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THE CULTIVATOR'S GUIDE TO GROW ROOM LAYOUT & DESIGN

Commercial scale indoor farm considerations and setup examples

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Controlled Environment Agriculture (CEA) is a wholly unique enterprise. While architects and engineers may broadly specialize in either residential or commercial construction, there are only a niche few who have extensive experience with indoor farms. When planning a cultivation facility, business owners are often not sure where to start with their facility design. With so many options available, the landscape can begin to look cloudy, and endless analysis is a real problem for time to market—not to mention the cost of making changes down the road if a cultivator changes their mind.

Grow rooms present design challenges unlike any other application. In some ways, cultivation facilities mimic the planning needs of major industrial manufacturing processes, but with less clarity about manufacturing methodology because there are so many "right" ways to do it. Facility design is further complicated by the intensity of the climate control needs, and the myriad of options available to maintain the right temperature and humidity. Cultivators and design teams must consider the entire grow cycle, from seedling or clone to post-harvest processing, and design the facility to best serve the life cycle of the plant.

Drilling down into cultivation itself, the layout of each grow room should be carefully considered and designed to best serve the methodology of the specific cultivator. Time is money, and grow room layouts will have a direct effect on the quality of the crop, as well as the efficiency of labor and overall operating costs.

But while a typical commercial building with poor design may result in people being aesthetically displeased or feeling too warm, the implications of poor planning for CEA are far more costly. Plants require precise conditions to grow properly, and a poorly planned grow room will increase operational expenses at best, and lead to the decimation of entire harvests at worst.

Having served indoor cultivators for over 15 years, we have seen all manner of outcomes. But while we've helped some of these growers retrofit a poorly designed facility, our central focus is on engineering operations that are set up for success from day one.

We offer this resource as an educational source of information. We hope you glean from this a better understanding of the components of a successful commercial grow room layout and are better able to visualize which options make sense for your business.

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MAJOR COMPONENTS OF A COMMERCIAL GROW ROOM

Before we can begin to discuss room layouts, you should understand which major components can be found in every cultivation operation. Keep in mind that no design decision is without consequence or impact to other elements in a room, and no piece of equipment operates in a vacuum. Every element of your operation will have an effect on another, starting with design coordination and continuing through active use of the building.

FACILITY DESIGN AND ENGINEERING

It's recommended that you begin engaging with design professionals at the very beginning of your business plan development. Even if you're not ready to start actively designing a building and applying for building permits, engaging with experienced design professionals as early as possible can assist you in developing your business plan by helping to establish construction budgets. It can inform your real estate selection by helping to evaluate the property you're considering for suitability, including zoning and infrastructure requirements and availability, and provide valuable information as you go through the process of fundraising and business planning. Once you have a general business plan and funding in place, you will begin assembling a design team which will consist of an architect and MEP engineer, and possibly a civil and structural engineer as well. This team will need to coordinate their work closely with one another, as each of their design decisions will impact the other design disciplines.

Depending on whether you opt for a new construction or to retrofit an existing structure, your architect will be tasked with the design and layout of your grow either from the ground up or through repurposing the building.

The architect's scope of work typically includes the following core components:

- Schematic design (floor plan development)
- Design development (refining the floor plan and implementing the cultivation and processing-specific equipment into the plan)
- Construction documents (the documents that the contractors will need to bid and implement the design)
- Construction administration (support for the contractors through the construction phase)

It's worth noting that if you plan to retrofit an existing structure, your architect will also likely need to provide you with as-built drawings. Original construction documents are rarely available to new business owners, and even if they are, buildings are often modified through the course of their use. As-built documentation serves as a basis for the project, providing a detailed blueprint of the site including specifications and dimensions, as well as locations of construction elements. Without access to the original construction documents, you will need your architect to deliver reproduceable plans to represent the existing structure. This provides the design team an accurate representation of what they're working with and ensures that existing infrastructure that needs to remain (such as structural supports) are incorporated into the final design.

MEP ENGINEERING

Engage with a Mechanical, Electrical, and Plumbing (MEP) firm early on in the planning and design process. They can help you assess options that will have an impact on your cooling and dehumidification requirements and work with you to land on a design that best serves your methodology and business goals.

Every element of your operation will have an effect on another, starting with design coordination and continuing through active use of the building.

The MEP Engineer's scope of work typically includes the following core components:

- Mechanical, plumbing, and electrical engineering
- Construction documents
- Project management

MEP Engineering: Mechanical engineers should produce a design that meets your requirements for redundancy, energy efficiency, maintenance costs, and operational complexity. They will perform complex load calculations to inform their design, specify HVAC equipment, and support HVAC construction efforts. Electrical and plumbing engineers will identify connected operating electrical load requirements; assist with power upgrades if necessary; specify major distribution equipment and wiring information for site electricians to reference; design the electrical and plumbing systems accounting for lighting density, mechanical systems, and irrigation needs; and identify gas, water, and wastewater requirements.

Construction Documents: Once the foundational design has been developed, your engineering team will provide the construction (IFC) documents needed to prepare for bidding and construction. These stamped documents will be presented to the city for Permit Review.

Project Management: As with your architect, the extent of your MEP engineering team's support will vary greatly between firms, and you should discuss these expectations with anyone you interview. A quality engineer will provide support throughout the buildout process to an extent. This support may include site observation, submittals, changes in work, and other coordination services.

It is important to note, however, that your engineers cannot finalize their design before you have made a few key selections, which we will describe in greater detail in the following sections.

CLIMATE CONTROL EQUIPMENT

There are numerous HVAC technologies that can be designed to serve an indoor farm. While your central unit(s) will be located outside of the grow rooms, there are certain elements that will play part in your grow room layout.

For one, you can choose between a system that moves air through air ducts (which may be located in-room, above the ceiling lid, or through walls) or one that is ductless, which would require in-room equipment. Of course, there is much more to consider beyond how much space the ducts/pipes and equipment will take up, but this is just one aspect to consider, and will directly affect decisions such as ceiling heights and access for maintenance.

Similarly, you will need to introduce cooling and heating within a room via air vents or fan coils. The location of these vehicles for HVAC delivery will play a crucial part in your overall grow room climate. Air circulation is extremely important and must be designed with the entire grow room layout in mind.

Dehumidification systems may be integrated into the cooling system or may utilize standalone units. There are pros and cons to each approach, but in general, integrated systems perform cooling and dehumidification operations within the same unit, while dehumidification is controlled separately from cooling in standalone systems. Standalone units range in size, capacities, and energy efficiencies. While some units have the ability to operate remotely and are ducted into the space, most are located in the cultivation room.

BENCHING AND RACKING

While it may seem like an odd factor to consider in relation to your environment, benching and racking selections will have a huge impact on the rest of the grow. There is a big difference between growing on a single-tier and growing in multiple-tiers, and in stationary rows vs. mobile systems. This decision will impact airflow, lighting, irrigation, and cooling and dehumidification selections.

Not only that, but benching and racking decisions will inform the overall layout of the grow room. For example, rolling racks allow cultivators to grow on multiple vertical tiers while also giving them the ability to move rows back and forth to create aisleways as needed. While this certainly helps maximize space, it creates unique challenges for the MEP engineering team to take into consideration including increased plant transpiration volumes and airflow conditions.

Benching and racking layouts will also be the primary driver for the lighting design, which is in turn the primary driver, along with irrigation volume, for the HVAC load calculations.

LIGHTING

As previously mentioned, lighting choices will affect electrical requirements and cooling loads. Watts are equivalent to sensible heat, regardless of whether those watts are delivered via HID or LED lighting. However, LED lights are usually incorporated at lower wattage in cultivation environments than HID lighting, because LED's are more efficient at producing usable light than HID lighting. That lower wattage translates to lower sensible HVAC loads, and a reduction in overall electrical consumption associated with both the lighting and HVAC elements of the facility design. This is a generalization, as some cultivators opt for higher wattage LED's, but in either case the lighting selection has a direct impact on electrical and mechanical design requirements. Lighting layouts should be modeled prior to installation to ensure that target PPFD is met with consistency across the entire plant canopy.

IRRIGATION

Understanding water volumes and irrigation strategies, as well as cultivation media, are vital to the engineering team in calculating humidity loads (mechanical/HVACD engineer), determining wastewater needs (civil engineer), ensuring electrical needs of pumps are incorporated into the design (electrical engineer) and designing the overall plumbing system (plumbing engineer). Keep in mind that irrigation design and the plumbing design for the building are two separate systems, and while the building's plumbing design will need to accommodate the volume of water needed for irrigation, the irrigation design itself is usually done by an irrigation specialist, and not by the plumbing engineer for the building.

GROW ROOM DESIGN CONSIDERATIONS

When planning a grow room layout, there are several important considerations growers and their designers should understand. These considerations will play a major role in guiding which direction to take the room layout.

CHOOSING A GROW METHODOLOGY

Grow methodology refers to the systems and SOP's a facility will adopt. These are all methods of operating an indoor grow that carry with them very specific grow room layout requirements. Such selections include:

- Cultivation media selections
- Fertigation and irrigation methods, volume and schedules
- Cultivation room purpose and planting cycles
- Planting and harvest schedules

Of course, there are a number of factors that can help determine which grow methodology is best for an operation. The grower's overarching business goals will inform these selections, and involving the design team at the very beginning of the business planning process will help to ensure the final design meets those needs.

What is most important for grow facility business models: long term sustainability, low operating costs, premium or organic quality product standards, high sales volumes/yields? Whatever a business' goals may be, they should be communicated to the engineering and equipment vendors so that they may help provide optimal solutions for attaining them. It is important to choose a design partner with enough experience in the industry to understand how to translate those goals into actionable design decisions.

Equally important is understanding applicable limitations (budget, space, access to utilities, codes and regulations, etc.). These limitations can make certain methodologies more advantageous than others just as much as your overall goals will. As with their business goals, growers should share these limitations with their design partners. If possible, his is another good reason to involve the design team before real estate selection, because they can help evaluate the site limitations to avoid jumping through expensive design hoops later to accommodate a less than ideal real estate selection.

ENGINEERING AND ARCHITECTURAL DESIGN

As previously mentioned, there are a number of facility design aspects that are unique to indoor agriculture that design teams must take into account. These design choices will have an effect on the functionality of the grow rooms and their climates.

Architects must understand plants' growth cycles when creating floor plans. For example, a vertically integrated cannabis producer may require dedicated rooms for clones, veg, flower, drying, and extraction, all securely separated from a dispensary retail front. These rooms usually have different size requirements. For instance, because its typical to dedicate one square foot of vegetative canopy for every four square feet of flowering canopy, veg rooms will be smaller and less numerous than flower rooms.

MEP engineering teams must have a similar understanding. Each stage of the growth cycle also has its own set of climate parameters for optimal growth. Similarly, adjustments between watering schedules and volumes at various stages of plant maturity will also need to be taken into account when sizing cooling and dehumidification systems. These nuances are important to take into consideration early on in the planning phase in order to deliver an HVAC system that can achieve the required setpoints.

Perhaps the most commonly overlooked aspect of CEA facility design is that of scalability. When launching a new operation, it can be easy to become hyper-focused on getting to market and serving one's current business goals. However, those who discuss future scalability with their design team will save a lot of time, frustration, and money in the long run. The following are just a few of the ways growers can set their businesses up for future expansion:

- Consider scaling needs in real estate purchases and, if the budget allows, select a piece of property that can accommodate future expansion.
- Discuss future expansion plans with the design team. What makes sense to design now? What makes sense to design later? How will future scaling affect existing operations?
- Understand how the HVACD system will scale over the long term. Will there be challenges with starting up at reduced loads? Will there be challenges with adding loads later? What will those challenges be and how will the team address them?
- Capital budgets are always limited, but they should be stretched as far as possible to accommodate design choices that result in lower operating costs over the long term. This results in faster cash flow, and a shorter runway to expansion.

Finally, while designing grow rooms that serve the unique needs of CEA is certainly the most challenging aspect of designing a facility, staff needs, storage, post-harvest processing and access must also be prioritized. Cultivation and operations staff need bathrooms, break rooms, and sometimes offices. The density of electrical and mechanical systems in the facility, in addition to irrigation requirements, usually necessitate dedicated mechanical, electrical and irrigation rooms, which should be easily accessed by maintenance staff and contractors. Hallways and doorways should be designed to accommodate pallet-sized loads or large carts, as well as convenient access to maximize productivity. Depending on the crop being produced, security might also need to be considered.

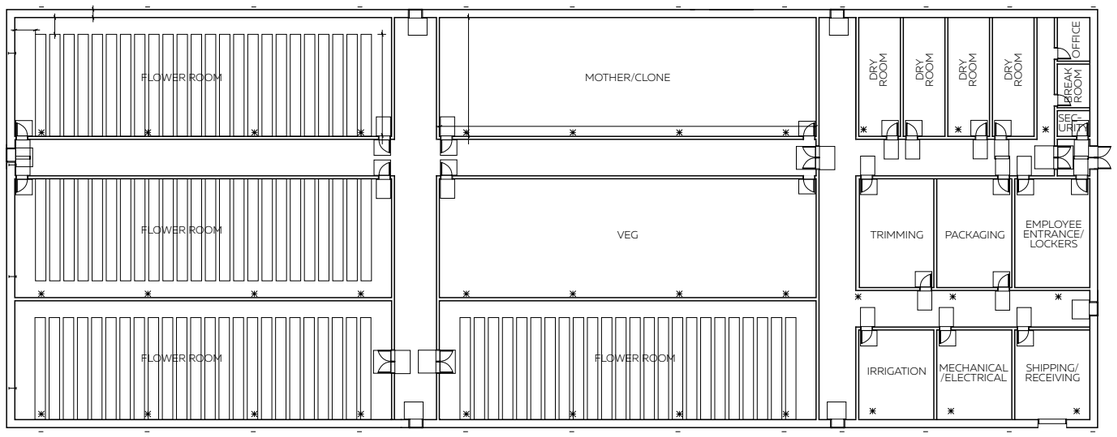
GROW ROOM LAYOUT EXAMPLES

This information is intended for educational purposes. It is no substitute for a skilled architectural and engineering team, nor does it reflect the full design scope necessary for facility construction. However, it will provide a good baseline of understanding for growers as they work through selections with their design teams.

We've provided a lot of information here about all the decisions that need to be made, and how they affect other decisions in a cultivation facility. But when it comes down to it, one of the most critical decisions is that of the layout of the cultivation rooms themselves, both because of the direct impact on the cultivation methodology, and because of the myriad of other design elements that are affected by the cultivation room layout. Is it best to grow in multiple-tiers or single-tiers? Should the benches and racks be stationary or mobile? What should the ceiling heights be? The truth is cultivators can be successful with any number of grow room layouts. But how does a cultivator determine which approach is right for their business? And how does one determine room dimensions that best serve that approach?

To assist with evaluating the various options, we've laid out the four most common benching and racking selections (single-tier stationary benching, double-tier stationary racking, single-tier rolling benching, and double-tier rolling archival racking) in the same room. For the purposes of this exercise, we've selected a room from an actual client floorplan which has approximately 2,400 SF of floor space. Cultivation rooms come in endless sizes and shapes, and vertical cultivation methodology is often more than two-tiers, but we've found this square footage to be a fairly common selection for many cultivators, and the information here can be extrapolated to apply to any size room and any number of tiers for effective comparison.

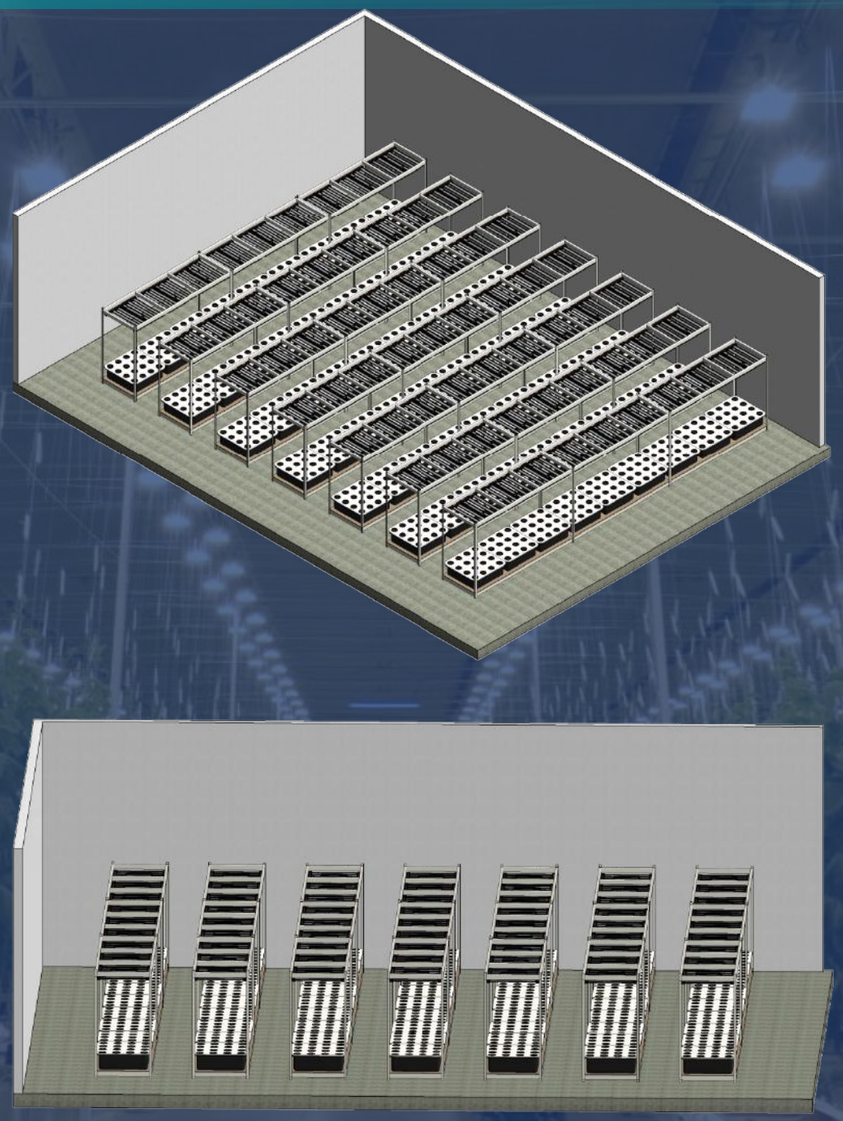
For the purposes of this exercise, we've utilized Surna's benching and LED lighting equipment. These technologies are comparable to similar products in the space provided by other manufacturers. We believe the products being utilized for this exercise are not only appropriate for the exercise, but also have some distinct pricing and warranty advantages that make them worth consideration for any cultivator. However, if a cultivator is considering alternative technologies, the lessons here are still applicable.



This layout is for illustration purposes only

STATIONARY BENCH EXAMPLE (SINGLE-TIER)

- Square Feet of Room: 2,352
- Square Feet of Canopy: 1,008
- Percentage of Space Utilization: 42.9%
- Number of LED Lighting Fixtures: 63
- Total Wattage of LED Lighting: 42,840



LAYOUT AND ARCHITECTURAL CONSIDERATIONS

The most noticeable feature of this example is that the utilization of square footage in the room isn't particularly dense—in fact it's the lowest space utilization of all options—and most cultivators would see this layout as having a lot of "wasted" space left on the table that could be filled with plant material. However, that's not necessarily reason to immediately discount this type of layout as a potential option. If a cultivator has limited square feet available to them, whether due to regulation or real estate selection, then the goal will likely be to utilize one of the other, higher space utilization, options. However, in some cases space is abundant and, in those cases, this type of layout should be on the list of considerations. In general, with indoor cultivation, the raw square footage is one of the least expensive components of the build out. The supporting infrastructure—lighting, HVAC, irrigation, etc.—tends to be more expensive than the square footage itself. In a less populated room, those costs will also be lower on a per-room basis, limiting the bulk of the expense to the square footage of the structure itself. While utilization is low, everything else is far simpler in a room with an open layout as shown here.

From an architectural standpoint, a layout like this can easily be deployed in a room with relatively low ceilings so long as LED lighting is in use (HID lighting requires more space between the fixture and the plant canopy so will require higher ceilings even in single-tier applications). The fixed nature of the benching requires egress (or access) between each row both for human occupancy (health and safety/fire code) and for access to plants. When determining room size, both the width of the bench and the access aisle beside it must be considered, so the addition of each bench would require 7 horizontal feet to accommodate the 4' wide bench and the 3' wide aisle.

LIGHTING

This type of layout lends itself best to the more collimated lighting pattern associated with LED fixtures. LED's tend to deliver light to a tighter target area, whereas HID lights deliver light at more of an angle (relying on cross lighting from neighboring fixtures to achieve consistency). With aisles between each row of plants, LED lighting will result in less waste because more light lands directly on the bench. HID lighting selections in this layout would result in substantial light waste.

HVACD

With an access row between each row of plants and abundant space above the canopy, homogenizing airflow is much simpler for your mechanical HVACD designer than in other densely populated rooms. There are few layout-related limitations on air handling and/or dehumidifier selections, and plenty of room to mix air to ensure consistency of temperature and humidity. There is less transpiration per cubic foot in the room, which tends to simplify humidity control and helps to level out spikes, because the moisture has more air volume in which to dissipate. Stratification is minimized because the lighting density does not cover the entire plane of the room. Plants are less crowded and airflow through the canopy is more consistent as a result.

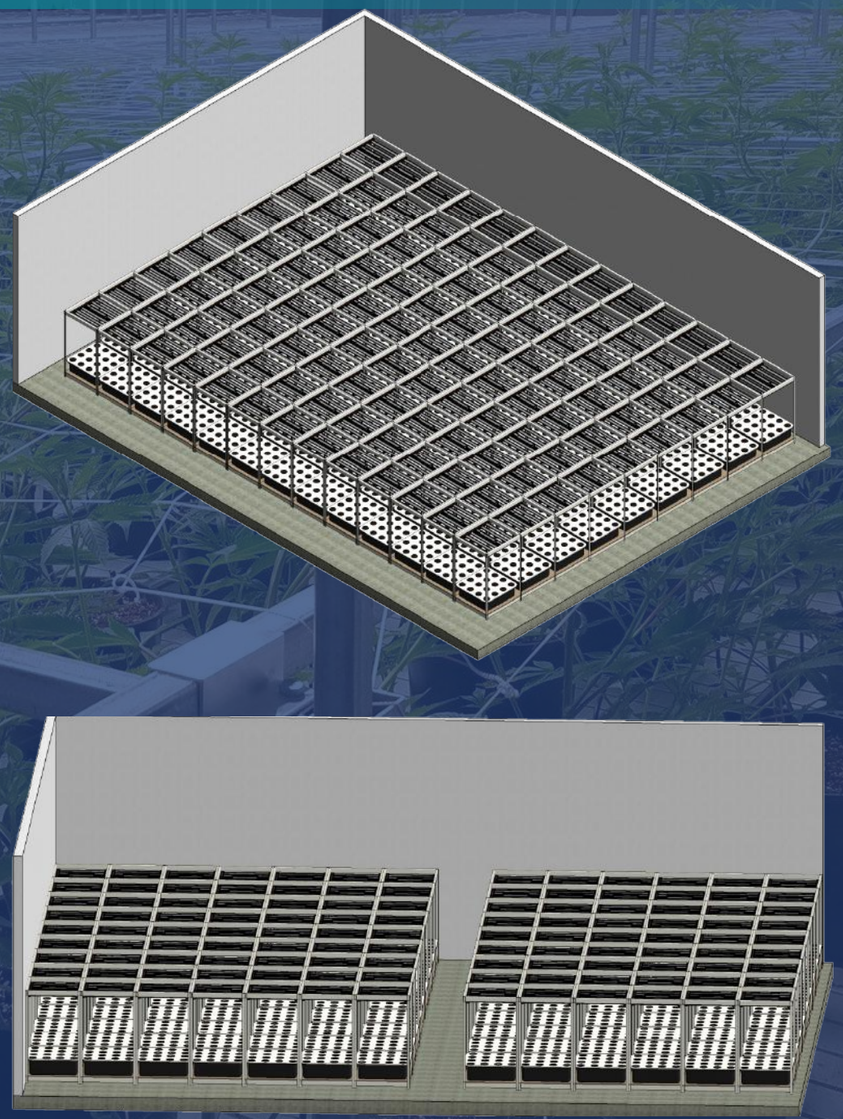
OPERATIONS

Operationally, layouts like this maximize convenient access to the plant canopy for pruning, trellising, and irrigation maintenance. They also maximize access to equipment that may be located in the ceiling for maintenance, such as lighting, fans and HVACD equipment that may be located in the space.

However, in spite of the numerous design and operational benefits associated with this type of layout, the significant limitations on space utilization mean that this approach is rarely used in most CEA applications.

ROLLING BENCH EXAMPLE (SINGLE-TIER)

- Square Feet of Room: 2,352
- Square Feet of Canopy: 1,976
- Percentage of Space Utilization: 84%
- Number of LED Lighting Fixtures: 130
- Total Wattage of LED Lighting: 88,400



LAYOUT AND ARCHITECTURAL CONSIDERATIONS

In this example, the bench tops can be moved horizontally, allowing cultivators to fill the horizontal space far more densely than with stationary benching, while still allowing for access to plants by way of a movable aisleway. This approach nearly doubles the space utilization in this particular room, and is the most common benching style utilized in single-tier applications due to its superior single-tier space utilization.

From an architectural standpoint, a layout like this can easily be deployed in a room with relatively low ceilings so long as LED lighting is in use (HID lighting requires more space between the fixture and the plant canopy so will require higher ceilings even in single-tier applications). The movable nature of the benches allows for limited "open" space allocated to aisleways, as egress and access requirements can both be satisfied by simply moving a bench. When determining room size, only the width of the bench and at least 4' of total aisle access must be considered, so room utilization is most efficient when total dimensions are in 4' increments.

LIGHTING

This type of layout can be effectively deployed with both LED or HID lighting, as the nature of the unbroken canopy allows for maximum utilization of lighting regardless of source. Utilizing LED's would require that, after plant maintenance, benches should be returned to their original positions in order to ensure that they are properly centered beneath the fixture serving that space. HID lighting would result in slightly more waste overall, with usable light landing on the areas of the room not covered by canopy, but with more flexibility as to bench position after plant maintenance.

HVACD

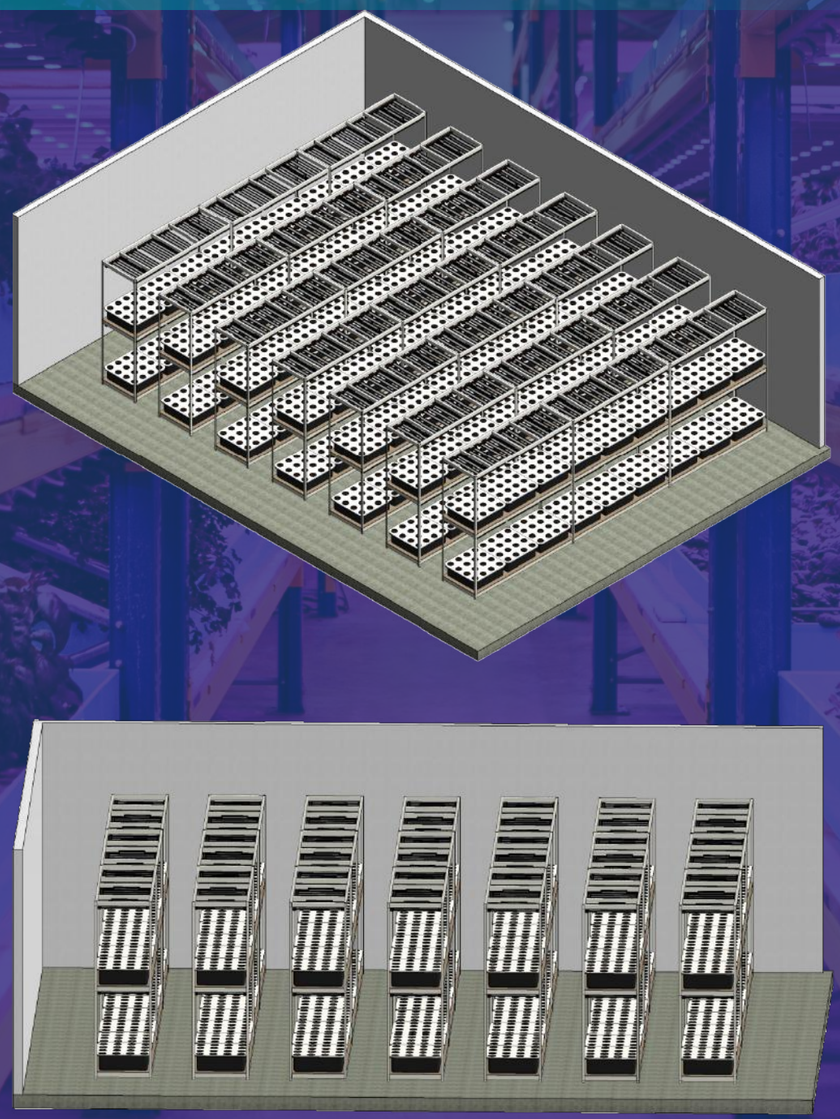
Challenges with HVACD design in this type of layout are usually related primarily to destratification because of the density of lighting, and ensuring adequate airflow through the canopy even through the center of the room. There are few layout-related limitations on air handling and/or dehumidifier selections, so long as ceiling height is adequately considered (10-14' for LED rooms and 12-16' for HID rooms is usually well-suited for cannabis cultivation; cultivators growing shorter plants such as leafy greens may be able to reduce the ceiling height slightly if desired). This approach allows for room to mix air above the canopy to ensure consistency of temperature and humidity; however, ensuring that conditioned air penetrates the canopy at appropriate velocities, and that warm, humid air is displaced back to the HVACD equipment for conditioning, does make the HVACD design more challenging than in less densely populated rooms.

OPERATIONS

Operationally, layouts like this allow fairly convenient access to the plant canopy for pruning, trellising, and irrigation maintenance. However, access to equipment that may be located in the ceiling for maintenance, such as lighting, fans and HVACD equipment is restricted by the width of the aisles and the limitations of bench top movement. Cultivators may opt to allow for more aisle space than in the example shown for this reason.

STATIONARY RACK EXAMPLE (MULTI-TIER)

- Square Feet of Room: 2,352
- Square Feet of Canopy: 2,016
- Percentage of Space Utilization: 85.7%
- Number of LED Lighting Fixtures: 126
- Total Wattage of LED Lighting: 85,680



LAYOUT AND ARCHITECTURAL CONSIDERATIONS

The most noticeable feature of this example is that the utilization of square footage in the room is precisely double that of the single-tier example of the same layout. This is a plug and play style rack that allows cultivators to build a single layer and stack it to take advantage of vertical space. Depending on the height of the crop, cultivators may be able to do substantially more than two-tiers, but we limited the example to two levels for ease of demonstration. While some cultivators may view the aisles as wasted space, the ability to stack the tiers allows for excellent space utilization without overcrowding the room.

From an architectural standpoint, the major consideration is ceiling height and ensuring that there is adequate open space above the racking (either open to the room or in an attic space) to allow ceiling mounted equipment, wiring and ductwork to serve the space. The fixed nature of the racking requires the same access rows as the single tier version of this layout, so when determining room size, both the width of the bench and the access aisle beside it must be considered. In most applications, the layout allows for significant access at the front of the room and limited access at the back of the room, but this should be discussed with the HVACD designer before finalizing.

LIGHTING

In addition to the collimation of LED's lending themselves well to a layout with significant aisleways, multi-tier applications are almost always deployed with LED lighting technologies. Depending on wattages, the recommended distance between LED's and the plant canopy is usually somewhere between 12-24", whereas with HID lighting that distance is usually recommended to be in the neighborhood of 48-60". When plant height is taken into account, it makes the heights of the racks less feasible for most cultivators when HID lights are in use.

HVACD

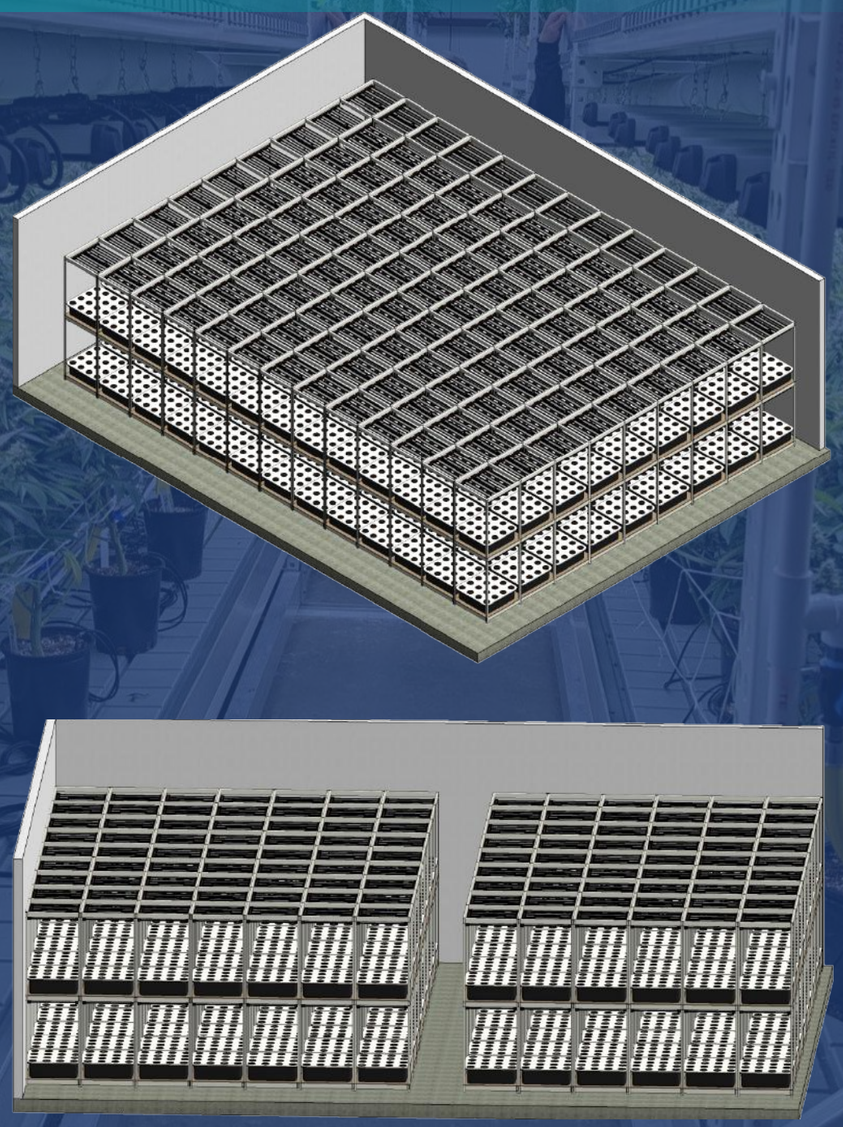
So long as there is sufficient space for ducting and equipment inside the room, and a plenum space in front of the room as shown, HVACD design is relatively straightforward, with the extra space allowed by the aisleways. However, delivering homogenized air to the canopy is a separate challenge which must be addressed, and multiple-tiers complicate those efforts. Some mechanical HVACD designers will incorporate the canopy airflow into their designs, and some will leave it up to the cultivator. Ensure that the solution to canopy airflow isn't overlooked when reviewing design scope for your HVACD designer. The most effective incorporation of canopy airflow is when this supplemental airflow is considered in the context of the entire HVACD design, and not as a separate element of the climate control system. When the mechanical designer is responsible for both, it helps to ensure that the airflow system is complementary to the HVACD system, and that they aren't working at cross purposes to each other or disrupting the intended airflow patterns of each system individually.

OPERATIONS

Operationally, layouts like this maximize convenient access to the plant canopy for pruning, trellising, and irrigation maintenance, although operators must consider access challenges associated with reaching plants on the upper tiers. Similarly to the single-tier version of this design, the aisleways can serve to maximize access to equipment that may be located in the ceiling for maintenance, such as lighting, fans and HVACD equipment that may be located in the space.

ROLLING RACK EXAMPLE (MULTI-TIER)

- Square Feet of Room: 2,352
- Square Feet of Canopy: 3,456
- Percentage of Space Utilization: 146.9%
- Number of LED Lighting Fixtures: 216
- Total Wattage of LED Lighting: 146,880



LAYOUT AND ARCHITECTURAL CONSIDERATIONS

The most impressive identifier of this application is the total square footage of canopy, which actually exceeds total room square footage by a significant margin. This type of approach is without question the most effective at maximizing square footage for canopy; however, it is also the most challenging in design and operation of the facility. In this example, a central aisleway is utilized and the mobile racking can be pushed toward the center of the room from each side to allow access between each row of benching. As with the rolling top bench options, one aisleway can serve a number of racks. For the most part, once the aisleway has been taken into account, the room can increase in size in 4' increments to accommodate the racking. However, most suppliers of racking systems recommend limitations on the number of racks per aisle (and sometimes there are manufacturing limitations to the distance that can be covered by a single track).

From an architectural standpoint, the major consideration is ceiling height and ensuring that there is adequate open space above the racking (either open to the room or in an attic space) to allow ceiling mounted equipment, wiring and ductwork to serve the space. Access to ceiling mounted equipment will be substantially limited and is therefore to be discouraged. Because of the HVACD and airflow limitations in rooms like this, the layout absolutely must allow for significant access in front of the room, as much access as possible in the back of the room, and the overall design is best discussed at length with the mechanical engineer during the layout process to ensure that desired plant conditions are achieved without excessive expense.

LIGHTING

As previously indicated, multi-tier applications are almost always deployed with LED lighting technologies. The recommended distance between LED's and the plant canopy is usually somewhere between 12-24", whereas with HID lighting that distance is usually recommended to be in the neighborhood of 48-60". When plant height is taken into account, it makes the heights of the racks less feasible for most cultivators when HID lights are in use. Further, in a densely populated multi-tier application, radiant heat is even more of an issue, so LED's serve to ease at least one of the myriad climate control challenges associated with this kind of design.

HVACD

The very dense plant canopy and associated high irrigation volumes, combined with extreme lighting density and associated sensible heat loads make for the highest HVACD loads of any of the room layout options discussed here. This is compounded by the limitations on space in the room to maximize homogeneity, combined with the challenge of ensuring that conditioned air reaches every plant in the rack, and that the warm humid air in the racks is delivered to the HVACD system for conditioning. For this reason, it is absolutely vital that the layout of the room is well understood by the mechanical designer, and when possible, the racking airflow system and the HVACD system should be designed together, or at minimum designed to compliment one another to ensure proper climate control to every tier. When possible, some open space should be allocated to allow for as much homogenization of temperature and humidity as possible, as it is undesirable to deliver cold, dehumidified air directly from the HVACD system to the plant canopy. A mechanical engineer who offers CFD (Computational Fluid Dynamics) to model airflow patterns in the room to determine the best approach will add enormous value in these types of layouts.

OPERATIONS

Layouts like this allow access to the plant canopy for pruning, trellising, and irrigation maintenance, although operators must consider challenges associated with reaching plants on the upper tiers. Access to ceilings is very difficult without catwalks or other permanent accommodation, so ceiling mounted equipment is largely discouraged in this layout.

While this design certainly has its challenges, it's also the option that allows for the most effective utilization of square footage for plant canopy. Operators who are limited on square footage for one reason or another may consider this option, although they should understand the infrastructure expense associated with the additional lighting, racking, irrigation and HVACD systems will mean the price per square foot of construction will be higher than in applications with lower utilization.

CONCLUSION

Cultivators have so many options available to them and there is no one "right" way to design a cultivation facility.

By understanding the available options, along with their benefits, challenges, limitations and operating ramifications, growers can narrow down the options that best fit their specific business goals. From there, close collaboration with their design team ensures construction of the best possible facility for those goals, without wasting time in the beginning, or money in the end.

Surna Cultivation Technologies is an industry-leading CEA facility design provider. We have been helping cultivators for over 15 years, and we offer a variety of products and services to help you design the facility of your dreams including architectural design, MEP engineering, controls and automation, lighting and benching, and so much more. Our designs are guided by your budget and goals, so you can grow with confidence.

For more information, visit surna.com today, where our team of experts are ready to understand your goals and discuss your options.

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