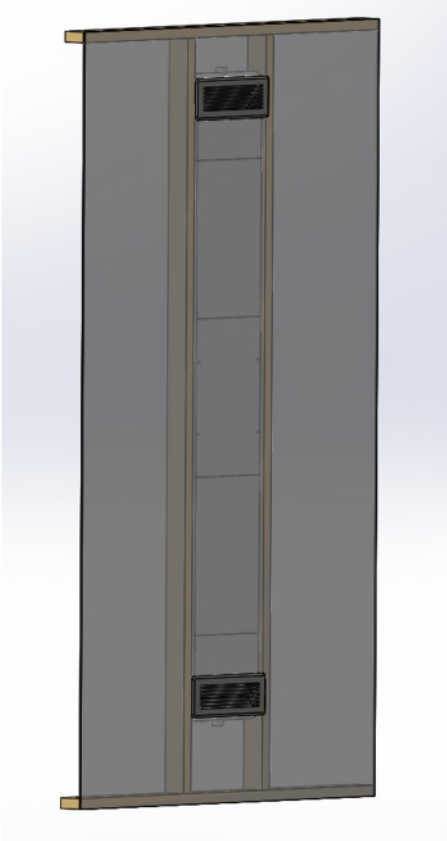
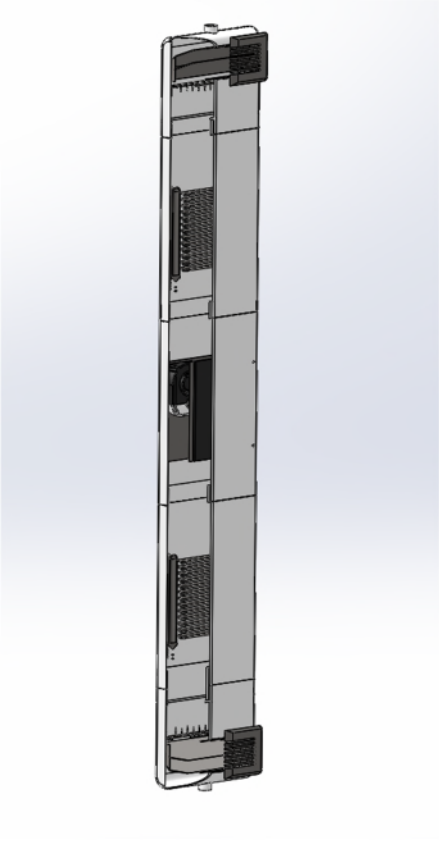
Point Conditioning Unit

An alternate means of providing air conditioning for a space is described that provides heating, cooling, and airflow in a package that fits within a standard stud wall. Point conditioning units are installed as necessary in spaces where air conditioning is required and operate independently or networked as required.





Basis of Design

The described design is a replacement for traditional ducted HVAC systems typically found in modern construction. The self-contained unit consists of a return plenum, heating/cooling coils, fan system, supply plenum, and associated controls. Heating and cooling are provided by heat exchange from a hot or cold water system supply to the coils to the air flow generated by the integrated fans. Supplemental heating could be provided by resistance heaters if needed and only heating service is provided. Major components of the system are:

- An outer shell of the point conditioning unit sized to fit within voids of a stud wall. The shell supports all components and directs air through the system. It consists of a vertical duct almost the entire height of the wall terminating in openings to the conditioned space on

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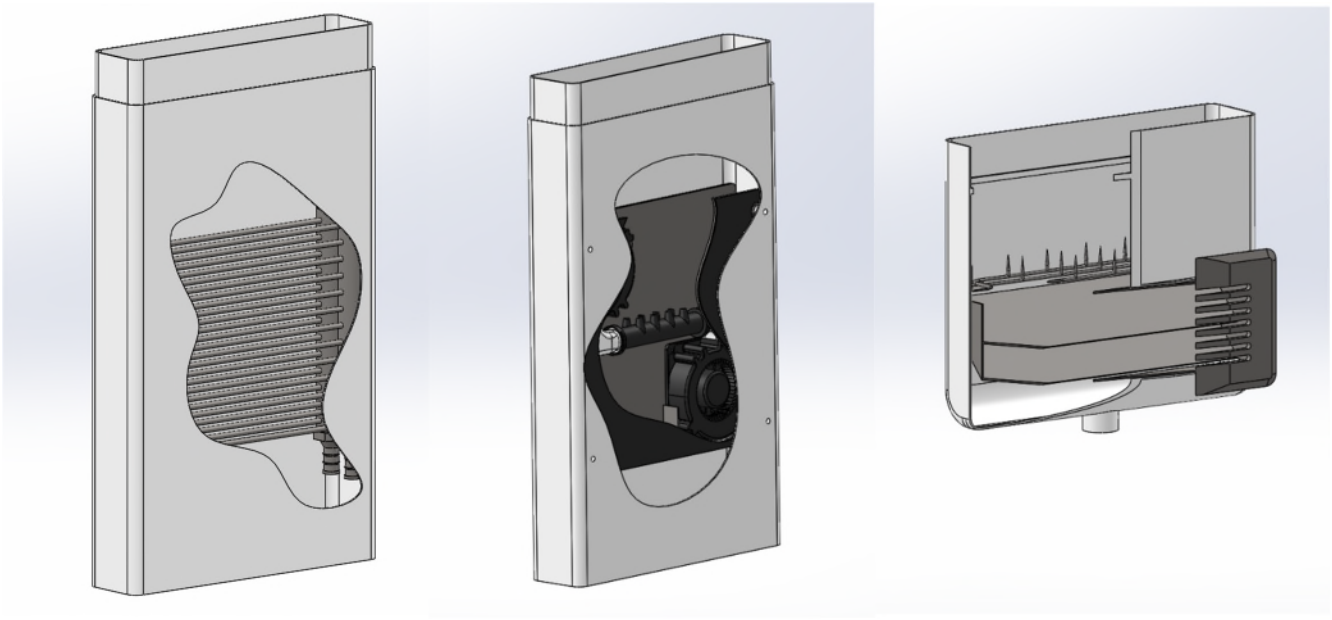
either end. Filtration may be provided as integral to these openings to remove particulates from the air.

- Heat transfer coils are provided for heating and cooling. In its simplest form, the same coil could be used for heating and cooling with a selector valve provided to select the service required. As an alternative, a separate heating and cooling coil could be provided which would allow for use of the unit in dehumidification and optimize the size of coils for the appropriate service.
- Fans are provided to move air through the boundary formed by the outer shell. The fans are of relatively low volume and operate as determined by the control system. The fans could be aligned to only provide flow in one direction, but the ability to change the direction of the flow would enable delivery of hot or cold air to the desired elevation within the space.

Current HVAC systems providing air flow are either centralized systems necessitating large ductwork to be routed throughout the space, or standalone units that are not integrated with the structure and are not optimized to provide the level of comfort of a centralized system. The proposed solutions seeks to leverage the simplicity of installation of a local conditioning system with the comfort control inherent with a centralized systems.



Conditioning Module
Contains heat exchanger coils

Flow Module
Contains blowers and controllers

Inlet Module
Contains filtration (electrostatic shown)

Unique Aspects of Design

A point conditioning unit is comprised of multiple modules which perform a specific function. Arrangement of the modules allows for customization of the functions provided by the point conditioning system, options used, and overall height of the unit. If repair is needed, it also allows for easy replacement of a specific module without the need to replace the entire unit. Modules fit together, and when mated, provide for all internal electrical connections. This minimizes the possibility of damaging wiring, incorrect connections, and simplifies future upgrades to new modules.

Similarly to the flexibility in module selection, the use of a self-contained point conditioning unit allows for customization of space conditioning by selecting a specific number of point conditioning units, determining an ideal location for placement of conditioning, and providing for internal space air circulation and filtration integrated into the air conditioning system.

To assist in the independence of each point conditioning system, each unit would have a basic controller integrated in the air flow module that would allow communication through local communications methods, such as Bluetooth. The controller could operate completely independently or be part of a mesh network established by all installed units where it operates in concert with specific other units or based on inputs from other areas of the residence. This provides a high level of flexibility in programming the point conditioning systems using only simple, distributed controllers.

The point conditioning systems are single pass ducts and have an outlet and inlet that are separated by a significant elevation. This ensures circulation of the air within the space, and the ability to choose the elevation at which conditioning is provided. Note that due to the potential for flow direction being selectable, hot air conditioning outlet could be at the floor level, where cold air conditioning outlet could be at the ceiling level.

Services provided by point conditioning systems include electricity and process water (hot, cold, or both). The amount of electricity required would be minimal as it drives a low power fan and internal electronics. Therefore, small capacity wiring or direct current systems would be able to provide the necessary power. The hot or cold water supplies provide the heating and cooling capacity. Due to the energy capacity of water, the volume of this flow would be very small and could be supplied by small diameter tubing. This allows easy routing of water supplies to any location where a point conditioning unit is needed. These features of design ensure that specific structures and ducts traditionally needed for air handling no longer constrain the location where air conditioning can be provided.

Usage Details

The Installation Process

Installation of a point conditioning system would be performed as follows:

1. The ventilation requirements of a space would be determined based on heating requirements, cooling requirements, and air recirculation and filtration rates.

2. The minimum number of point conditioning units would be determined based on the most demanding of the space requirements.
3. Locations for the point conditioning units would be determined based on space layout, space usage, access to services, avoidance of other services (outlets, water piping, etc), and potential future uses of the space. This includes the ideal length of the conditioning units to optimize the inlet and outlet locations in the wall to ensure proper air mixing in the space.
4. The point conditioning systems are assembled by connecting the selected modules as required by services to be provided and overall height of the required assembly.
5. Prior to installing sheetrock or similar facing boards, point conditioning units would be installed between studs. Services in the form of electricity, hot water, and cold water would be provided at this point.
6. After installation of wallboards, the final louvres would be installed. They may have integrated filtration systems if provided.

Programming and Operation

After physical installation, the point conditioning system is ready to be programmed and operated. Programming the system will be highly dependent on the specific installation and must consider several factors including:

1. Does the point conditioning system work together with other units or is it independent?
2. What temperature control algorithm is required for the specific space?
3. What options are available for the point conditioning unit?

Once the requirements for the program are established, the program is uploaded to the point conditioning units through wireless protocols, such as Wi-Fi, Bluetooth, or near field communications. The upload is managed from an app driven device, such as a tablet, smartphone, or computer. After upload of the program, the point conditioning units are ready to be used. The same app used for upload could be used to manage operation. The manner of operation would be dependent on the installation performed, program uploaded, and options available on the point conditioning units.

Operation could also be controlled by dedicated control panels that communicate with the point conditioning units through a local wireless network. These control panels could be located wherever convenient and be assigned access and capabilities as defined by the program defined for the point conditioning system.

Perceived Benefits

The use of point conditioners as opposed to a centralized conditioning system is the increased flexibility in installation, ability to customize the operation, provide recirculation and filtration specific to a space, and redundancy in case of failures. Additional benefits could be realized in the form of lower energy usage by using room sensors to prevent unnecessary space conditioning, quieter operation, prevention of air stratification, and increase ability to upgrade and repair individual units.

There are certainly challenges that would be encountered by this approach due to the departure from currently available systems. The use of such a system requires installation of a hot and cold water loop – services generally not available in residences. Additionally, access for repair may be limited with typical wallboard coverings. An alternative to traditional sheetrock where the wall board can be removed to provide access to in-wall services is envisioned, but not explored in this design study. Another challenge is air filtration. As envisioned, air filtration is integrated into the inlet and outlet plenum of each point conditioning unit – potentially as an electrostatic precipitator and paper filter combination. Therefore, each unit would have to be serviced independently as opposed to one larger filter for an entire zone. This may result in additional maintenance effort, though it could also significantly reduce maintenance costs as each point conditioning unit could monitor filter condition and only required servicing when needed as opposed to fixed intervals.