Next Generation HVAC

One can reduce HVAC energy consumption with more control. One can get control with $3 microcontroller IC's in physical devices networked together with reliable communication. Devices include:

- motorized dampers inside ducts
- motorized dampers at vent openings
- fans inside ducts
- motorized valves at radiators
- pumps that moves 60°F water from ground source into radiators and heat exchangers
- pumps that move water from thermal storage tank in basement into radiators and heat exchangers (water heated or cooled via solar when sun shining)
- sensors (occupancy, indoor/outdoor temperature, sun, wind pressure)

With the above technology, one can:

- more precisely control airflow from central HVAC fan
- move air from one room to another room while HVAC is off (e.g. move cool air from basement to warm office on 2nd floor without turning on central HVAC)
- route ground source 60°F water as needed
- route thermal storage water as needed
- integrate large appliances, thermal storage water, ground source 60°F water, and central HVAC

Devices with processors exist, yet we are not doing the above due to:

- a standard way to electrically plug the above devices into a building does not exist
- a common operating system for all devices that supports plug and play and reliable integration does not exist
- standard physical plug-in modules with fans and dampers does not exist

Standardization reduces cost via commoditization. Plug and play reduces cost via less design and installation labor.

One would want a system whose additional cost is paid for with reduce energy bills within a reasonable period of time. If researchers can do this, then mass adoption becomes feasible.

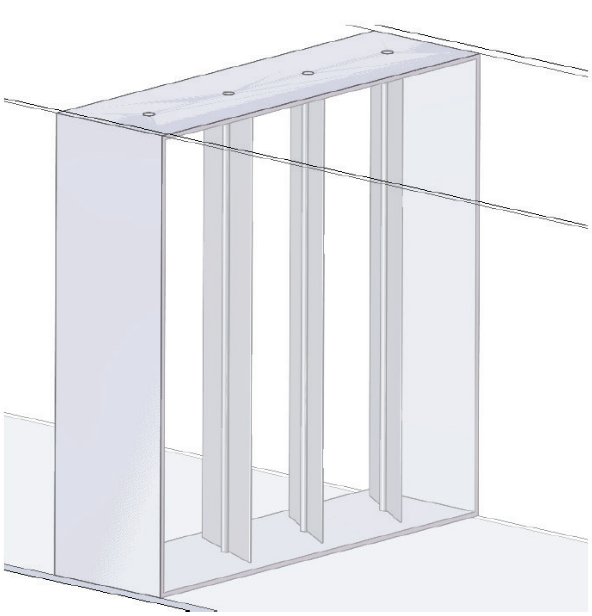
Standard Plug-In Fans and Motorized Dampers

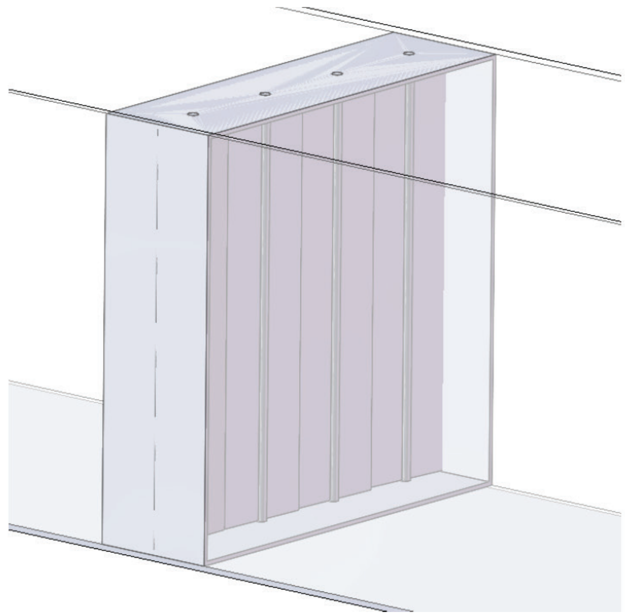
If one places a proprietary damper or fan in a duct and it fails every 15 years while the building lasts 100 years, and the manufacturer stops production after 5 years, then the building will degrade in value due to difficult to obtain replacement parts. The only way to resolve this is to make use of standardized plug-in modules at vent openings.

For example, to replace a fan or motorized damper within a duct, one would remove the vent cover, reach into the duct, remove ~4 bolts, unplug the module, remove through vent opening, and replace with new standardized module, plug-and-play.

Motorized Damper Module

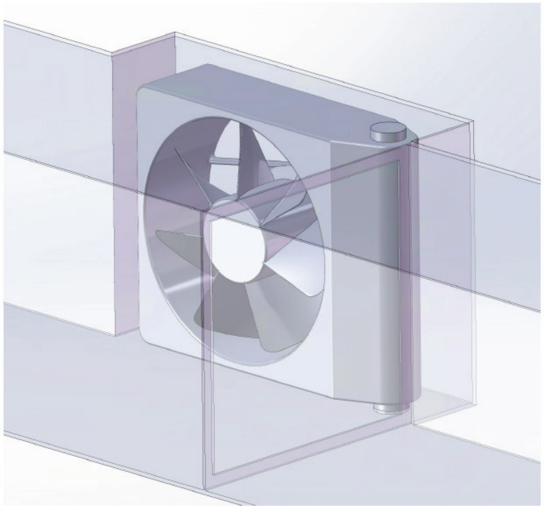
Below is an example of a motorized damper module. This attaches to a bracket via 4 bolts, and the bracket is spot welded to the duct wall. One positions this near a vent opening to support replacement. These would be available in standard sizes which match standard ducts sizes; and standardization would allow one to replace with units from different manufacturers. One could place this in-line to control duct airflow; or place in the channel between duct and vent to control air into one room.



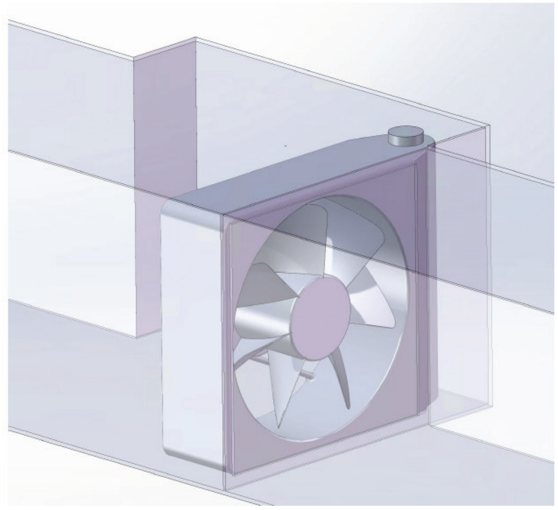


Pivot Fan in Duct Module

Shown here is an example of a pivot fan module which either resides in a storage position while the central HVAC fan controls air; or pivots to an in-line position. If deployed, it can either act as a booster fan while the central HVAC fan is on; or it can move air between rooms while the central HVAC fan is off. A powerful fan might shake; therefore one would need to secure to a hefty bracket that attaches to wood framing (e.g. 2x4) in the wall. Like the above motorized damper, this would be available in standard sizes and it would support replacement near a vent.



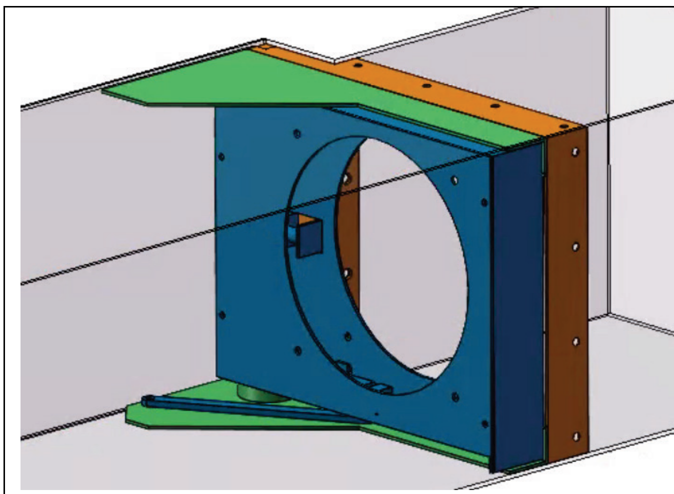
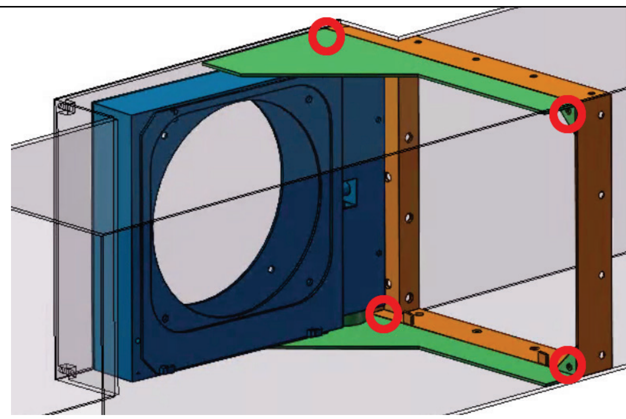
Pivot Fan in the off position

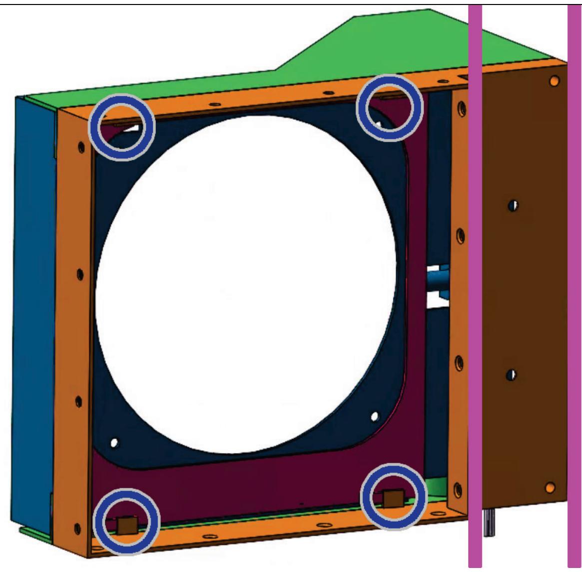


Pivot Fan in the on position

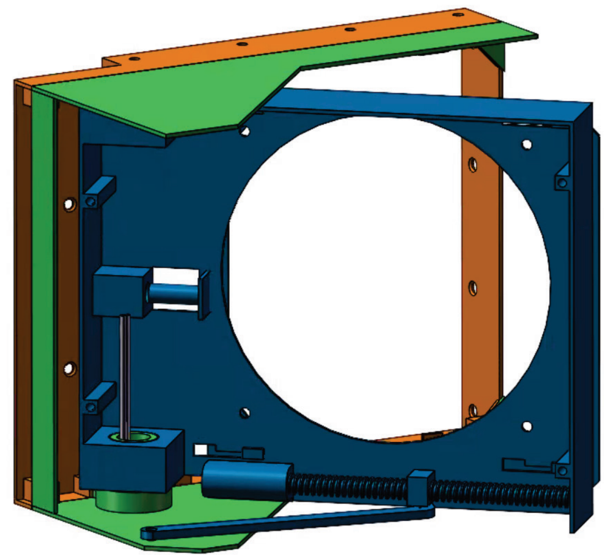
Example Fan Module

Below is an example of a replaceable fan module.

	
Bracket (orange) is spot welded to duct and attaches to module base (green) via 4 bolts. Circular fan (not shown) mounts within pivot assembly (blue). Replaceable module consists of base (green) and pivot assembly (blue). HVAC designer places this near vent, to allow access during replacement.	*Module pivot assembly (blue) is shown here in storage bump-out position, possibly between wood wall framing (e.g. 2x4). During storage, only a small amount of central HVAC air is obstructed. Bolts (red) secure bracket to module base (green), supporting module replacement.*



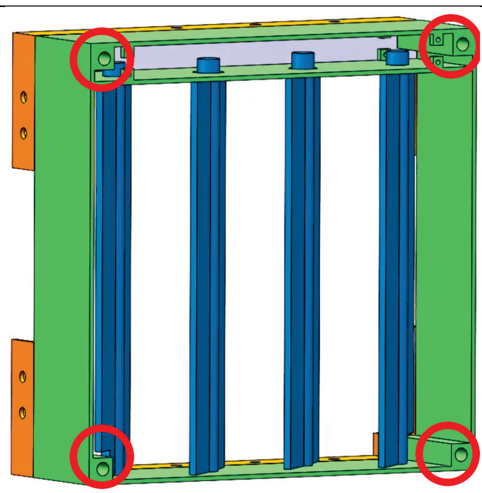
Bracket (orange) secures to wood framing (violet) outside of duct. Fan vibration is transferred from fan to pivot assembly, to bracket, to wood wall framing (e.g. 2x4). Pivot assembly (blue) secures to bracket via sliding locking plate (burgundy) to reduce vibration.



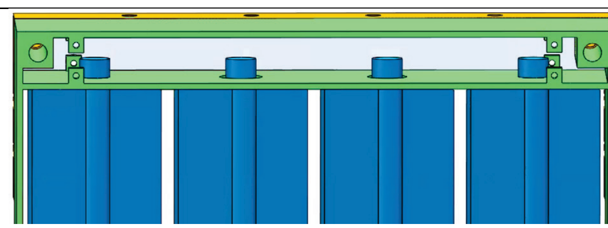
Mechanism rotates pivot assembly (blue) 90 degrees and slides locking plate (on reverse side, not shown). Designers are proposing these to be made in standard sizes, to support replacement by multiple companies over building lifetime.

Example Motorized Damper

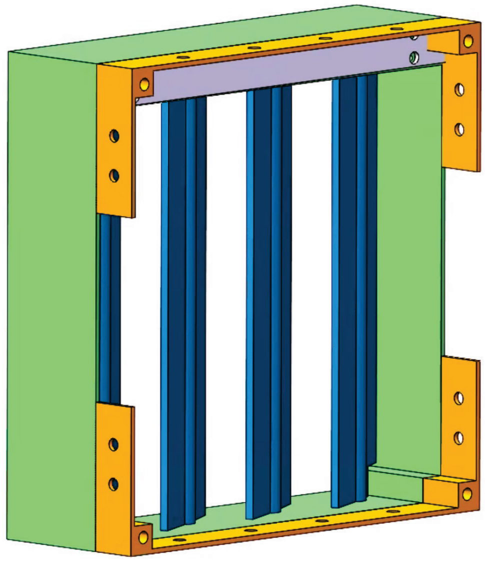
Below is an example of a replaceable damper module.



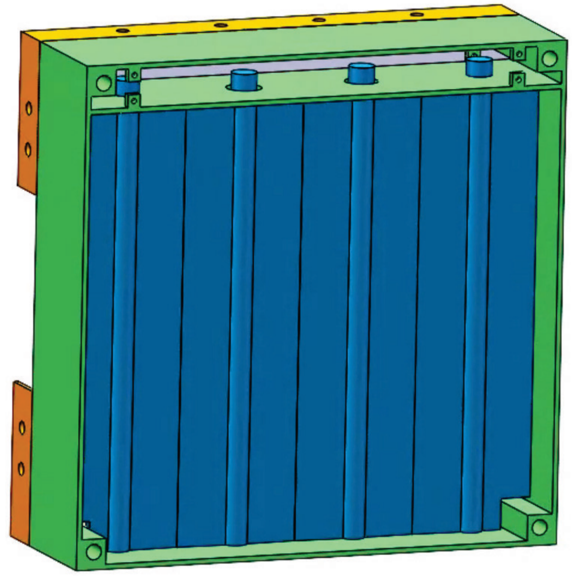
Bracket (orange) is spot welded to duct and attaches to replaceable plug-in module (green) via 4 bolts (red).



Motorized mechanism (not shown) controls damper opening.



System minimizes obstruction of airflow when fully open. HVAC designer places this near vent, to allow access during replacement.



These are made in standard sizes, to support replacement by multiple manufacturers over building lifetime.

Proposed Standard

A standardized system would support replacement by multiple manufacturers, with the hope of ensuring maintenance over a building's lifetime. This requires manufactures to agree on the mechanical interface between bracket and plug-in module, for several module sizes (e.g. 2x10x10 in, 3x12x18 in). More specifically, the following parameters would need to be agreed upon at a standards body meeting: module height, module width, position of bolts, thread size, position of electrical connector, connector type, position of pivot, and thickness of module. Researchers can propose values for several common module sizes; with the hope that industry engineers will later rework to their satisfaction.

Design Problem

Assignment for researchers:

> *Develop free and open networkable HVAC components, including: fans in duct, dampers in duct, fluid valves and pumps (e.g. for heated water, ground source water, and thermal storage water), thermal storage system, ground source system, heat exchangers, and HVAC components. Propose mechanical plug-in standards that support replacement over building lifetime. All components attach to building wiring and network via Smart Building initiative, described previously. Support plug-and-play to reduce installation and design costs. Propose standards that define how components connect together, including mechanics, electronics, and communications. Write free and open software that runs on component processors; and coordinates them in a system. Write software that supports diagnostics, monitoring, trouble-shooting, and user interface. Test components in a system (e.g. dozens of components mounted in 19" rack, components interconnected in small test home).*

Summary

With relatively little money, the world can develop standardized plug-and-play components that provide more control over air.

See Also

For an example of free and open next generation hvac research, click here.