers, division schedulers, and FMS staff
2. Identify small classes assigned to large classrooms. (Low seat utilization)
3. Provide “Requesters” with the desired resources to ensure rooms are booked based on optimal space usage, not on available resources.
4. Make sure that spaces are being used optimally.
5. Make sure that the booked classes follow one after another instead of having classes with gaps between them; this will optimize HVAC usage.
6. Make sure that “schedulers” use the HVAC zoning map before booking spaces based on the HVAC zone since each zone serves several rooms in some buildings. It will be optimal to book rooms that are in the same HVAC zone. (Contact Elaine Cole, Sustainability Coordinator, elaine.cole16@pcc.edu for a list of HVAC zoning maps)
7. Track critical metrics such as space usage, and cancellations, along with generating automated scheduling reports. It is important to track space utilization and apply the data to improve space efficiency. Without tracking the data, it will be hard to make an informed decision regarding strategic scheduling. Tracking such data will show which spaces are being used the most, or not at all, and that will help to improve space management more cost-effectively. Space and resource management platforms can help assess the efficiency level of rooms to identify how and when PCC’s spaces are being used. Event provider platforms such as EMS Software, 25Live/R25 CollegeNet, Inc., and Ad Astra can help PCC to optimize buildings and room usage. It can identify which buildings or rooms are underutilized. This can help as PCC’s infrastructure

expands by providing an informed choice of whether new buildings are needed in the future or not. (See Appendix A for a List of Event Providers platforms alongside data analytics tools)

8. Sending automatic reminder notifications to users to cancel reservations for unused space can help to decrease the issue of reserving spaces for longer than needed or making reservations in advance to ensure that the space is available even though they are not being used.

SECTION III: DISTRICT-WIDE SHUTDOWN

The main goal of the district shutdown is to save energy, money, and reducing the carbon footprint. These are case studies of saving during the winter shutdown:

- In 2018 Cornell University practiced winter setbacks and saved 1.5 million kWh of electricity and $115,000 saved during the shutdown. (11)
- The facilities services at the University of North Carolina at Chapel Hill in 2019, implemented HVAC control strategies in 75 buildings during the winter break. This effort resulted in saving 7,900,000 kBtus and saved $81,400. (12)
- Western Kentucky University saved $128,340 over winter break, and reduced energy consumption by 1,052,932 kWh by shutting down the campus, for three weeks. (13)

The term “Set Back” refers to set back the HVAC system district-wide from 70-75 degrees to 50-55 degrees in the heating season and from 70-75 to 80-85 degrees in the cooling season.

Along with other practices such as shutting down exhaust fans, reviewing the need for building ventilation, and shutting down all unnecessary ventilation fans Shutdown occurs during the break, summer, holidays, weekends, or when buildings are not occupied.

Buildings and equipment critical to PCC are excluded from this project. To facilitate the shutdown, staff should be offered to telecommute options and vacation time. Critical staff

such as public safety, FMS, and some enrollment services that are required to be on campus should share the same space instead of working in separate buildings.

DISTRICT SHUTDOWN STEP BY STEP

HVAC

- Set back the HVAC system district-wide from 70-75 degrees to 50-55 degrees in the heating season and from 70-75 to 80-85 degrees in the cooling season. (Sean Scorby)
- Identify and document all exhaust fans included in shutdown and those that are not. (Sean Scorby)
- Identify and document all HVAC included in shutdown and those that are not. (Sean Scorby)
- Ensure areas around ventilation units are clear. (FMS Tech)
- Turn off the domestic hot water. (It can damage the equipment, but we can turn the temperature down) (Sean Scorby)

LIGHTING

- Check that all lighting control schedules (time clocks) are working. (Mark Erikson)
- Turn off interior and exterior lights except for exit/security lighting or public safety lights like in a boiler room. (Mark Erikson)

ELECTRICITY AND EQUIPMENT

- Turn off all unnecessary electrical appliances such as copiers, computers, projectors, printers, fax, water coolers, space heaters, and others. (IT responsible for the computers in employee's office, departmental/center responsible for kitchen equipment, FMS can be responsible for other equipment)
- Unplug vending machines.
- Turn off kitchen equipment (Food Service Manager).

- Combine items from all refrigerators into one, while adjusting the temperature setting to lower temperature to unoccupied refrigerators instead of turning them off to avoid mold and energy loss that is required to reoperate them. (Food Service Manager)
- Turn off electric water heaters (Not Possible)
- Turn off heat-generating lab equipment (hot plates, stir plates, ovens, and others) and nonessential electrical devices. (Lab Tech)
- Verify that lab hoods are closed. (Lab Tech)

WATER

- Turn off automatic flushing systems. (No need since it has batteries that are charged by solar energy)
- Turn off drinking fountains. (FMS Tech)
- Check water meters to confirm there are no water usage and no leaks. (FMS or Irrigation Tech?)

THINGS TO CONSIDER BEFORE THE SHUTDOWN

- Send district-wide e-mail to faculty, staff and students. Make sure to include all the identity centers. (Sustainability Office)

- Avoid shutting down the system in the Kennel and Cattery where dogs and cats live, as well as a barn that contains farm animals such as sheep, cows, rabbits, llama, alpacas, and a horse on the Rock Creek Farm. (Avery)
- Ensure you can leave on solar energy while shutting down Rock Creek building 9, Newberg & Willow Creek
- Avoid shutting down the greenhouses/hoop houses at the Landscape Technology Department. If there are experimental animals, power, and ventilation should be turned on.

- Buildings, where Public Safety, FMS, and enrollment services are required to be on campus, will be excluded from the shutdown.
- Inform laboratory staff about the shutdown to secure chemical, biological, and radioactive materials.
- Ensure that freezers, refrigerators, and critical research equipment are kept on.
- Plan for reopening protocol, consider how many hours in advance for each item on the list that needs to be turned on and checked. Verify that unused equipment is still functioning, even stuff that was "left on." Updating drivers.
- Check the equipment that may have been affected by a power disruption. (FMS Tech)

SECTION IV: THE PATH TOWARD A CENTRALIZED SCHEDULING

IDENTIFYING THE PROBLEM

There is no consistent way of recording all events at PCC. Most "Classroom-Based Instructions" are recorded through 25Live. While many "Other Activities and Events" recorded using Outlook, Google calendars, or handwritten records, some are recorded after the event or not formally recorded at all. Also, relying on individual departments to set classroom schedules can create obstacles to optimize space utilization and capacity. Course schedules can impact student satisfaction, graduation rates, and PCC expenditures. Centralizing the classroom scheduling function instead of depending on different departments to set schedules is critical to optimization.

WHY IS NON-CENTRALIZED SCHEDULING A PROBLEM?

1. Lost opportunity in optimizing space utilization
2. Lost opportunity in energy saving
3. Meaningless space utilization analyses, since data are not recorded

4. Lack of space access to event requesters. Since there is no single platform to request all available spaces instead, PPC has many “division schedulers” (other than “Room schedules”) that you can request physical space by either emailing or calling them.
5. Absence of complete information about space availability, since there is no way to know if the space is available unless you contacted the right “division scheduler” in departments.
6. The complexity in the process of booking the physical space and finding the responsible schedulers will lead to lost opportunities in revenue-generating activities.
7. A decline in college enrollment. Since having insufficient data on space utilization, identifying specific performance metrics will fail to fulfill students' needs (scheduling).
8. Difficulties in scheduling because of a lack of information on space use and availability because of the absence of good data at present.

OBSTACLES FOR ACHIEVING CENTRALIZE SCHEDULING

1. 25Live scheduling is updated frequently which might cause some difficulties to users.
2. The staff has an old perspective that 25Live Scheduling is hard to use and will take more time to schedule events. College Net planning to release its 25Live Scheduling mobile app, which can make it easier for schedulers to use 25Live Scheduling. However, 25Live Scheduling already has a web-based phone-friendly version that allows users to search room availability, create an event, and request space and resources.
3. Academic divisions want to “own” the rooms. Rooms should be owned by the college.
4. Giving division schedulers (IAA schedulers) the privilege to be “schedulers” at 25Live (not “requester”) to schedule “Other Activities and Events” will add more

tasks to primary schedulers to track new hires in IAA staff and inform IT to make a change in scheduling privilege.

5. Using 25Live might add more tasks to division schedulers (IAA schedulers).
6. Learning to use new software might be challenging.
7. Some people are opposed to change.
8. Different campuses and different operating times
9. PCC gets rid of all its trainers
10. Some people have been working at PCC for a long time and they are set in their ways.
11. Schedulers prefer requesters to use "syrooms@pcc.edu" when requesting a room instead of using 25Live via so they can have better communication about the details of the requestor any correction.

SOLUTION

The main problem is that PCC's campuses use various event provider platforms (lack of centralization)

Solution: Use a centralized web-based scheduling platform district-wide for scheduling courses, meetings, events, and calendaring. Using a single scheduling platform to consolidate all of PCC's schedules will improve the coordination between event schedulers, academic schedulers, FMS, and Public Safety. This will help facilitate room reservations, increase room availability, and make it easier for academic/event schedulers to optimize PCC's scheduling.

Using a centralized web-based scheduling platform district-wide will save time, energy, and money. There are various scheduling platforms with different benefits; see Appendix A for a list of event provider platforms. As a result, this single-system approach is eliminating time-consuming and costly manual processes. According to the Facilities Forum, 2016 Classroom Utilization, Education Advisory Board, adapting centralized scheduling

increases space availability by 17%. Adopting a centralized scheduling platform will make campus management easier and facilitate communication between various departments allowing them to independently communicate with each other. Having one system district-wide will simplify processes, like catering requests and notifying staff about logistic requests and room needs based on space schedules. The overall result is an improvement in efficiency and productivity since strategic scheduling will save time, improve communications between various departments, and enable staff to accomplish their goals.

Since various events are not booked via event provider platforms, creating a policy that requires courses, meetings, events, and calendaring reservations that occur on campus to be booked through a centralized web-based scheduling platform (25Live) will facilitate alerting different departments to take care of various procedures, event logistics, public safety concerns, HVAC scheduling (space scheduling), and others.

ROOMS AND EVENTS ARE NOT ON 25 LIVE SCHEDULING

1. "Formal Instruction" for academic credit:
    a. Sylvania campus: the library.
    b. Rock Creek campus:
        i. Special labs (e.g., Biology and Chemistry)
        ii. Welding classes (Bldg 2, Rooms 131 & 132, and Bldg 6, Room 110) are essentially open labs.
        iii. Computer Systems Applications (CAS)
    c. Cascade campus
    d. Southeast campus: all classes get scheduled through 25Live, except for the computer labs in the library, conference room at SCOM (sometimes scheduled at 25live, and others on the google calendar by IAA), study rooms at the library, and the events at STEM lab.

e. Centers:

i. Swan Islands Trade Center: The welding shop is essentially a teaching lab, and generally is not formally scheduled.

2. “Other Activities and Events”:

a. Sylvania campus: common / conference rooms in the cafeteria.

b. Rock Creek campus:

c. Cascade campus

d. Southeast campus

SECTION V: FINAL RECOMMENDATIONS AND REQUIRED ACTIONS

i. Centralized Scheduling Platform and Centralize Classroom and Events Scheduling Functions: Adopt a centralized web-based space scheduling platform. This will require all “Classroom-Based Instruction”, “CLWeb”, and “Other Activities and Events” to be booked via a unified web-based space scheduling platform. Making such a step needs to be a top-down approach. To achieve this recommendation PCC need to consider these recommendations:

A. Giving “Division Schedulers” the privilege to be “Scheduler" (in Live25) for specific rooms that are already in their control.

B. Centralize classroom and events scheduling functions instead of depending on different departments to set classroom schedules that can play a great role in improving space utilization and space capacity. Having a unified and consistent approach to recording classes and events will facilitate optimizing class schedules. A centralized scheduling platform will facilitate tracking non-academic uses of instructional spaces since there are no consistent and systematic ways to record these events district-wide.

C. Develop standard nomenclature for each room type to eliminate the inconsistent descriptions of rooms. Having a single comprehensive room inventory database will help in future data analysis.

D. Give event requesters an option to request a space via 25Liven for all physical spaces district-wide to facilitate the process of requesting the space. Instead of having to email departments or meeting in person to reserve a conference room.

E. Embed event request forms to specific rooms in 25Live or create an online form for all “Other Activities and Events”.

F. Ensure meetings/events, that require security access, to be recorded on 25Live even though it is not visible to the public.

G. Advocate for 25Live adoption across all stakeholders

ii. Optimizing Class Scheduling

A. Ask 25Live developers to upgrade the software with customization that makes the Optimizer runs to fill location based on their HVAC zone and prioritizes optimal space usage.

B. Prioritize class schedule based on students' needs and optimal space utilization (save energy), instead of scheduling classes based on instructors' and departments' preferences. Late afternoon from Monday-Thursday, Fridays, and Saturdays have low utilization and many students prefer these times to balance between school and work since more than 70 % of college students work and 40% work at least 30 hours. (14). Making a schedule based on students' needs has great potential in increasing seat utilization at PCC.

C. Make space utilization based on HVAC zoning maps. General-purpose classrooms have the most potential for saving since they have flexibility in their physical locations. As mentioned before general-purpose classrooms

have low room utilization at 8 am and late between 3 pm to 5 pm, Mondays through Thursdays, and even lower utilization on Fridays and Saturdays. However, increasing the room utilization of general-purpose classrooms at times when utilization is low may not be optimal for saving energy. On the other hand, low utilized periods give more flexibility for schedulers to schedule classes in zones that can optimize energy saving.

D. Ensure that spaces are owned and controlled by the college and not by departments. The idea of owning the space by the department and the limitation that it creates might decrease enrollment since classes are scheduled by departments considering instructors' preference, not students' needs.

E. Increase room utilization on Fridays, Saturdays, and late afternoon from Monday-Thursday which can decrease the peak demand during prime class time and can create opportunities to save energy based on space utilization. Making a schedule based on student's needs instead of scheduling classes based on instructors' and departments' preferences has great potential in increasing seat utilization and enrolment at PCC.

F. Make Special Purpose Room / Teaching Lab more readily to be adaptable to other instructional functions rather than having them function as a single type of use. Allowing other classes to be scheduled in the priority classrooms such as “Special Purpose Room / Teaching Lab”, and “computer lab” will help to optimize the class schedule.

G. Optimize the usage of General-purpose classes since they are the most flexible and can play a major role in optimizing class schedules.

iii. Occupancy Scheduling

A. Adopt Events2HVAC, to sync the scheduling platform with the HVAC schedule.

B. Making sure that all new buildings are equipped with a BAS and consider renovation for old ones.

C. Switch to LED lighting district-wide.

D. Install light motion sensors district-wide.

E. Use X25 to predict the daily potential customers to minimize food waste and determine the required number of foodservice staff per shift.

iv. District-Wide Shut down

A. Adopt a step-by-step approach to shut down campuses.

B. Develop a protocol to reopen the campus.

v. Software

A. Events2HVAC is the most essential software to save energy, time, and money. For more information about Events2HVAC see Appendix B.

B. 25Live, the most convincing software to be used as a centralized scheduling platform.

C. EMS Software, explore this software to replace 25 Series. For more information about EMS Software see Appendix A.

D. X25 can generate analysis to help understand how well PCC's space is being used, develop trends, show the effects of possible changes in space supply and demand. Using an automated data analytical system that gives real-time recommendations will best utilize the space/building to eliminate energy waste and increase efficiency.

vi. Training: Provide primary schedulers with strategic scheduling-based training to consider efficient space utilization when scheduling classes.

A. Strategic scheduling-based training to “Room Schedulers” and IAA schedulers

B. X25 training to “Room Schedulers”

C. 25Live training to division schedulers (“schedulers” training)

D. 25Live training to others (“requesters” training)

E. Promote training opportunities to PCC community members

APPENDIX

APPENDIX A. EVENT PROVIDERS PLATFORMS

Event Providers platform is a web-based platform that allows the user to reserve room spaces and manages event details and resources.

Event Providers platforms:

i- EMS Software (for more info click here):

Benefits:

1. Integrate with other building systems. Import facility information and integrate with HVAC systems to automate heating and cooling to save energy.
2. Custom Integrations. Integrate EMS to other software and hardware.
3. Track critical metrics such as space usage, cancellations, group and meeting type, generate automated scheduling reports, and more.
4. Export data for use with other analytics tools to improve strategic scheduling.
5. Identify room utilization to accommodate more events without adding more space.
6. Facilitate collaboration between schedulers and departments or individual instructors.
7. Identify underused and overused rooms.
8. Allow users to view images of the room, floor plan, room capacity, and other features.
9. Filter available rooms by buildings/campus or by available equipment (projectors, monitors, …)
10. Create event logistic requests, catering, or other requests.
11. In addition to making new reservations and viewing current reservations, it allows users to extend or end existing meetings which will work well with Events2HVAC software.
12. Automate the request process for rooms that require approval.

13. Integrates with the most popular systems: PeopleSoft Campus Solutions(ORACLE), Ellucian Colleague, Ellucian Banner, Ellucian PowerCampus, Unit4 CAMS, and Jenzabar CX/EX.

ii- 25Live/R25 CollegeNet, Inc.:

The Series25 offer three services:

- Schedule25: optimize course scheduling
- 25Live: event management and scheduling
- X25: help users with graphical reporting, data warehousing, master planning, and modeling.

Benefits:

1. Provide users from basic, online room requests to detailed event and resource management.
2. The X25 web-based master planning system provides the user with graphs and analytic data to identify and correct inefficiencies, space, and building allocation.
3. X25's Real-Time Benchmarking® comparison analytics make it possible to track your progress and predict future trends.
4. Track critical metrics such as space usage, cancellations, group and meeting type, generate automated scheduling reports, and more.
5. Identify room utilization to accommodate more events without adding more space.
6. Facilitate collaboration between schedulers and departments or individual instructors.
7. Identify underused and overused rooms.
8. Allow users to view images of the room, room capacity, and other features.
9. Filter available rooms by buildings/campus or by available equipment (projectors, monitors, …)

10. Create event logistic requests, catering, or other requests.
11. Automate the request process for rooms that require approval.

iii- Ad Astra:

In addition to the basic online room requests to a detailed event and resource management. Ad Astra provides customers with strategic scheduling evaluation service, onsite assessment, "executive summary and roadmap of influencing scheduling", and supports implementation and assessment of the progress.

APPENDIX B. Events2HVAC SOFTWARE

i- What is Events2HVAC?

According to Tonya Russell, Streamside Solutions, Sales & Marketing Manager, Events2HVAC connects to 25Live via the API. The connection is very simple. It requires a username and password to be set up for Events2HVAC to use with read-only permissions for the room schedules. The Events2HVAC representative will need the URL for the location of PCC's 25Live instance. On the HVAC side, Events2HVAC can send commands through BACnet/IP. E2H includes a BACnet explorer, so an Events2HVAC representative just has to be able to see the BACnet points that PCC wants to control on the network. If it was not visible on the network, additional work may be needed by FMS staff (Sean Scorby, EMS Engineering Specialist) to make them visible. Events2HVAC can either send occupied/unoccupied commands to each BACnet point at the appropriate time, or it can send a 24-hour schedule to a BACnet schedule object if PCC wants to use optimal start in its BAS for some large spaces.

ii- Benefits of Events2HVAC (Johnson Controls MSEA Interface)

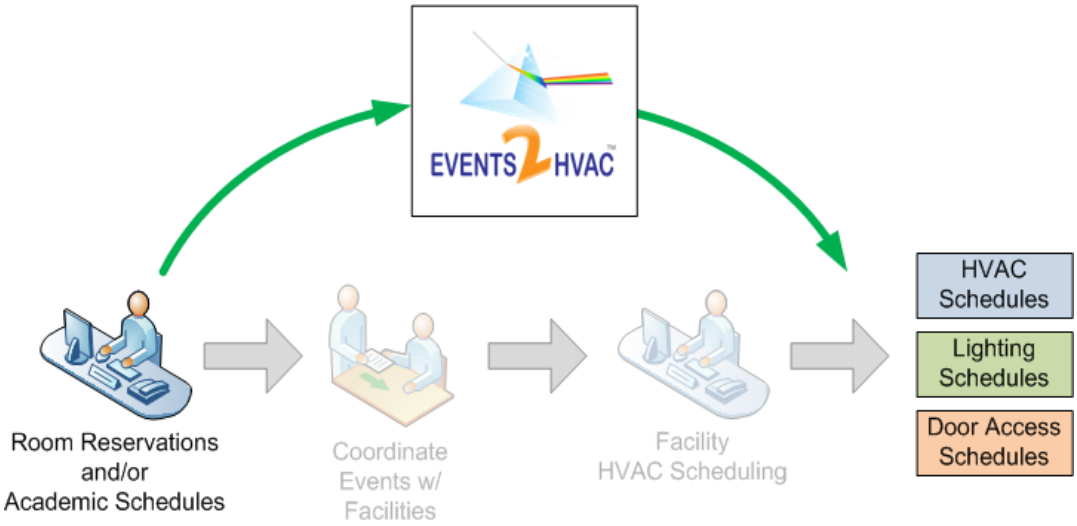
1. Save energy and money: According to Streamside Solutions, adopting Events2HVACit can save 20-40% of energy. $1,300/room annually.

2. Save FMS time by automatically integrating the room and HVAC schedules instead of operating it manually.
3. Automatically schedules to the room level.
4. Eliminates redundant scheduling in the MSEA system.
5. Scheduling of energy is performed by the users of the space, not the facility operators.
6. It allows facility managers to view events directly.
7. Increases the value of your investment in HVAC equipment and event management software.
8. Reduces PCC's carbon footprint and helps to get PCC's building's LEED-certified and move towards a carbon-neutral campus.
9. Increase productivity
10. Flexibility, Events2HVAC can integrate with various event scheduling platforms and BAS operating platforms.

iii- Events2HVAC In Figures:

Figure A1 shows how Events2HVAC can serve as a bridge between room schedules and HVAC schedules. And how improving automated synchronization can save energy and time.

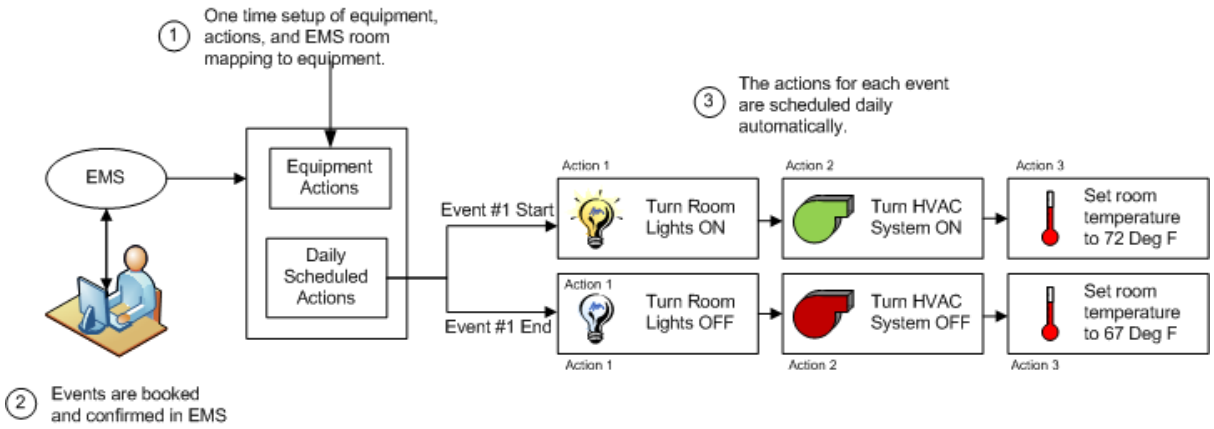
Figure A1. Automated synchronization produces



Source: Streamside Solutions 2020

Figure A2 presents the three key steps of Events2HVAC automation, mapping systems, and rooms, making reservations as usual, and automatically sending commands.

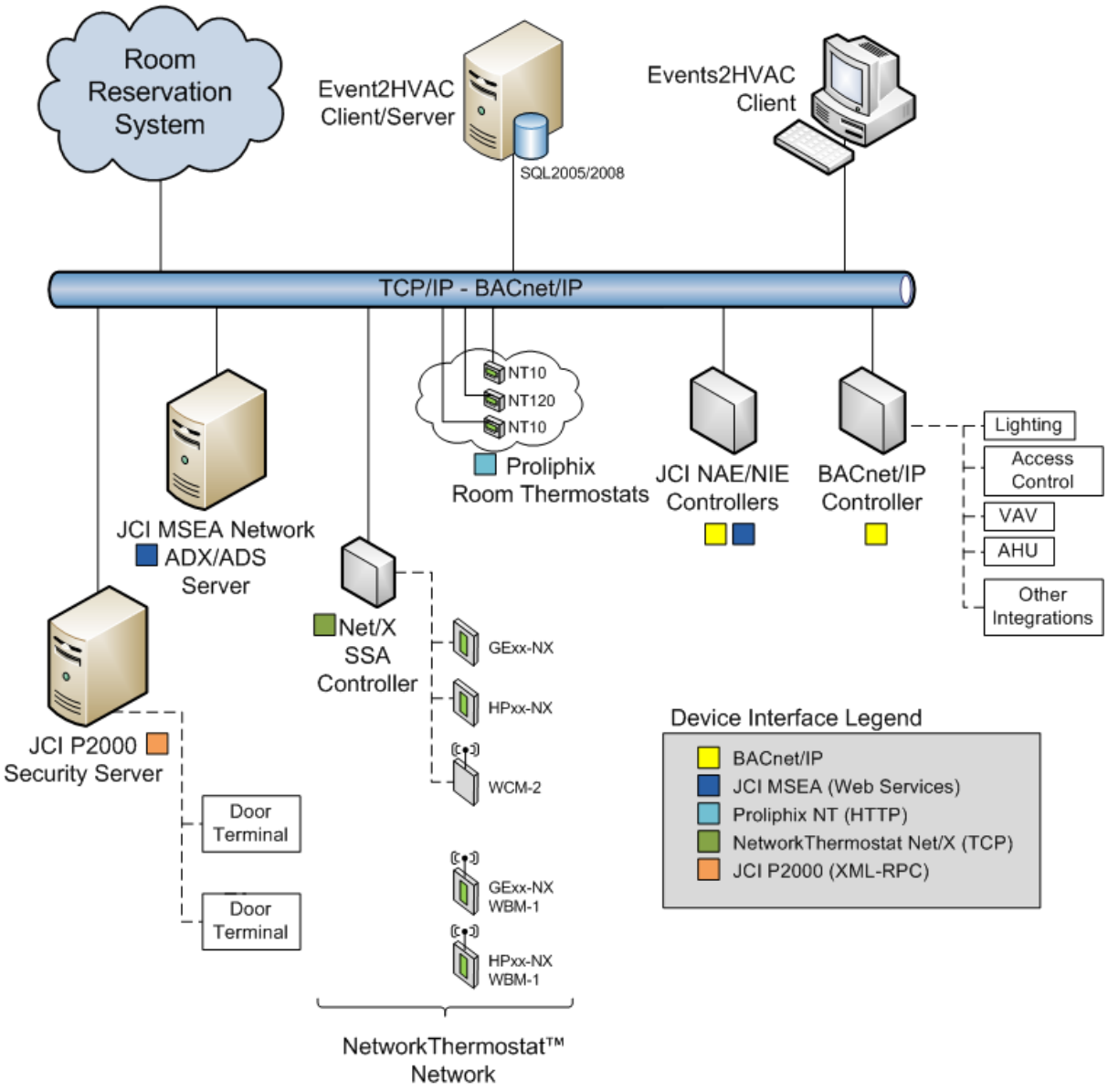
Figure A2. Three key steps of Events2HVAC automation



Source: Streamside Solutions 2020

Figure A3 illustrates how various types of devices can be connected to the system. It can work with several interfaces to different types of devices.

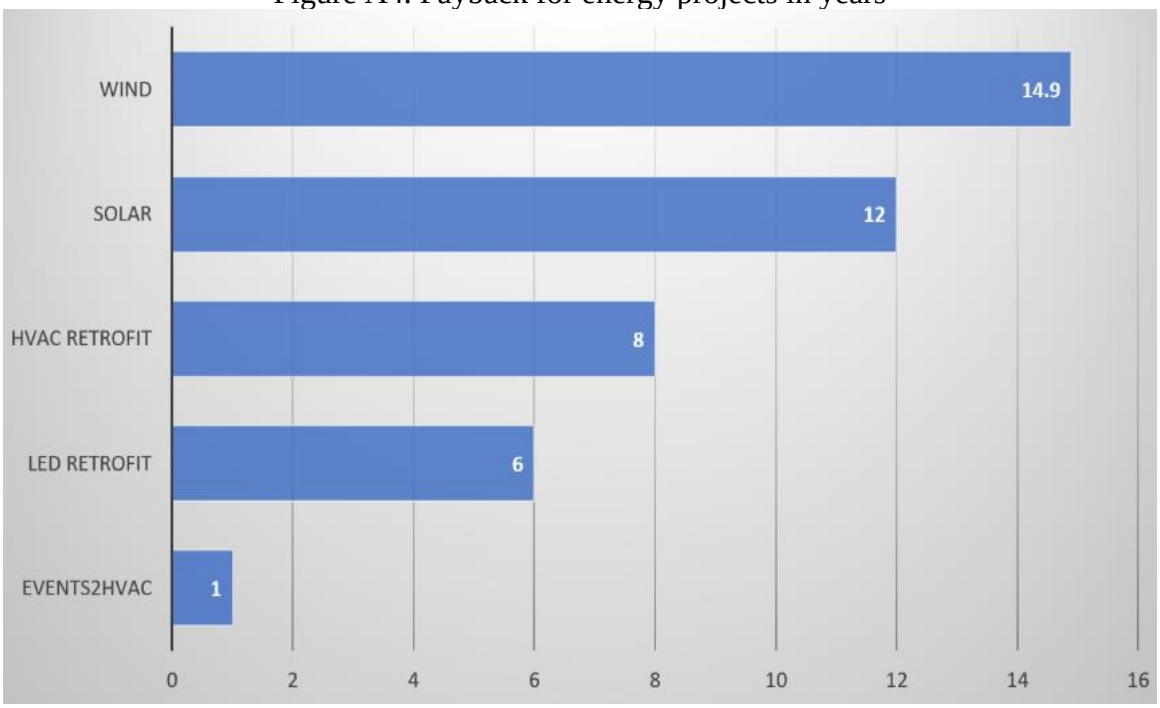
Figure A3. How Events2HVAC works with several interfaces to different types of devices



Source: Streamside Solutions 2020

Figure A4 shows the Payback for energy projects in years. The typical payback period for Events2HVAC is 6 months to 1 year. (15)

Figure A4. Payback for energy projects in years



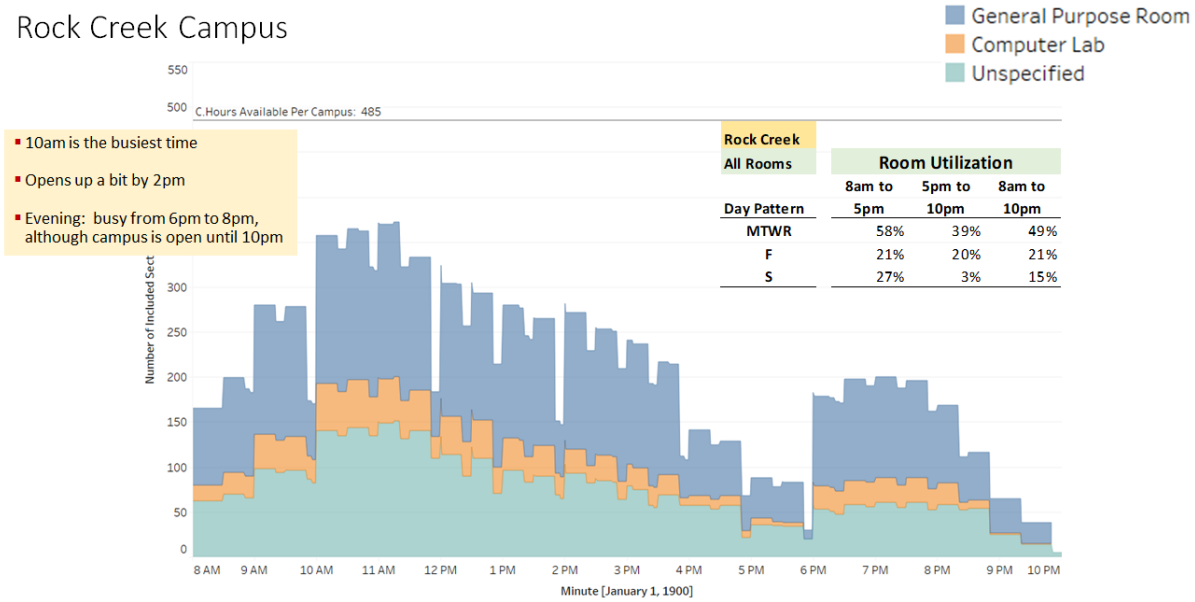
Source: Streamside Solutions 2018

iv- Events2HVAC Features: according to Streamside Solutions, Events2HVAC has these features:

- Flexible Automation: Automates commands for selected equipment, but always preserves control in building automation systems.
- Wide Compatibility: Provides interfaces compatible with many types of HVAC systems, and can control lighting and security too.
- Multiple Actions: Commands multiple actions per equipment and room - can trigger an event start/stop, setup/teardown, or pre-start/post-stop.
- Schedule View: Provides the facility department with a calendar view of event schedules they may not have access to otherwise.

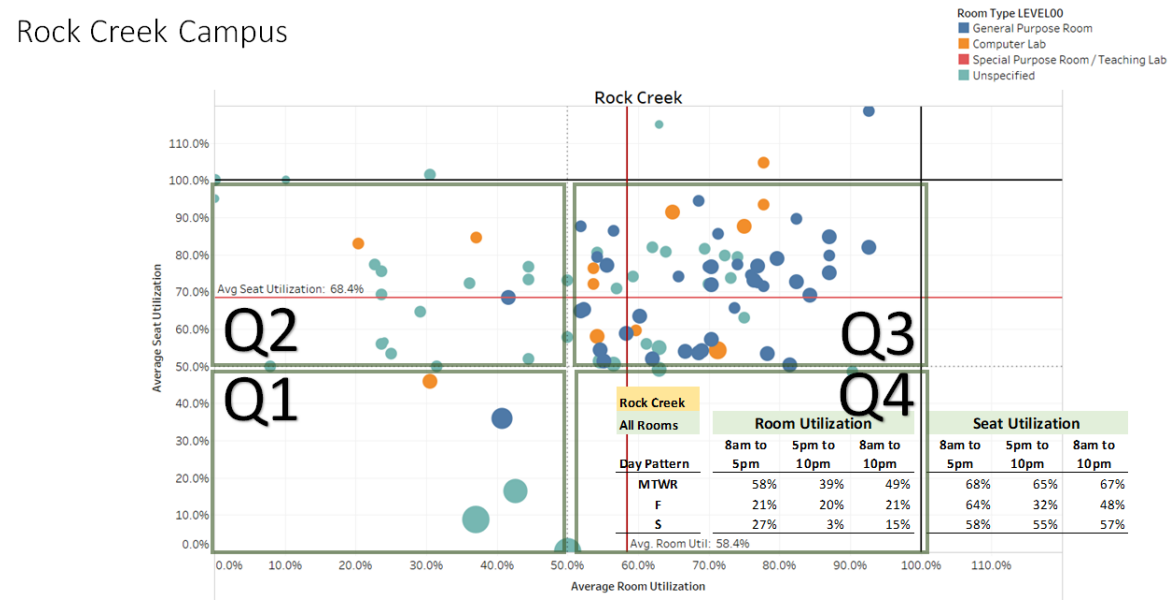
- Daily Reports: Sends daily reports of automated events to users who signup to receive them.
- Email Alerts: Sends email alerts to selected users when a command fails for any reason - network issue, power outage, etc.
- Pre-Start & Post-Stop: Adds optional pre-start and post-stop time so equipment can warm up or cool down before and after events.
- Zone Scheduling: Combines rooms into zones for systems serving multiple rooms or whole buildings so you can start/stop systems on the first/last event of the day.
- Add Rooms/Interfaces: Permits adding rooms or interfaces to existing implementation by uploading a new license to extend the use of the software.
- Multiple Calendars: With a Professional edition, query multiple types of system calendars for a single scheduling source.
- Auto-Sync: On command failures, automatically resync zone state when failure clears.
- Expected Occupancy: Take action based on the expected % occupancy of the room. Adjust HVAC load and/or OA intake.
- Push Schedules: Send daily exception schedules directly to BACnet schedule objects in controllers.
- Security Integration: Lock and unlock doors based on your room/bldg reservation schedules.

Figure A4. Rock Creek: Demand over Time: Monday through Friday-All Rooms (97 Rooms)



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

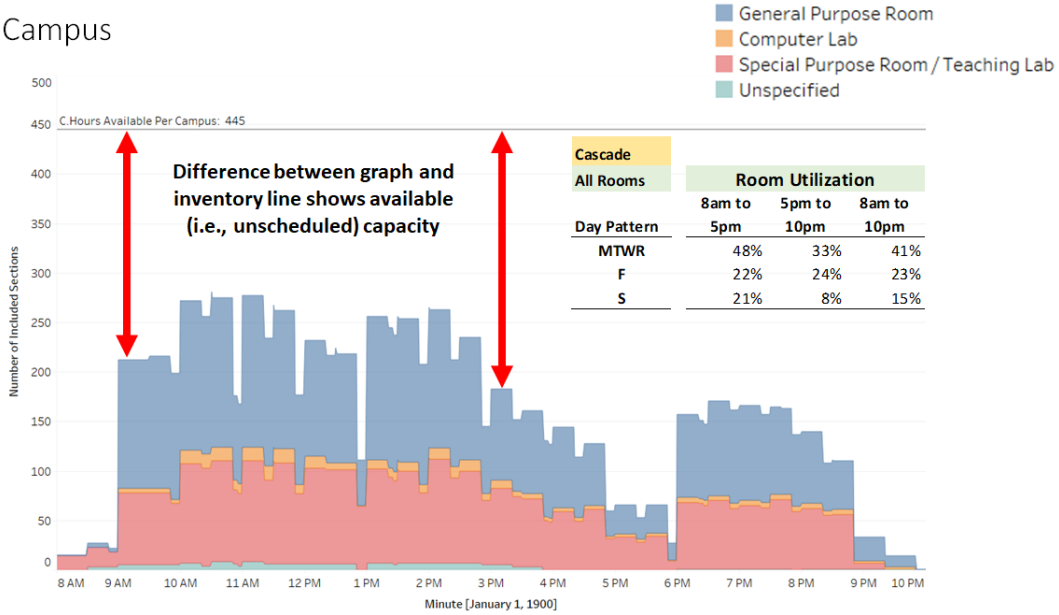
Figure A5. Rock Creek: Room vs. Seat Utilization MTWR 8 am to 5 pm All Rooms (97 Rooms)



Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure A6. Cascade: Demand over Time: Monday through Friday – All Rooms (89 Rooms)

Cascade Campus

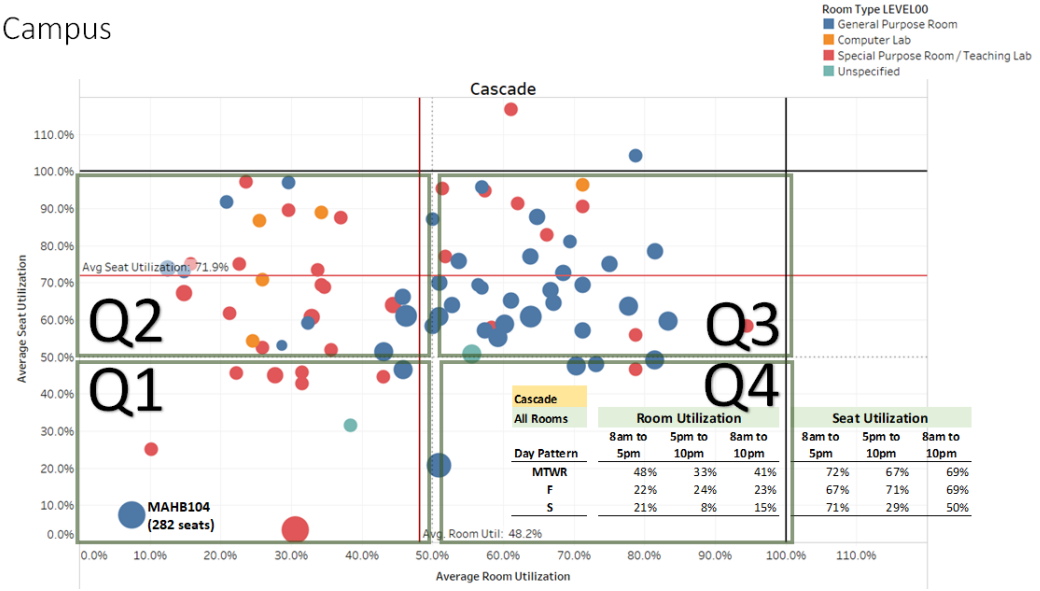


Cascade All Rooms	Room Utilization		
Day Pattern	8am to 5pm	5pm to 10pm	8am to 10pm
MTWR	48%	33%	41%
F	22%	24%	23%
S	21%	8%	15%

Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure A7. Cascade Room vs. Seat Utilization MTWR 8 am to 5 pm All Rooms (89 Rooms)

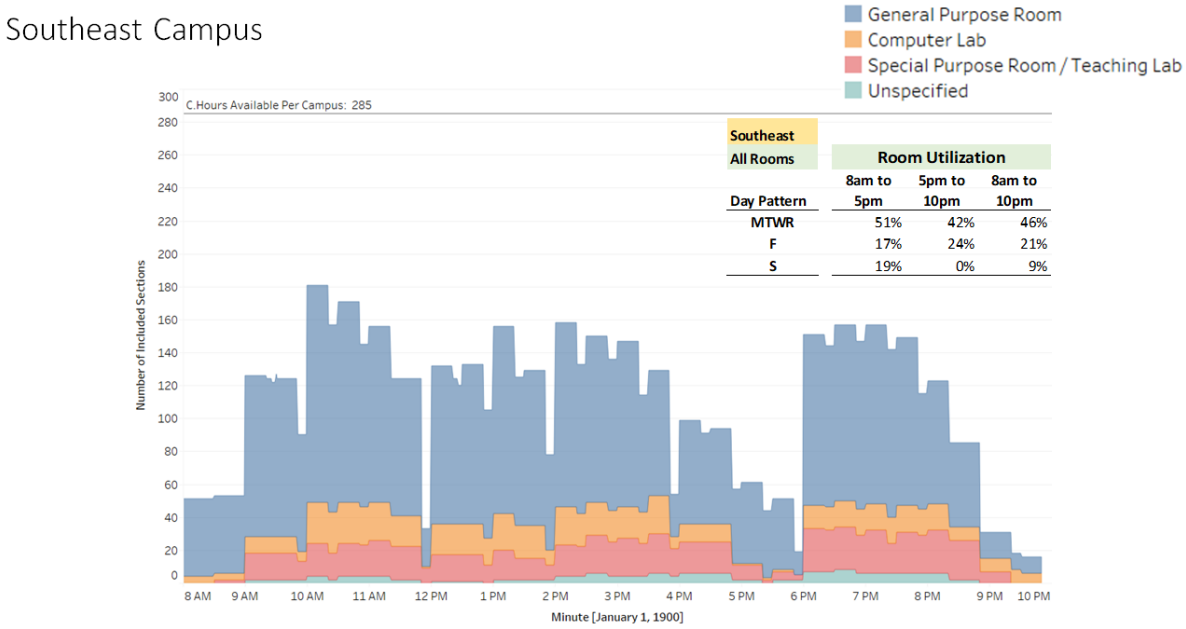
Cascade Campus



Cascade All Rooms	Room Utilization			Seat Utilization		
Day Pattern	8am to 5pm	5pm to 10pm	8am to 10pm	8am to 5pm	5pm to 10pm	8am to 10pm
MTWR	48%	33%	41%	72%	67%	69%
F	22%	24%	23%	67%	71%	69%
S	21%	8%	15%	71%	29%	50%

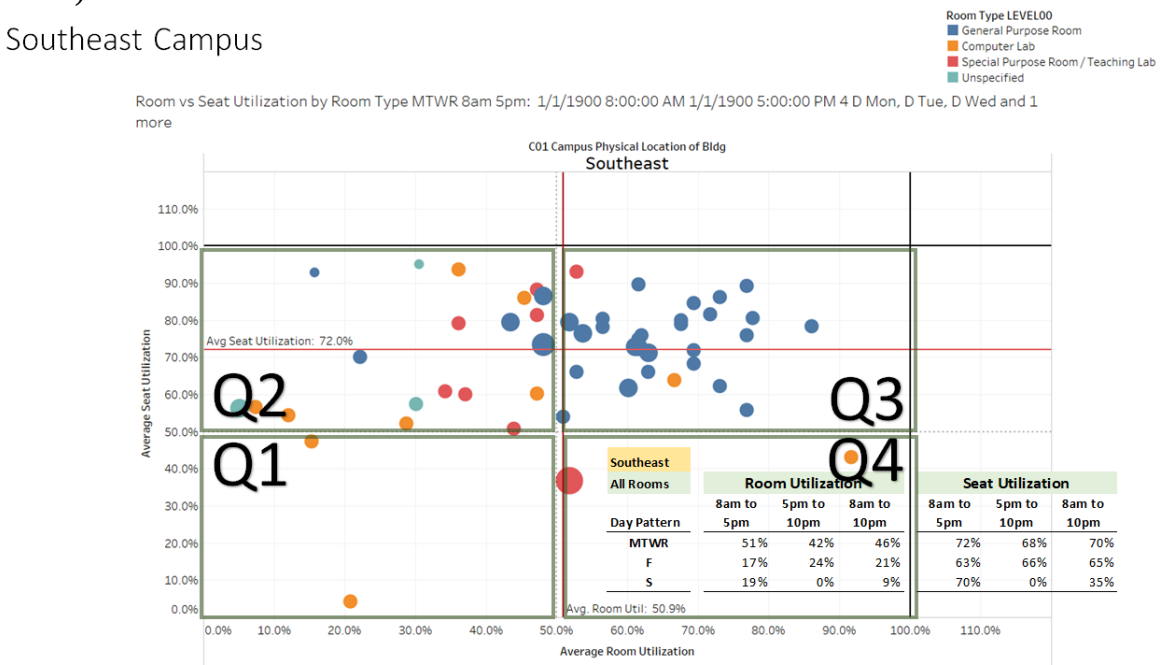
Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure A8. Southeast: Demand over Time: Monday through Friday – All Rooms (57 Rooms)



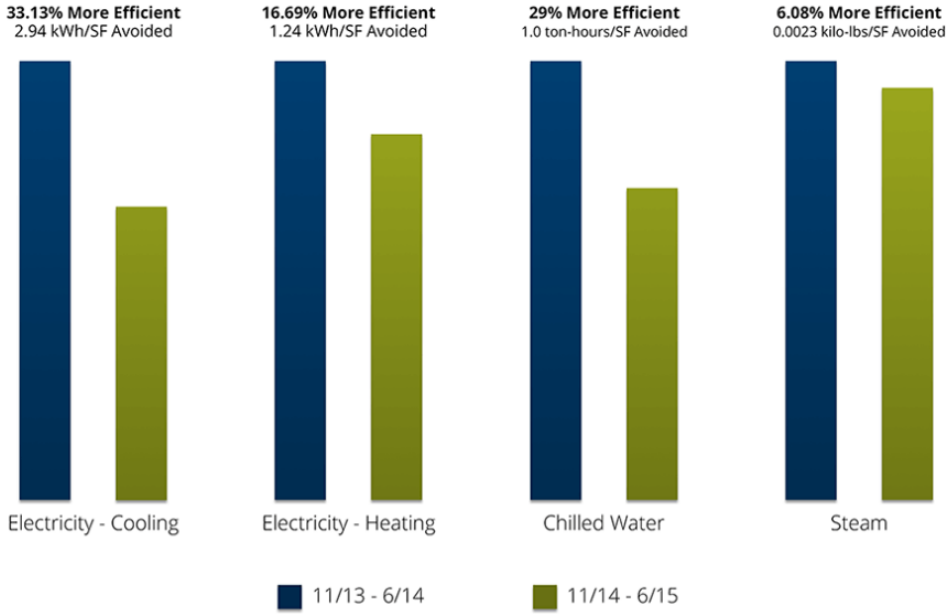
Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure A9. Southeast: Room vs. Seat Utilization MTWR 8 am to 5 pm All Rooms (57 Rooms)



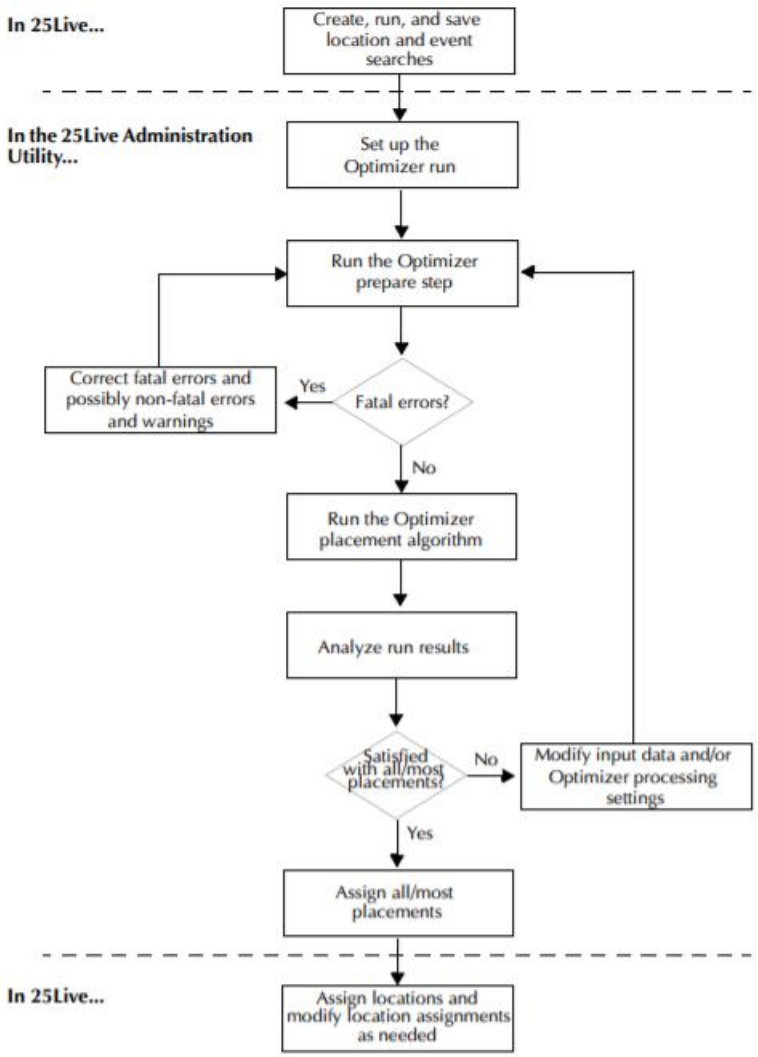
Source: PPC - Facilities Technical Reports - Space Utilization, (2017)

Figure A10. Carolina Union Energy Efficiency Summary



Source: EMS Software Website, 2020

Figure A12. Typical Event Placement/Assignment Process



Source: Schedule25 Optimizer User Guide, CollegeNET, Inc, 2016

Figure A12. Key Stakeholders

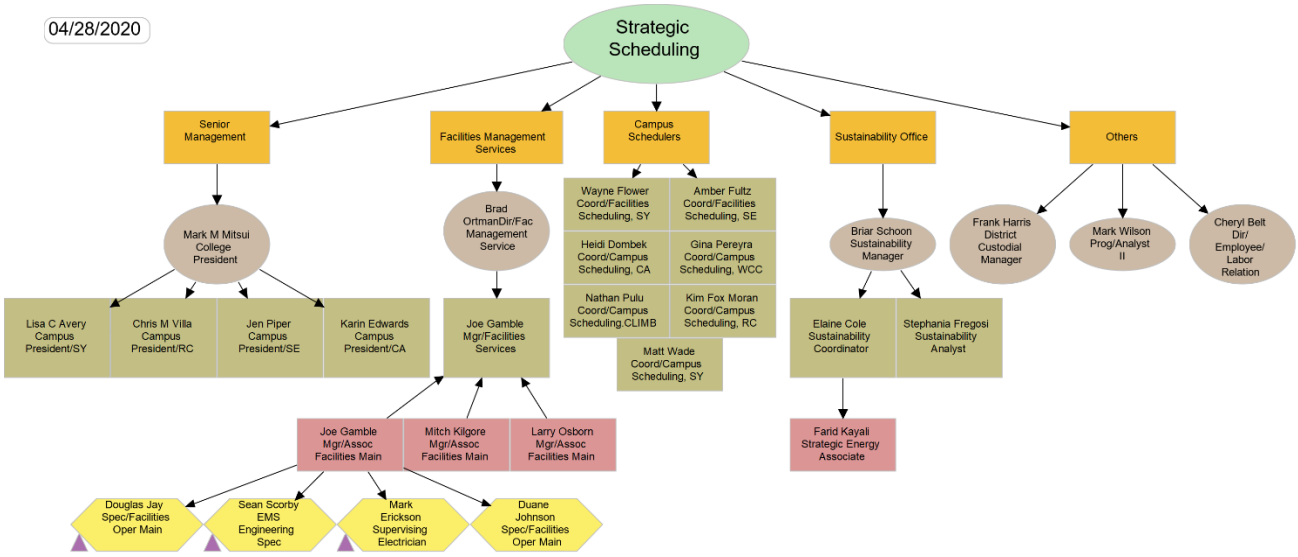
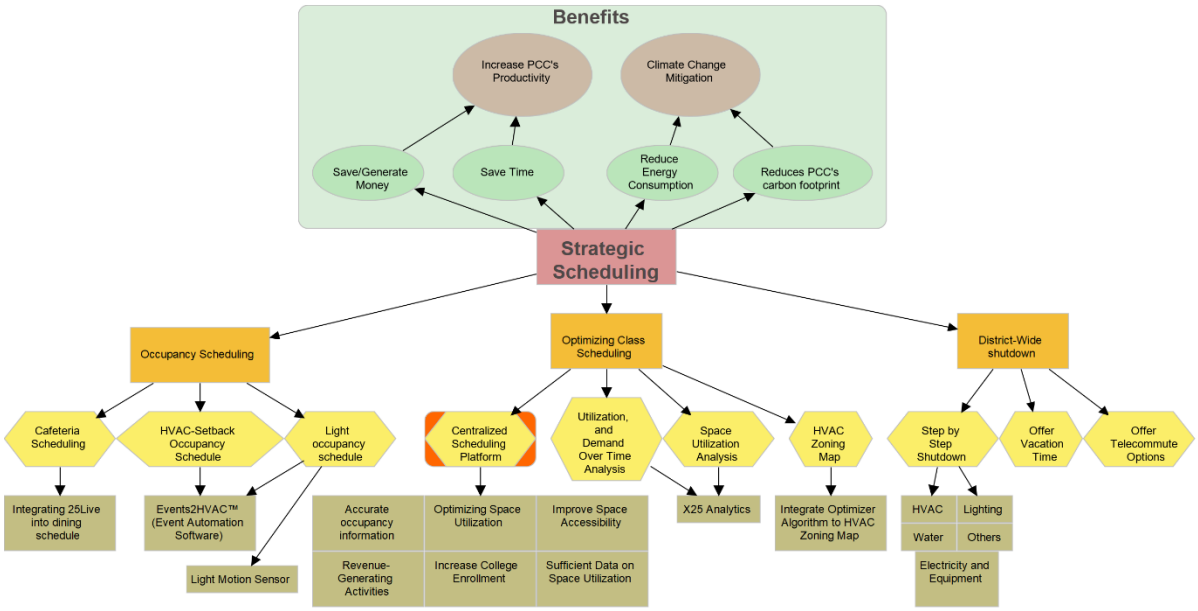


Figure A13. Strategic Scheduling Summary Map



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