MOVEABLE WALL SYSTEMS

IN THIS SECTION

OVERVIEW

Moveable wall systems, also known as architectural walls or system wall products, are often made by commercial furniture manufacturers. They are frequently used in lieu of conventional wall construction because they are flexible: they can be reused or reconfigured over time while still meeting many of the standards of conventional walls. They are commonly used for private rooms or to serve as a physical separation between spaces. Moveable wall systems offer a wide range of design and finish options to achieve a desired appearance or to feature an interior space.

There are two major types of moveable wall systems on the market: **unitized** and **component-based**.

UNITIZED SYSTEMS

DESCRIPTION

Unitized system products, also known as removeable wall systems, are non-progressive,[1] moveable, and reconfigurable. This type of wall system is usually shipped and delivered in one "unit" and, depending on client requirements, it can also be delivered complete with glass and frame. Electrical, communication, and security requirements are prefabricated and delivered to the site for installation. The product can be removed, relocated, and reinstalled in different layouts with all parts reusable. Examples of different types of unitized systems include: Haworth Enclose, Steelcase V.I.A., Trendway TrendWall, and Allsteel Beyond.

HAWORTH ENCLOSE

STEELCASE V.I.A.

ALLSTEEL BEYOND

TRENDWAY TRENDWALL

[1] A progressive wall is one where installation begins at one end and moves progressively in a linear fashion. With a non-progressive wall, installation can start and stop at any point and work in any direction.

INSTALLATION

Unitized products come in panel form with set widths and heights. Panels are prefabricated and fully assembled off-site. This makes the installation process more efficient, as the products are delivered preassembled and ready for installation on-site.

Panels are pressure fitted in place with concealed fasteners (e.g., carpet and ceiling grippers). This means there is no damage to the finished floor or ceiling surfaces. Typically, dealers provide certified installers (either in-house staff or contractors) to assemble the product.

RECONFIGURABILITY

All of the products are reusable and can be repurposed in new configurations. Old and new panels (if additional panels are needed for new layouts) can be combined, if needed.

ELECTRICAL CABLING

Electrical cabling can be hardwired into the panels with a factory-installed "whip"[2] that allows for connection into a junction box in the ceiling, much like the installation of system furniture panels. Electrical back boxes[3] and conduits[4] for voice, data, and security cabling are built into the panels by the manufacturer, with the actual cabling installed on-site.

STORAGE AND INVENTORY MANAGEMENT

Unlike component-based systems, unitized wall systems cannot be fully disassembled; therefore, they may require more storage space. If some panels cannot be reused in a new layout for certain reasons, they may end up accumulating in large numbers and left in storage over time.

ADVANTAGES AND DISADVANTAGES

Advantages: Unitized wall system products have many advantages, such as faster and more efficient installation. For example, because conduits and back boxes are pre-installed at the factory, installation can be done quickly once delivered to the site. They also offer the option of having wall-mounted furniture; however, pre-planning and precise site measurements are essential before ordering this product.

Disadvantages: The lead time for unitized systems is longer (than for component-based systems) because the panels are specifically manufactured to fit the space where they will be installed. Determining the height between the floor and the ceiling is a critical factor that needs to be verified before manufacturing. This system does have levelling capabilities (achieved by adjusting the top or bottom attachment hardware); however, adjustability for height is limited and varies by manufacturer.

Another disadvantage to unitized wall systems is that the location of outlets and switches cannot be altered after the panels are installed. These systems tend to be larger, so they can encroach into the usable square footage, and replacement glass, if needed, must be provided by the manufacturer (i.e., not locally sourced). In addition, unitized systems are less adaptable; they have a limited capacity for adjustment in the event of unforeseen or changing conditions within the space because the panels have been made to fit within the space they were designed for.

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[2] A whip is a cable (power, voice, or data) embedded into systems furniture or a moveable wall system that is connected to a power source to distribute power.
[3] A back box is what is used to fit the socket to the wall.
[4] An electrical conduit is a closed pipe or channel used to route or protect electrical wiring.

COMPONENT-BASED SYSTEMS

DESCRIPTION

Component-based wall system products, also known as demountable[5] wall systems, are non-progressive, moveable, and reconfigurable. This type of wall product is typically shipped to a site in pieces. The basic partition elements are assembled on-site, giving the product the flexibility of being disassembled, relocated, and reassembled in different layouts, with all parts reusable. Teknion Altos and DIRTT products are examples of component-based systems.

TEKNION ALTOS

DIRTT

INSTALLATION

Component-based systems are delivered on-site as separate component parts. Installation is done in consecutive steps, much like conventional (i.e., gypsum board) wall construction. Ceiling, floor, and vertical components are installed first, followed by any required field-installable elements such as plumbing, electrical conduits and back boxes, and insulation materials, then finished with the installation of fascia panels. The installation process usually takes longer than for unitized systems, as everything is put together at the job site.

Vertical post structures are pressure fitted between the ceiling and floor tracks and secured to both tracks for stability. Ceiling and floor surfaces sustain no damage. Much like the unitized system, dealers typically have their own in-house or contracted certified installers who are brought in to put the product together on-site.

RECONFIGURABILITY

The vertical post structures in component-based wall systems provide reconfiguration flexibility. Fascia panels can be removed, cut, and modified to suit a new configuration. Some fascia materials can be field-modified, and edges can be refinished on-site with new edging material. In addition, some structural components can be altered to work with a new layout.

ELECTRICAL CABLING

Various options for electrical installation are available for component-based systems. The electrical conduits and back boxes can be installed at the factory like the unitized systems, or installed on-site like conventional construction.

[5] A demountable system is one that can be dismantled or removed and readily reassembled or repositioned.

STORAGE AND INVENTORY MANAGEMENT

Component-based wall panels can be fully disassembled and organized in a way that takes up less space in storage facilities. However, managing all the different components can be challenging, requiring an inventory system for managing the different component parts.

ADVANTAGES AND DISADVANTAGES

Component-based systems have many advantages. They have slimmer profiles, their glass can be locally sourced, and their component parts can be cut (trimmed) at the job site. In addition, their lead times are shorter, since all parts are simply ordered and assembled on-site. Like the unitized systems, all dimensions must be verified prior to ordering, especially the height between the floor and ceiling. Component-based systems can also be levelled by adjusting the top or bottom hardware; however, adjustment heights vary by manufacturer.

With component-based systems, electrical conduits and back boxes can be installed at the factory or on-site, but the latter option requires a greater level of coordination.

A disadvantage is that the installation process is longer than it is with unitized systems, since the component parts must be assembled on-site. Assembly usually includes placing the track, erecting metal studs, doing the electrical work, and installing the finished panels.

Table 1: Comparison of Unitized and Component-Based Systems

	Unitized	Component-Based
Installation	Panels are prefabricated and fully assembled off-site, making installation faster and more efficient.	Component pieces are delivered to the job site unassembled, so installation takes longer.
Lead time	Requires a longer lead time because the panels are manufactured to order.	Lead times are shorter because all parts are ordered and then assembled on-site.
Reconfigurability	All of the products are reusable and can be repurposed in new configurations, but not resized.	Fascia material (the material on the panel surface) can be removed, cut, and modified to suit a new configuration.
Adaptability	Less adaptable; limited capacity for adjustment.	More adaptable; greater capacity for adjustment.
Cabling	Cabling whips, electrical conduits, and back boxes are installed at the factory.	Cabling whips, electrical conduits, and back boxes can be installed at the factory or on-site.
Storage	Because they cannot be fully disassembled into their component parts, they require more space to store.	Can be fully disassembled, taking up less space; however, managing inventory (lots of pieces) can be challenging.
Levelling capacity	Some capacity for levelling, but height adjustability varies by manufacturer.	
Size (profile)	Tend to be larger (may reduce usable square footage).	Have slimmer (smaller) profiles and component parts can be trimmed (cut) at the job site.
Glass	Cannot be sourced locally.	Can be sourced locally.

PRODUCT AVAILABILITY AND TRENDS

Both unitized and component-based products come with a wide range of finishes and have the ability to integrate technology and accessories. Each manufacturer offers its own standard products in terms of finishes and sizes, combined with some customization options.

FASCIA MATERIAL

Fascia is the surface material on the panels. Much like a piece of furniture, demountable partition products come in a variety of finish options that are standardized in different grades for pricing purposes. The fascia can be monolithic (one piece) or segmented (joined pieces), and each panel can have a fascia in a different finish.

Each manufacturer offers a set of standard finishes with the option of upgrading (for a premium charge). The most common finishes are: low- and high-pressure laminates, fabrics, vinyl wall coverings, painted medium-density fibreboard (MDF), wood veneer, glass, metal, and solid surface. The fascia can also be replaced with accessory boards, whiteboards or other writable surfaces, a "tack-able" surface (i.e., surface can accept tacks to pin items to surfaces), and back-painted glass. Depending on the manufacturer, these finish options have varying levels of environmental sustainability. Sustainable finishes include those with low or no volatile organic compounds (VOCs) or urea-formaldehyde, those with recycled content or that contain wood products certified by the Forest Stewardship Council (FSC), or products that are locally sourced.

Trims and frames are usually offered in aluminum finish, white, grey, or black. The trim and frame can be sourced from more sustainable sources that use recycled materials.

INTEGRATION OF PLUMBING AND ELECTRICAL SERVICE

Electrical and plumbing service can be integrated within the wall cavities of both unitized and component-based panels, with the exception of full-height frameless glass panels, where outlets can be installed only at the base. Unitized panels require pre-planning of outlets and switch-control locations, because the panels must be hardwired during the manufacturing process. However, services for component-based products can be integrated at the job site, or they can be ordered prewired or with modular connections.

Depending on the products, some manufacturers offer the option of integrating outlets in the base trim, leaving the fascia with a clean look. Some offer the option of integrating the outlets in a vertical post that can be installed between glass panels.

Plumbing elements for sinks and dishwashers in kitchenettes can also be incorporated into these types of wall systems, as long as the pipes fit in the wall cavity. Each panel comes in a set thickness (typically 4 inches [10 centimetres]), but some products have the capability of increasing thickness, which would allow for more substantial plumbing services to be installed within the walls.

DOORS AND HARDWARE

Solid doors and glass doors of different types and sizes are available for wall system products. Doors are part of the wall system package and come in many different options. Standard door options include: sliding, reversible pivot, and hinged. Aside from glass doors, the typical doors supplied by the manufacturer are either paintable MDF or laminated.

Doors do not need to be supplied by the wall system manufacturer; they can be provided by the client or the general contractor, but this would normally need to be communicated before the contract documents are completed. The installation of these doors is no different than the installation of manufacturer-supplied doors.

In terms of hardware, wall system manufacturers typically have very few options. If needed, the manufacturer can prepare the supplied doors to accept the hardware provided by the client or general contractor. Security hardware and devices (e.g., card readers, electrical strikes) for high-security rooms can also be integrated if the wall system manufacturer has been provided with the details of the security requirements ahead of time. This will allow them to prepare the doors and frame to accept these devices when the wall systems are delivered to the site. Coordination between the security contractor and the wall system installers will be required.

STRUCTURAL ADVANTAGES

Moveable wall systems allow for the hanging (suspension) of millwork, furniture, storage units, and accessories right on the panels—with no additional support or blocking required. The total load that one wall system can hold depends on the size of the panels and whether the load is on one side or both sides of the wall. Each manufacturer has a different allowance range based on the construction of their product. However, a typical single-wall system can hold between 50 and 150 pounds (23 to 68 kilograms) of suspended add-ons. Additionally, if blocking is required within the wall panels, the general contractor would install it. Coordination between the installers and the contractor would need to take place on-site before the walls are closed.

Seismic reinforcement is built into wall system products installed in most regions, including Ottawa–Gatineau. Dealers typically have the seismic bracing for the wall systems reviewed and stamped by a certified structural engineer as part of the product package.

TRENDS

Let there be light

Clean lines and frameless full-height glass panels are becoming a popular choice for office interiors in part because of their ability to let light pass through. Natural daylight is an important element that supports both mental and physical health.

"Why Light Matters: Designing with Circadian Health in Mind," [6] an article by Ed Clark and Marty Brennan of ZGF Architects, explains the benefits that a well-lit daylight environment can have on occupants in the workplace. The authors teamed up to create a tool to analyze the "impact of design decisions on the circadian light resource."

Having access to natural daylight, say the authors, can closely affects human circadian rhythms.

In the twentieth century, improvements in mechanical and electrical systems in buildings reduced the need for occupants to be located close to exterior windows to access fresh air or light. This resulted in occupants spending the majority of their day sitting in workstations with high panels, or in enclosed offices with no windows. In effect, this built environment severed the link between humanity and nature. "Recognizing this

[6] Ed Clark and Marty Brennan, "Why Light Matters: Designing with Circadian Health in Mind," *Metropolis*, http://www.metropolismag.com/interiors/healthcare-interiors/why-light-matters-designing-with-circadian-health-in-mind (

grand deficiency," the article notes, "we architects, who regularly incorporate metrics-based daylighting strategies and principles of biophilia[7] in our work, are pushing toward solutions that are in tune with our natural heritage, that support human physiology, and that can elicit a greater tie to the local context and the cycle of the day."

Allowing natural daylight to penetrate into the office space increases the well-being and productivity of the occupants, which is the reason why glass panels have become increasingly popular. In addition, full-height glass panels offer a simple yet elegant appearance, providing a physical division between spaces while still creating openness. A disadvantage to such panels is they are normally constructed with single-layer glazing. As a result, they can achieve a sound transmission class (STC)[8] rating of only about 35, making them unsuitable for areas where speech privacy is important.

Not just for offices

To date, moveable wall systems have been used mainly in office spaces. In recent years, however, they have been used in many other applications. For example, for hygienic reasons, they are a good choice for examination rooms in health care environments due to their smooth, easy-to-clean, non-porous surfaces. They have also been used as feature walls in reception areas because of their flexibility and ability to integrate technologies.

[7] Introduced by Edward O Wilson in 1984 in his book *Biophilia* (Cambridge, Mass: Harvard University Press), *t*he biophilia hypothesis suggests that humans possess an innate tendency to seek connections with nature and other forms of life.

[8] STC is a numerical system that assigns a value according to how well an acoustic barrier (e.g., wall, partition, door) blocks human speech sounds. The higher the rating, the more effective the barrier is at blocking sound. See Document *Acoustic Requirements for Open Spaces*.

COST-BENEFITS AND PRODUCT LIFE-CYCLE COSTING

INSTALLATION COST

It is recommended that only certified installers be used with moveable wall systems to ensure the products are properly installed. Whether the products are unitized or component-based, only one trade is needed for the installation. Since the product measurements and locations are determined at the planning stage, the installation time is reduced significantly; installers will simply put up the products exactly where they are planned to go.

RECONFIGURATION COST

The cost to reconfigure a space using moveable wall systems is minimal, whether the reconfiguration is due to relocating, repurposing, or refinishing. All parts of the product can be disassembled for easy relocation, change of service or technology, and fascia replacement. Detailed planning with proper tools helps in managing all the parts being installed, and in determining what additional parts will be required for new locations. Disruption to occupants during the reconfiguration is negligible due to the minimum amount of work and labour required, and minimal noise and waste generated.

Since a moveable wall system is installed in a way that it does not damage any floor or ceiling surfaces, there is minimal repairs required to areas where the walls are removed.

LIFE-CYCLE COST

The initial cost of a moveable wall system is high when first purchased. However, in the event of multiple site renovations—something that most organizations go through—the reconfiguration and repurposing of this product becomes justifiable. Like furniture, moveable wall systems become part of the site's assets. Plus, the installation costs are lower than conventional walls, since only one or two installers are needed to put the product together; no drywall specialists or painters are required, saving on labour costs.

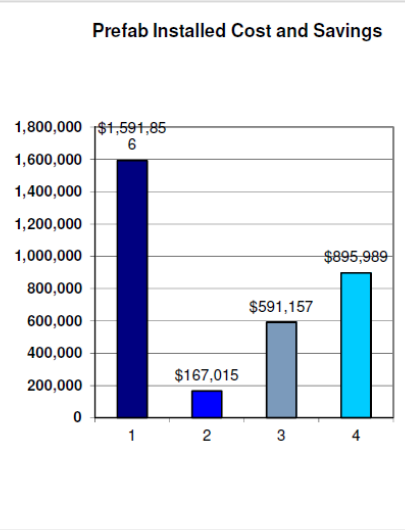
In conventional construction, 70% of the budget is spent on labour, contingencies, fees, and conditions—none of which is required for moveable wall systems. When it comes time to change the space, the cost of having an installer disassemble the product and move it to its new location is far lower than the cost of demolishing a conventional wall, patching, and repairing, constructing the new walls, and cleaning the area of dust. In addition, with all the finish options available for these walls (glass, vinyl, etc.), they can easily be maintenance-free, reducing costs for cleaning and repairs or touch-ups.

The Workscapes case in Figure 1 study also looked at the waste rate for carpet laid in conventional construction (where carpet is laid after the walls are built) compared with fit-ups using moveable wall systems (where carpet is laid before the wall systems are installed). Thus, the waste generated from carpet installation (rolled goods) is 13% to 20% in conventional construction compared with only 1% to 2% in moveable wall system installation. The difference, however, is much smaller when using carpet tile, ranging from 3% to 5% in conventional offices and 1% to 2% when the carpet is installed in conjunction with moveable wall systems.

Figure 1: Possible Cash Benefits of Sustainable Prefabricated Interiors Versus Conventional Construction

Cost Premium or (Savings)	$177,514	12.55%

SAVINGS		Cash savings/recovery by going prefab			
		After 1 year	After 3 years	After 5 years	Settings
Details	Churn	$ 42,065	$ 128,434	$ 219,156	10%
Details	Reconfigurations	$ 49,421	$ 151,146	$ 258,485	5%
Details	Tax Benefits	$ 75,528	$ 311,577	$ 418,347	40%
Details	Construction Schedule	-	-	-	-
Details	Contractor Overhead	$ -	$ -	$ -	10%
	Cumulative Cash Difference	$167,015	$591,157	$895,989	
	Per Square Foot Savings	$ 2.78	$ 9.85	$ 14.93	
	% Total Project Cost Recovered	10.49%	37.14%	56.29%	
	Other Savings*	$0	$0	$0	



Source: Workscapes (no title), February 2013, https://issuu.com/workscapes/docs/dirtt_iceberg.

"Skeptic to a Believer" is a case study prepared by DIRTT on one of their larger-scale projects, the fit-up of an office building comprising 35,600 square feet. That study looked at the cost difference between conventional wall construction and moveable wall installation throughout each stage of the project. During the schematic design phase, for example, the budget was estimated at $2,443,342 using a conventional approach. As it moved to the design development stage, the budget was lowered to $2,383,866 when the approach was switched to moveable wall systems. The final pricing for the project came in at $2,229,699, demonstrating an overall cost saving of $213,643. Figure 2 shows a detailed breakdown of each trade and how the cost saving was achieved.

Figure 2: Prefab Interior Construction—Post-Project Analysis

CSI Code	Trade Description	SD Budget	DD Budget	Bid Pricing/ GC Award	DELTA Savings	Savings per USF
15130	Protection/Cleaning	125,720	76,235	40,740	(84,980)	(2.39)
81000	Doors/Frames/Hardware	99,450	45,000	25,545	(73,905)	(2.08)
88000	Glass and Glazing	109,259	42,000	48,550	(60,709)	(1.71)
92900	Drywall	397,015	85,000	136,100	(260,915)	(7.33)
95000	Acoustical Ceiling	196,293	134,000	119,115	(77,178)	(2.17)
96000	Flooring & Base	200,582	162,000	143,000	(57,582)	(1.62)
99000	Painting	96,234	41,855	32,640	(63,594)	(1.79)
102219	DIRTT Walls	-	781,087	781,087	-	21.94
210000	Fire Protection	84,318	63,456	54,450	(29,868)	(0.84)
220000	Plumbing	53,500	48,000	31,425	(22,075)	(0.62)
230000	HVAC	436,789	367,239	329,500	(107,289)	(3.01)
260000	Electrical	513,765	438,000	396,706	(117,059)	(3.29)
-	Permits	45,417	33,994	25,841	(19,576)	(0.55)
-	General Conditions	85,000	65,000	65,000	(20,000)	(0.56)
	SUBTOTALS	**2,443,342**	**2,382,866**	**2,229,699**	**(213,643)**	**(6.00)**

CSI = Construction Specifications Institute; SD = schematic design; DD = design development; GC = general contractor; USF = usable square foot.
Source: "Skeptic to a Believer: Prefab Interior Construction—Post-Project Analysis" (no date),

If the ceiling height in a new space is higher than the top of a previously purchased moveable wall, some manufacturers can supply an add-on to the wall for a seamless appearance. There will be a cost to this add-on, but it will allow the reuse of the existing products.

Architectural wall systems have the potential to last through multiple organizational changes, and every manufacturer offers a limited warranty of 5 to 10 years on their wall products.

ENVIRONMENTAL BENEFITS

According to Cornell University,[9] in conventional construction, about one pound of drywall goes into the landfill for every square foot of drywall installed. Drywall waste is generated from cutting the panels to suit ceiling heights, when creating openings for doors and windows, and when making changes to the space after the initial fit-up. Research shows the average rate of drywall waste ranges from 10% during renovation, 12% during manufacturing, and 14% during demolition, to 64% during new construction. [10]

The major wall system manufacturers (e.g., Teknion, Steelcase, DIRTT, Allsteel, Haworth) all stress that they are seriously committed to sustainable production. The common characteristics shared between products in terms of sustainability are the use of materials with high levels of recycled content and high recyclable rates. They also contribute to better indoor air quality, lower waste reduction during production and delivery, and the manufacturers offer recycle programs to maximize recycle rates at the end of product life.

Architectural wall systems meet LEED certification for commercial interiors, thus supporting a healthy work environment. Compared with conventional construction, they have numerous benefits when it comes to sustainability.

Using architectural wall products in projects enable the collection of points toward achieving LEED certification, including LEED CI (commercial interiors), LEED CS (core and shell), LEED NC (new construction) and WELL Building Standard. There are a number of different types of potential credits that can be earned by installing moveable wall systems:

- energy and atmosphere
- material and resources
- indoor environment quality
- innovations and design process.

Green Globes certification is another rating system and building management tool. Developed to assist architects and builders of sustainable commercial buildings and licensed under the Green Building Initiative, Green Globes is designed to guide green building best practices for property developers, building owners, and facility managers and result in better building performance. There are seven main sections under this rating system:

- project management policies and practices
- site
- energy
- water
- resources, building materials, and solid waste

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[9] Joseph Laquatra and Mark Pierce, "Waste Management at the Construction Site," *Integrated Waste Management, Volume I* (2011), https://doi.org/10.5772/16501.

[10] California Integrated Waste Management Board, Wallboard (Drywall) Recycling (2009), cited by the Environmental Protection Agency in "Drywall," https://www3.epa.gov/epawaste/conserve/tools/warm/pdfs/Drywall.pdf.

- emissions, effluents, and other impacts
- indoor environment

DEMOLITION AND CONSTRUCTION

Once assembled, moveable walls have the same performance and appearance as conventional wall construction but without the issues associated with the installation of the latter, including waste, demolition, airborne dust and pollutants, and disruptions to tenants. Gypsum board creates a significant amount of dust and debris when cut and installed (nailing, taping, sanding, etc.). With moveable walls, the wall components are manufactured according to the project specifications, minimizing any possible dust generated on-site. However, as mentioned under component-based systems, while some cutting can be initiated on-site, it is still minimal compared with conventional construction. When moveable walls need to be reconfigured or remounted, minimal airborne dust is generated versus the demolition and construction of a new gypsum partition. Typically, moveable walls are taken apart piece by piece and reassembled with ease.

The Workscapes case study shows that the amount of waste generated when redesigning and renovating a typical 60,000 square foot office interior is significantly reduced when using moveable walls.

FINISHES

Architectural wall panels from the major manufacturers, which are prefinished in the factory prior to arriving at the construction site, are produced using low-chemical-emitting and GREENGUARD-certified materials.[11] During installation and reconfiguration, no dust or debris is generated. In conventional construction, a significant amount of dust and debris are generated by cutting gypsum wall boards. Even though low VOC paints are available, painting still emits fumes. Furthermore, multiple coats of paint are usually required to achieve a smooth finish on the wall, and each coat of paint takes hours to dry. Consequently, painting is usually done after-hours if the floor is occupied, which leads to occupants being exposed to paint fumes for days during the space modification.

Additionally, moveable walls come in pre-selected colours and finishes, which eliminates the need to paint or varnish on-site, reducing the potential for VOCs and off-gas emissions, which affect indoor air quality.

GLAZING

Architectural walls allow for light to penetrate the building's core using glazed panels. Glazing reduces the building's energy consumption by increasing the amount of daylight utilized within the space. Although conventional walls can also accommodate glazing to increase the amount of daylight, they are more expensive because they are not as reconfigurable. Glazing in moveable walls is easily reconfigured to match changes in the space. The DIRTT Workscapes case study (Appendix C), shows that the cost of glazing in moveable walls is 76% less expensive than for conventional walls.

[11] GREENGUARD certification is part of Underwriters Laboratories (UL) Environment, which helps manufacturers create—and buyers identify—interior products and materials that have low chemical emissions, improving the quality of the air in which the products are used. See http://greenguard.org/en/index.aspx.

MANUFACTURING

Careful planning of moveable walls reduces the amount of construction-related waste that would otherwise be sent to a landfill. (Hydrogen sulfide gas, which is produced when gypsum from conventional walls is sent to a landfill, may become toxic at high concentrations.) With moveable walls, each part is made or cut to the exact dimension required so that minimal waste is generated during the manufacturing process, and no waste is generated on-site.

Architectural walls are 100% reusable, allowing the space to be easily adapted for future use. When a space needs to be reconfigured, moveable walls greatly reduce construction downtime.

ACOUSTICAL PERFORMANCE

All the moveable wall system manufacturers (e.g., Teknion, Haworth, Allsteel, DIRTT, Steelcase, Trendway) test their products for acoustical performance, which differs depending on the materials used and the way the product is constructed. The result of the testing also varies and depends on whether the product was tested in a laboratory or in the field.

The acoustical rating for glass panels ranges from STC 30 to STC 44, assuming the glass used is at least 6 mm thick. STC ratings for glass are influenced by the type and thickness of glass installed in the panels, and the number of layers of glass.

Solid panels usually have much STC higher ratings because of how they are constructed. For example, insulation material within the wall cavity helps increase the sound rating. The rating for solid panels ranges from STC 39 to STC 45. STC ratings for solid panels are affected by several factors: the type of fascia material and whether the panel is segmented or a full (monolithic) piece, the thickness of the product, the type and amount of insulation material, and the size and number of penetrations made when installing electrical or other services.

Although the products are tested for their acoustical performance, the surrounding environment has a significant impact on the true acoustical level of the space. For example, the type of ceiling, whether or not there is a sound barrier in the ceiling plenum[12] area, and the number of mechanical connections from one space to the other all play an important role.

[12] A plenum is a separate space provided for air circulation for heating, ventilation, and air conditioning.

GAP ANALYSIS of ARCHITECTURAL SYSTEMS VERSUS CONVENTIONAL

	MOVEABLE WALL SYSTEMS	**CONVENTIONAL WALL CONSTRUCTION**
FINISH	Architectural walls come in various finishes, all of which are applied during the production stage. The amount of finish options is limited, and customization of fascia shape and size is a challenge. Walls are always segmented either vertically or horizontally, and visual separation between panels is always visible. Quality and consistency of finish, however, can easily be maintained. Since the wall panels are installed on top of finished flooring material, it allows for continuous flooring installation; no floor patching or repairing will be required after the wall panels are removed or reconfigured.	Conventional walls can be finished on-site with all kinds of finish materials. Walls can be constructed at any height and in any shape and it is possible to achieve a seamless appearance on a long span of wall surface. Custom and special finishes can be applied; however, quality and consistency of the final product can vary depending on the craftsmanship of the contractor. Usually, walls are constructed on top of the floor slab, and built before the floor finishes are installed. Continuous flooring installation is not possible, which means that patching and repairing will be required after the walls are removed. Reconfiguration means that demolition and reconstruction are required, resulting in more destruction from construction and gypsum board work. Modifications with conventional wall construction take longer than with wall systems.
ACOUSTICAL PERFORMANCE	Wall systems have a set sound rating for each product. Modifying a product to improve the sound rating is difficult and can be costly. No plenum barrier is available from the manufacturer, so it is usually purchased separately and then installed by a contractor.	Conventionally constructed walls can achieve different sound ratings by using differing amounts and sizes of walls boards, metal studs, insulation material, and different kinds of metal channels. Modifications can be made to the walls to improve the sound rating—even after the walls are constructed. To improve the sound rating, walls can be constructed continuously from the floor to the ceiling slab.
SECURITY	Wall systems are secured in place with floor and ceiling channels. They can be disassembled easily by a skilled installer using the proper tools. Segmented panels do not allow for the installation of wire mesh or sheet metal. The ceiling plenum is open, unless a plenum barrier is installed.	Security elements can be installed continuously from the floor slab to the ceiling slab. The wall cannot be disassembled. Wire mesh and sheet metal can easily be incorporated to accommodate high-security requirements.

	ARCHITECTURAL WALL SYSTEMS	CONVENTIONAL WALL CONSTRUCTION
LOAD BEARING	Can support a restricted amount of load on the panels. Not designed to bear any load from the building structurally.	Can support a significant amount of load on the walls by installing blocking and additional vertical and horizontal stiffeners. Conventional walls can be constructed to support structural loads from the building.
ADAPTABILITY	Designed to be adaptable. The system can be disassembled at any time to allow for changes to the finish, replacement of damaged parts, upgrading of technology, and new configurations.	Fixed in place. Modifications or replacement of any elements, such as the millwork or the technology that is built in to the walls, can easily result in excess labour and material cost, and waste.
SURFACE-BURNING PERFORMANCE	Typically has a flame-spread index of less than 200 and a smoke-developed index of less than 450 when tested using ASTM E84, the best-known test for developing ratings.[13] Typically, materials used in a building will be categorized by flame-spread rating and flame-spread class (I, II, or III). The lower the rating and class, the more resistant it is to fire: • class I: flame-spread rating of 0 to 25, smoke-developed index of 0 to 450 • class II: flame-spread rating of 26 to 75, smoke-developed index of 0 to 450 • class III: flame-spread rating of 76 to 200, smoke-developed index of 0 to 450.	Has the flexibility of being fire-rated, as there are many options of fire-rated materials that can be utilized to meet the desired rating.

[13] A flame-spread rating is a way to compare how rapidly a flame spreads on the surface of one material compared with another. A smoke-developed index measures the concentration of smoke a material emits as it burns. The American Society for Testing and Materials (ASTM) E84 standard test method measures flame growth on the underside of a horizontal test specimen, commonly known as the tunnel test.

COST COMPARISON

	ARCHITECTURAL WALL SYSTEMS	CONVENTIONAL WALL CONSTRUCTION
COST OF WALL METHOD	Varies from product to product, project to project, and region to region. Selection of finish materials, thickness of glass, and the project scale all have an impact on the final cost of the installation. The costs in the following rows are provided by dealers (all amounts are an approximation). Technology integration is not taken into consideration for this comparison.	Varies from contractor to contractor, project to project, and region to region. The type of walls being constructed, the chosen finishes, and the timeframe allowed for the installation affect the final cost of the installation.
INITIAL COST	Solid panels: • material: $200 to $600 per linear foot • labour: $100 per linear foot Glass panels: • material: $200 to $600 per linear foot • labour: $100 per linear foot Sliding doors with hardware: • material: $2,000 to $3,800 each • labour: $300 each Hinged doors with hardware: • material: $1,800 to $2,500 each • labour: $300 each Electrical outlets: • material: $100 to $250 each • labour: $20 each	Solid walls: • material: $50 to $300 per linear foot • labour: $21 to $25 per linear foot Glass walls: • material: $140 to $250 per linear foot • labour: $45 to $71 per linear foot Sliding doors with hardware: • material: $1,500 to $2,500 each • labour: $600 each Hinged doors with hardware: • material: $1,400 to $3,400 each • labour: $230 to $430 each Electrical outlets: • material: $213 each • labour: $172 each
RECONFIGURATION COST	Less waste: Approximately 90% of the material can be reused in a new reconfiguration; 10% will be new material, reducing the amount of waste.	More waste: Approximately 10% of the material can be reused if it has been removed with care, and 90% will be new material.
OVERHEAD, PROFIT, AND OTHER COSTS	Usually, 15% of material and labour costs will be added on top of the cost for each trade, if trade costs are carried by the general contractor. The trades involved in moveable wall systems include the installer of the wall systems and the electrical tradespeople.	Usually, 15% of the overall material and labour costs will be added on top of the cost for each trade. There are many trades involved in a conventional construction project (e.g., painter, drywall installer, flooring contractor, electrician). The effect of inflation on material and labour costs should also be taken into account when considering the overall cost.

IMPACT ON PROJECT SCHEDULE

MOVEABLE WALL SYSTEMS

The lead time for a moveable wall system is six to eight weeks, depending on the manufacturing schedule. The installation of a wall system does not affect the work to be done by other trades, but it is usually performed after all other trades have completed their scope of work. The installation can be very smooth if all other architectural elements are constructed as per plan. The overall installation of the moveable wall panels can be three to four weeks faster than conventional wall construction.

CONVENTIONAL WALL CONSTRUCTION

The materials for conventional construction are rapidly available and can be purchased from many suppliers. The construction of the walls is dependent on many different trades. The framing of the walls will need to be completed first, followed by the installation of electrical, cabling, and plumbing and, most likely, built-in technology. Once all services and blocking are installed, the walls can be closed with gypsum board. Taping and sanding of gypsum board is labour-intensive and can generate dust that will need to be removed before other materials can be installed. If the walls are being painted, the application of multiple coats and the drying process will take several days. If one trade fails to complete its work as per the schedule, all other trades are impacted, and the project will be delayed.

REUSABILITY, RECYCLABILITY, AND ENVIRONMENTAL IMPACT

Commercial construction places a heavy burden on landfills, as approximately 25% to 55% of all landfill waste is from construction, renovation, and demolition. During construction, approximately 12% of the gypsum board will end up as scrap in a landfill from off-cuts and, as mentioned earlier, for every square foot of drywall installed, approximately one pound of drywall is sent to the landfill. Moveable wall systems, however, are produced with post-consumer recycled material, and almost all parts are reusable and recyclable, with the exception of some fabric options; thus, minimal waste will go to the landfill if diverted properly at the end of the product's lifespan.

Consider a typical office fit-up: there is initial construction to prepare the space for tenant occupancy. Then, over time, churn within an organization results in further renovation of the tenant space being required. These renovations result in demolition and construction waste, swing-space requirements (either within the tenant's existing space portfolio or additional rented space), potential employee downtime, and a decrease in employee productivity. Off-gassing, dust, and debris from construction activities can cause discomfort to employees.

In addition, if the tenant's space requirements change and they move to a new location, the capital invested in the interior construction cannot move with them.

RECOMMENDATIONS

Moveable wall systems have countless benefits in commercial fit-ups, and there are many reasons to choose them over conventional wall construction.

Moveable wall systems can **adapt** to changes to the office landscape:

- panel and door assemblies can be removed, relocated, and reinstalled in new layouts, with all parts reusable
- most systems allow panel faces to be interchanged over time to adapt to changes in design trends and room function
- architectural walls become assets; they can move with the tenant to future spaces.

Moveable wall systems **shorten construction and renovation** schedules:

- panels are manufactured off-site and are significantly faster to install on-site than conventional (gypsum board) partitions
- panels can be manufactured pre-wired, reducing the amount of on-site electrical work required
- swing-space requirements are reduced as reconfigurations and builds require less time to complete; plus, fewer employees require swing space during minor renovations because adjacent areas are not affected by the reconfigurations of moveable walls
- disruption to existing occupants is reduced.

Moveable wall systems create more **environmentally sustainable** spaces:

- panels are delivered to site prefinished, so there is no off-gassing from on-site painting and finishing activities
- waste —from reconfigurations, demolition, and renovation—is eliminated, as all parts of the wall system are fully reusable
- many systems contain high amount of recycled content in the panel and door assemblies
- many systems components can be recycled at the end of their life cycle
- manufacturers reuse product packaging or it is recyclable
- the manufacturing process results in fewer trades being needed on the construction site, reducing vehicular emissions.

While moveable wall systems are preferable in many ways, conventional wall construction cannot be eliminated completely. For example, conventional construction is superior when it comes to acoustics, fire rating, and security. When deliberating between the two, both the project budget and user requirements must be taken into consideration. In addition, the length of the lease for the space, the possibility of future organizational changes, and how the space will be used will all have an impact on the decision.

See Appendix A for detailed information on wall systems for six different manufacturers according to different technical specifications, including: framing and structural connections, whether panels can be cut/trimmed on-site, available sizes and finishes, available hardware, sustainability, door sizes and frames, technology, and other factors.