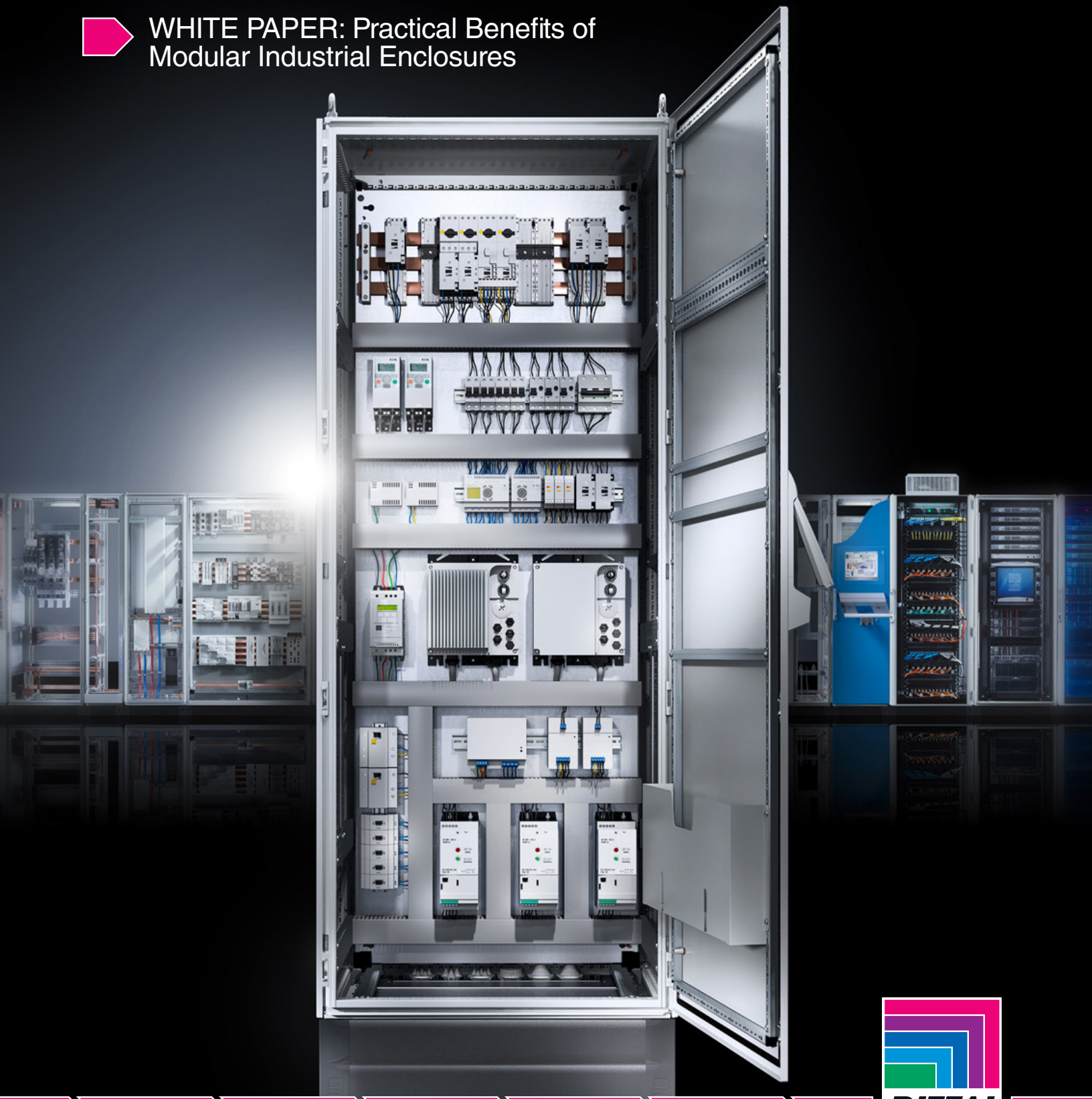
Rittal – The System.

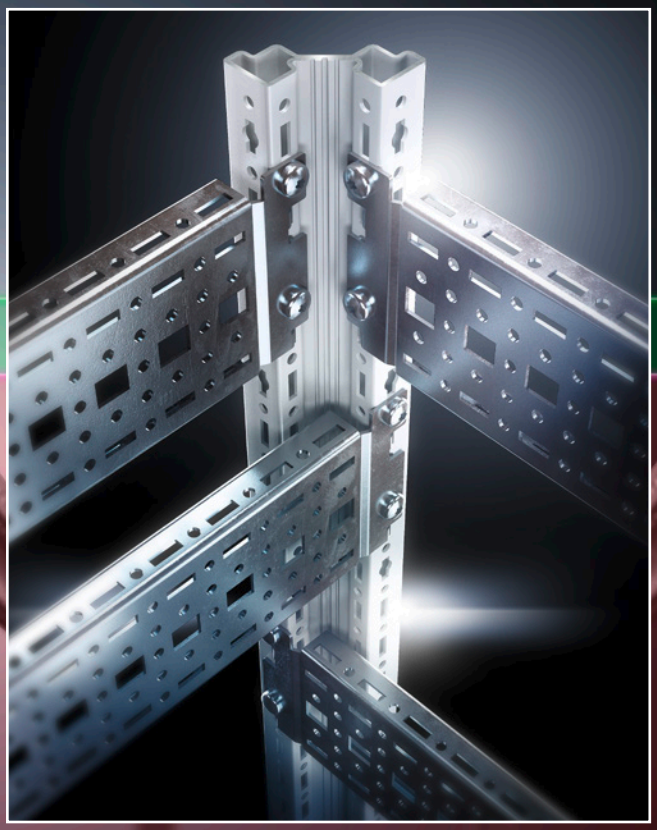
Faster – better – everywhere.

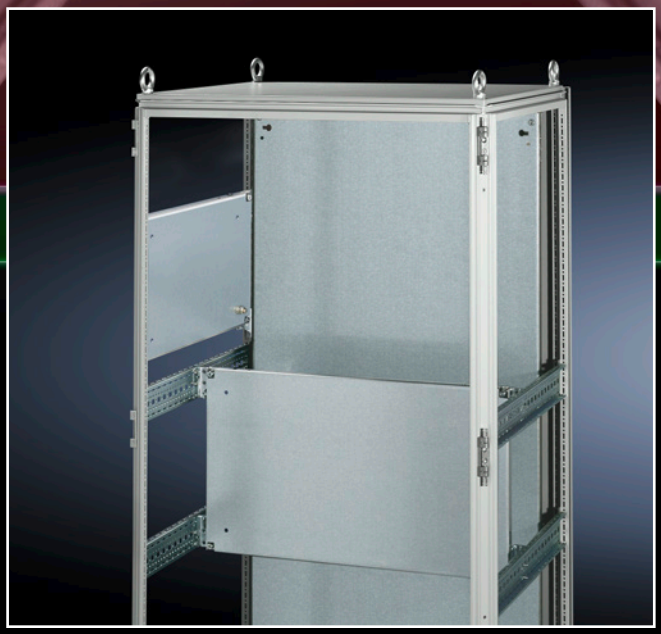
WHITE PAPER: Practical Benefits of Modular Industrial Enclosures



ENCLOSURES | POWER DISTRIBUTION | CLIMATE CONTROL | IT INFRASTRUCTURE | SOFTWARE & SERVICES

FRIEDHELM LOH GROUP





Executive Summary

Modular freestanding enclosures offer a number of key advantages when compared to traditional unibody enclosures. Many times these attributes are overlooked either out of a false perception of increased enclosure costs, reluctance to change, or a simple lack of awareness to the possible benefits of modular solutions.

This white paper seeks to provide a more clear understanding, for designers, integrators and end users alike, of the benefits offered by modular enclosures. Examples will be made to demonstrate the savings that can be realized over the lifespan of an enclosure after factoring in common use and operating costs such as maintenance, modifications and expansions associated with typical industrial applications.

Definition of Modularity

The strength (both literally and figuratively) of a modular enclosure lies with its frame. The frame consists of metal forms with a series of holes spaced at standardized units of dimensions such that common accessories can be added to the interior without drilling or welding. Multiple frames can be joined together (side-to-side, back-to-back, side-to-back, top-to-bottom, etc.) to create infinite configurations. This flexible arrangement is accompanied by an ease of use. Conversely, traditional unibody enclosures are folded sheets of metal with welded seams designed for singular use. Changes are very difficult without costly fabrication techniques

Common Functionality

Although construction methods vary, the most basic functions for either modular or unibody enclosures are the same. Both serve as a place to safeguard workers from electrical equipment and safeguard electrical equipment from the environment. Each can be certified to NEMA 250 and UL 50/50E standards to offer the same protection ratings (3R, 12, 4, 4X, etc.). While the main goal of a unibody enclosure ends there, the modular enclosure strives to provide more. With a modular system the designer, integrator, and end user has the freedom to make assemblies as basic or complex as they wish.

Tangible Differences

The physical differences between modular and unibody enclosures provide the first discernible advantages. The most basic differences are described below.

Gasket

The most basic of unibody enclosures use a peel-and-stick strip gasket for the door seal. Most modular enclosures feature a foam-in-place gasket that is poured continuously around the perimeter of the enclosure skin (door, sidewall, etc.) such that no gaps exist. This provides an overall better seal with memory retention. Some unibody enclosure manufacturers have switched to foam-in-place gasket following the modular enclosure lead.

Hinge/Latch

Virtually all unibody enclosures use a piano hinge for their doors. Latching is done with multiple clamps around the door perimeter or a 3 point latching handle. Modular enclosures feature discrete, captive hinging that is hidden from view for greatly improved aesthetics. The modular design allows for scalable door latching which some manufacturers take advantage of and offer 4-point latching.

Paint

Any plain carbon steel enclosure will be required to be painted for corrosion protection. The paint of choice is generally powder paint, known for its hard durable finish. In a closed frame modular enclosure, the addition of an electrophoretic dip-coat primer adds a level of protection beyond which the unibody enclosure offers. This two-part primer and powder coat combination ensures maximum corrosion resistance and durability.

Mounting Panel

The most commonly modified part on any enclosure, the mounting panel, differs in both construction and ease of use. Unibody panels are generally painted steel and constructed with an L-fold around the perimeter to stiffen them. Modular panels are generally zinc-plated steel allowing for an easier, more accessible ground that does not require the scraping of paint. They may also feature a C-fold for easier handling and greater strength.

The modular enclosure design allows for the addition of rails making it possible to slide the panel into and out of the front, side, or rear enclosure openings. This saves time and increases safety when compared to the unibody technique of laying the enclosure on its back and lifting the panel with a crane or forklift.

The construction of a modular enclosure allows for a greater opening and thus a larger mounting panel when compared to a unibody cabinet. Also, because the modular enclosure can be ordered without a cable plinth, the overall size of the unit can be enlarged further increasing the panel size.

	Typical Mounting Panel Comparisons For Free-Standing Enclosures						
	Unibody			Modular			
	Enclosure Size	Panel Size	Panel Area (ft^2)	Enclosure Size*	Panel Size	Panel Area (ft^2)	% Dif
Single Door	60.0 x 24.0	48.0 x 20.0	6.7	59.1 x 23.6	51.0 x 19.6	6.9	1.5%
	72.0 x 30.0	60.0 x 26.0	10.8	67.0 x 31.5	58.9 x 27.5	11.2	1.8%
	90.0 x 36.0	78.0 x 32.0	17.3	90.6 x 39.4	82.5 x 35.4	20.3	8.0%
Double Door	60.0 x 48.0	48.0 x 44.0	14.7	59.1 x 47.2	51.0 x 43.3	15.3	2.0%
	72.0 x 60.0	60.0 x 56.0	23.3	67.0 x 63.0	58.9 x 59.0	24.1	1.7%
	90.0 x 72.0	78.0 x 68.0	36.8	90.6 x 70.9	82.5 x 66.9	38.3	2.0%
	Note: (*)= With non-required 4-inch plinth						

	Typical Mounting Panel Comparisons For Free-Standing Enclosures						
	Unibody			Modular			
	Enclosure Size	Panel Size	Panel Area (ft^2)	Enclosure Size*	Panel Size	Panel Area (ft^2)	% Dif
Single Door	60.0 x 24.0	48.0 x 20.0	6.7	63.0 x 23.6	59.0 x 19.6	8	8.8%
	72.0 x 30.0	60.0 x 26.0	10.8	70.1 x 31.5	66.9 x 27.5	12.8	8.5%
	90.0 x 36.0	78.0 x 32.0	17.3	86.6 x 39.4	82.7 x 35.4	20.3	8.0%
Double Door	60.0 x 48.0	48.0 x 44.0	14.7	63.0 x 47.2	59.0 x 43.3	17.7	9.3%
	72.0 x 60.0	60.0 x 56.0	23.3	70.1 x 63.0	66.9 x 59.0	27.4	8.1%
	90.0 x 72.0	78.0 x 68.0	36.8	90.6 x 70.9	82.5 x 66.9	38.3	2.0%
	Note: (*)= Without plinth						

External Skins

Modular enclosure skins offer many benefits over their unibody counterparts. The ability to easily remove the door, sidewalls, and other parts allows for greater accessibility and more accurate cutouts and modifications. The inside door surface has a stiffener with multiple holes which is capable of supporting a wide variety of chassis rails or panels, yielding an entire separate mounting surface to be utilized. Standard off-the-shelf uni-body enclosures only allow the attachment of a print pocket.

Frame

In addition to the aforementioned ability to join enclosures and easily add accessories, the modular enclosure frame will accommodate more door options as well. Custom motor control center (MCC) solutions can be configured with several smaller partial doors making up the face of the cabinet. Then both horizontal and vertical dividers can be added to the frame, easily separating these compartments – e.g. high/low voltage sections.

Intangible Differences

Modular enclosures provide advantages beyond just those physical attributes. These intangible attributes while not as obvious, are just as real.

Aesthetics

No longer is the plant floor a dirty environment where equipment is designed sole-ly based on function. Modern digital technology has paved the way for a factory floor where cleanliness and aesthetics are nearly as important as ergonomics and reliability. Designers have switched to newer digital control and automation technology. Yet some continue to package their products in enclosures that were designed in the 1950s,

resulting in an end product that looks dated like old technology. Modular units, with hidden door hinges and single handle locks versus clamps provide a look more consistent with this newer technology.

Ease of modification

The flexibility provided by a modular enclosure system allows for easier modification. The design process is smoother with standard solutions available as off-the-shelf accessories. The overall design process is also much more forgiving when using a modular enclosure. Early mistakes can be corrected or late changes can be accommodated much easier on the modular platform.

Misperceptions

Modular enclosures have gained acceptance in almost every industrial market, however misperceptions continue to exist. The most common of these misperceptions are:

Modular enclosures are not as strong as unibody enclosures.

False. This misperception stems from the fact that the enclosure walls are thinner in a modular enclosure than a unibody enclosure. However, the strength of a modular enclosure comes from its frame, not the enclosure walls. The load being exerted on the enclosure due to the weight of the equipment installed is transferred to the vertical frame members. Later we will discuss why the thinner wall material is actually advantageous.

Many part numbers must be ordered to complete a modular enclosure assembly.

False. A basic modular enclosure consists of as little as two part numbers – the core frame/assembly (with included mounting panel) and a pair of sidewalls. Coincidentally the equivalent unibody enclosure will also require two part numbers – the core enclosure plus a mounting panel.

Modular enclosures require a lot of assembly work like an erector set.

Assembly work, while required, is minimal for a basic system. The more complex the configuration, the more assembly required, however the system accessories can be added by someone without specialized training, unlike the more difficult fabrication techniques (cutting/welding/bending) needed to modify a unibody enclosure

Modular systems are more expensive.

Standard pricing on core systems are comparable to unibody enclosures. Additionally, there are many hidden costs which are reduced when factoring the total lifecycle of the enclosure.

True Cost

Most people are familiar with the concept of ROI (Return On Investment). Considering the savings or possible yields of a decision beyond the initial cost is a wise course of action in any business. For the purposes of this paper, a variation of this concept will be employed which will be referred to as “true cost.” True cost is calculated by simply totaling the costs of an enclosure solution over the course of its lifecycle via practical examples, and is represented by the short equation below.

Acquisition Costs + Use Costs + Operating Costs = True Cost

Acquisition costs are realities for control panel shops, integrators, OEMs, and end users alike as these costs are passed down from one group to the next. However, when taking the actual design and procurement processes into account, the primary benefactor of reduced acquisition costs will be the system designer. After the initial purchase decision is made however, panelshops and integrators are more likely to be concerned with use costs while a significant portion of the true cost for end users will come from operating costs. Use costs are mostly attributed to labor and the use of floor space during integration while operating costs generally include labor for maintenance, lost productivity due to downtime and costs incurred during expansion. The inherent advantages of modular enclosures can substantially reduce all of these costs.

Acquisition Costs – Primary Design and Physical Acquisition

When considering the acquisition cost of enclosures or enclosure systems, all phases of design as well as the procurement process should be considered. After all, the easier an enclosure system can be configured and sourced, the cheaper its acquisition cost will become.

With a traditional unibody enclosure, system designers must be careful to accurately define the scope of work of a project such that this information can be conveyed to an enclosure manufacturer. The enclosure manufacturer then must determine if the scope of work will fit within their manufacturing processes. If the scope of work isn’t well defined, assumptions will need to be made and dialog will begin regarding the design. Even if the scope is fully understood odds are high the enclosure manufacturer will need to ask the designer to make concessions based on their capabilities. The potential for a lengthy RFQ-to-redesign-to-quote-to-redesign-to-requote loop is probable. If successful the end result is likely a specialized configuration with a very long lead time.

Modular enclosures offer the ability for the designer to create special one-off configurations using standard catalog items. Compatible solutions are pre-engineered such that direct communication with the enclosure manufacturer may not be necessary. There is a much greater probability of these standard parts being in stock, significantly reducing lead times.

Use Costs

Use Costs at integration and panel shops, time and floor space are always at a premium. The more labor that is needed to perform and complete a task, and the more space it requires, the less efficient the processes of the entire business become. This translates to lower productivity and, as a result, less profitability.

Use Cost - Door Removal

Human machine interface components require modifications to be made to the doors of industrial control enclosures. Traditional unibody cabinets use a continuous (piano) hinge for the door. Removal and installation of a door with this type of hinge can take up to 30 minutes. For this reason, most integrators choose to leave the door in place and perform cutouts while the enclosure is on its back—taking up valuable floor space and in many cases, incurring additional labor costs involved in tilting the enclosure on its back including the possible use of cranes or forklifts. When cutouts are done this way, it is very common for the metal shavings created by the cutout to fall into the enclosure—requiring a thorough cleaning to remove and adding even more labor costs to the process.

Conversely, the doors of a modular enclosure are attached by multi-point, captive hinges and can be removed in as little as 30 seconds and taken to a separate location for modification. The costs associated with properly positioning a unibody enclosure for door modifications are completely eliminated and as an added benefit, work can be performed inside the enclosure at the same time as the cutouts are being made to the door resulting in increased productivity.

Use Cost - Adding Cutouts

The time and cost benefits of performing cutouts at a separate location do not end with the door. With a truly modular enclosure, all of the skins including the sidewalls and roof are removable as well. Since it is very common for enclosures to be modified to accommodate, among other things, some type of component cooling solution such as fans, heat exchangers or air conditioners, the ability to simply remove the mounting surface for modification is a tremendous advantage. As with the door, performing cutouts on the other surfaces of unibody cabinets uses valuable floor space, requires cleaning and often, additional time and labor to stage the enclosure with forklifts or cranes.

Beyond the logistical and labor benefits that modular enclosures provide when adding cutouts, the maintenance and purchase cost of tools used to create the cutouts benefit as well. Unlike unibody cabinets, the strength of modular enclosures comes from the frame and not the skins. This difference is beneficial because, with average steel thicknesses of 10-12 gauge for unibody and 14-16 gauge for modular enclosures, performing cutouts to the skins of modular enclosure is easier on the tools used to make them—increasing tool life and thereby decreasing tool maintenance and replacement costs.

Use Cost - Mounting Panel Removal and Replacement

Mounting panel removal and replacement in a unibody cabinet can require extensive labor and machine costs. A crane or forklift is needed to put the enclosure on its back, remove the panel for equipment installation, drop it back in over the studs and then raise the enclosure back to its upright position. In the case that multiple enclosures and panels are needed for a project, the enclosures must be staged due to limited crane availability, monopolizing valuable floor space that could be used for other jobs. With the additional movement of the enclosure and occasional unpredictability that comes with using a crane, there is an increase in the likelihood that the paint finish on the unibody enclosure will be damaged.

Mounting panels customarily found in modular enclosures are larger in height and width, depth adjustable and easily slide in and out of the enclosure. In addition to the benefit of easily adjusting the mounting panel depth, use cost savings include the labor to install panels (panels slide in and out) without the need for staging and craning, and the elimination of additional required floor space.

Use Cost - Weight

Because of their thick 10-12 gauge steel construction, unibody cabinets weigh considerably more than their modular counterparts. Without sacrificing strength or protection, modular enclosures are lighter and thus easier to transport around the shop floor and cheaper to ship—resulting in significant savings of time and freight. Typically, weight savings for modular enclosures are 75-175 lb for single door and 300 lb for double door configurations when compared to unibody equivalents.

	Typical Mounting Panel Comparisons For Free-Standing Enclosures (in lb.)									
	Unibody				Modular					
	Size	Enclosure	Panel	Total	Size*	Enclosure*	Sidewalls (Pair)	Total	% Dif	lb. Dif
Single Door	72x25x18	250	45	295	71x24x20	206	24	230	12%	65
	72x31x24	290	57	347	71x32x24	265	26	291	9%	56
	90x24x20	313	56	369	87x24x24	249	35	284	13%	85
	90x36x24	440	88	528	87x32x24	307	35	342	21%	186
Double Door	60.0 x 48.0	575	119	694	71x47x20	382	24	406	26%	288
	72.0 x 60.0	600	119	719	71x47x24	396	26	422	26%	297
	90.0 x 72.0	650	144	794	87x47x24	458	35	493	23%	301
FMD (1 Dr)	84x40x18	642*	-	642	79x40x20	346	28	374	26%	268
Note: (*)= Weight includes mounting panel										

Use Cost - Special Configurations

Last minute changes and/or re-designs can often happen. Modular enclosures offer the ability to reverse the door hinge, replace a rear wall with a door, swing a side panel, or add an accessory with little more than a few self-tapping screws. Unibody options are limited to expensive fabrication procedures and may not even be possible to implement in the field leaving a special order from the enclosure manufacturer as the sole option.

Operating Costs

End users can benefit from use costs as well, however, it is easier to demonstrate the benefits of using modular enclosures when viewed from the perspective of saved operating costs. Savings include labor for maintenance, more productivity due to decreased downtime and easier expansion capabilities.

Operating Cost - Maintenance

Scheduled maintenance on machines and control panels is necessary to keep operations running smoothly. Unscheduled maintenance, on the other hand, can cost a company millions of dollars in lost productivity. The flexibility of modular enclosures makes them easier to maintain and limits users' exposure to unplanned downtime. Doors, walls and roofs can all be removed within minutes of an occurrence allowing for easier access to installed equipment and simplifying what can be very labor intensive processes with unibody enclosures—even under planned conditions. And since mounting panels easily slide out of the front of modular enclosures, the panel can be removed without time-consuming enclosure staging In the event that an accident damages a modular enclosure, often times, the affected enclosure surface (sidewall, door(s) or roof) can simply be replaced. Unibody cabinets do not provide this flexibility. At a minimum, all of the components will need to be removed from the cabinet and repairs made by cutting out the damaged surface(s) and welding new sheet metal in its (their) place. If enough damage has occurred, the entire cabinet may need to be scrapped.

Operating Cost - Expansion

A factory floor is a dynamic environment where needs can frequently change. If the control panel in a unibody cabinet is full and additional equipment needs to be installed, a new, larger enclosure is usually required. With this comes the removal and reinstallation of existing components to the new panel. Conversely, if a similar need to expand the capacity of a control panel arises while using a modular enclosure, multiple options exist to quickly and easily install new equipment to complete the expansion. Solutions include installing partial mounting panels, chassis bars, or 19" rails. These options are standard accessories for most modular enclosures that seamlessly integrate into the existing cabinet.

In the case that an expansion plan exceeds the size of the existing enclosure but requires that the added equipment be housed with the previous components, the difference between modular and unibody enclosures is also clear. Using a unibody cabinet under these circumstances, like in the previous panel example, requires a completely new and larger enclosure - populated with both the new equipment and the existing components that have been removed from the prior cabinet. In this same situation, using a modular enclosure solution, it is possible to expand the original enclosure by simply joining another enclosure to it. Because all of the walls of modular enclosures can be quickly removed, enclosures can easily be joined together in nearly infinite configurations to accommodate expansion—front-to-back, side-to-side and so on. This flexibility saves time, money and frustration because it allows end users to adapt their current installations to suit new needs instead of starting over from scratch as required with unibody cabinets. Modular bayed suites can grow to be as large as needed over time or even scaled back if necessary—offering levels of convenience and customization not available with unibody cabinets.

Conclusions

Despite a number of functional and financial advantages offered by modular enclosures as compared to unibody cabinets, portions of the industry continue to adopt a somewhat shortsighted focus based solely on acquisition cost, and in some cases, the mistaken notion that modular enclosures are inherently more expensive. When specifications for control panels and other applications are written, the true costs and benefits of utilizing one enclosure solution over another must be fully considered—especially in today's economic climate where every penny counts.

While in some cases choosing a unibody cabinet might seem to be a more cost effective course of action at first glance, once the use and operating costs are factored into the equation, a unibody solution may prove to be cost-prohibitive. Because the lifecycle of a typical industrial enclosure is filled with planned and unplanned changes and/or repairs, using a modular platform can limit exposure to risks associated with additional costs and downtime—often making a modular enclosure the most sensible choice. Modular enclosures provide the protection required for industrial drives, controls and other equipment along with the practical flexibility to evolve with the changing demands of modern business—all while saving time and money over the course of their lifecycles.

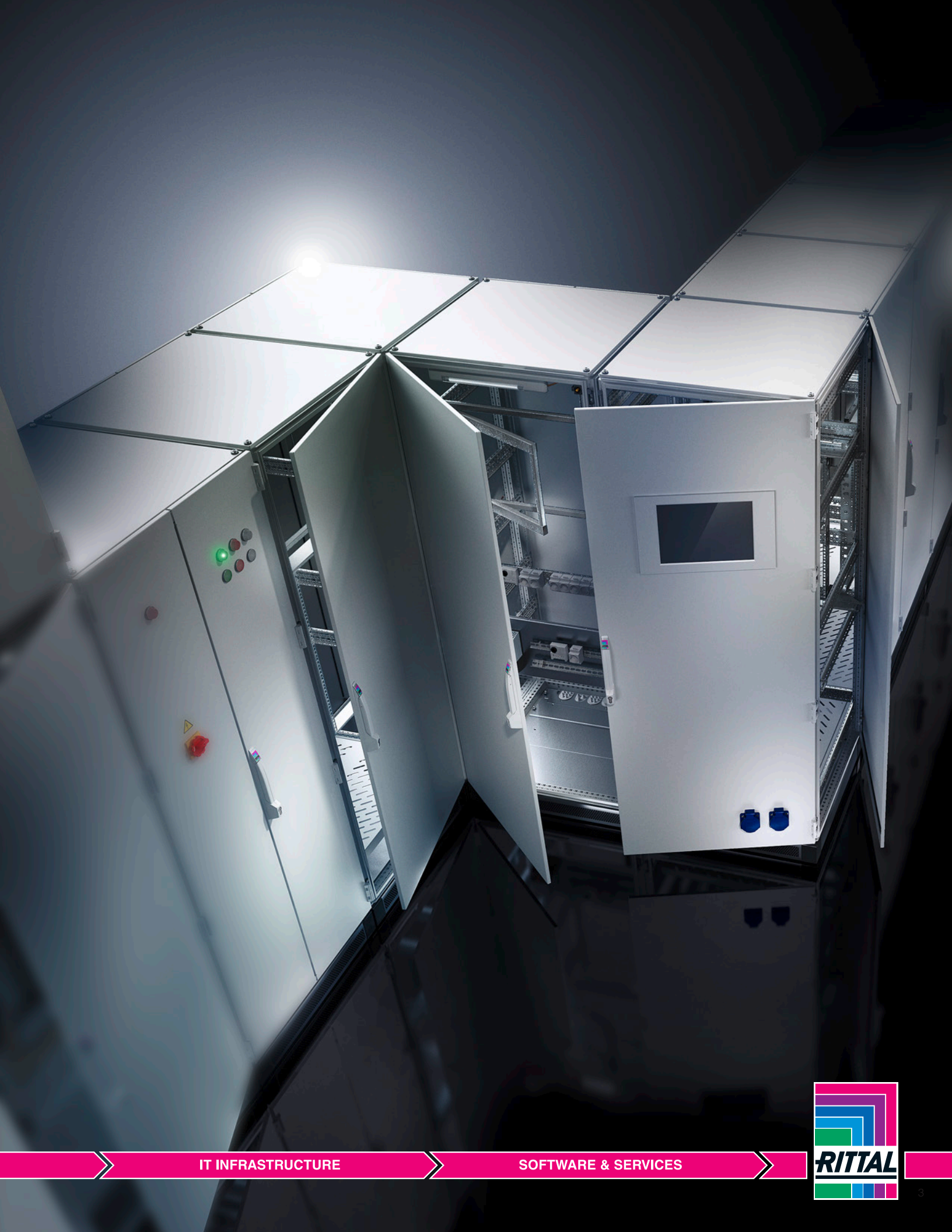
Modular - vs - Unibody, Direct Comparison					
	Large Modular Advantage	Small Modular Advantage	Neutral	Small Unibody Advantage	Large Unibody Advantage
Ability to Add Accessories	X				
Ability to Repair Damage	X				
Ability to Withstand Damage				X	
Accessibility	X				
Aesthetics		X			
Door Construction	X				
Door Removal	X				
Gasket Type		X			
Gasketed Points of Entry					X
Hygienic Qualities (fewer crevices)				X	
NEMA/UL Rating			X		
Panel Construction		X			
Panel Insert/Removal	X				
Rear Wall Construction		X			
Rear Wall Removal	X				
Rigidity (off-the-shelf)				X	
Roof Construction		X			
Roof Removal	X				
Sidewall Construction		X			
Sidewall Removal	X				
Strength			X		
True Cost	X				
Weight		X			

About the Author

Nathan Xavier is a Rittal Corporation Consulting Engineer and has been with the company since 2007. He holds a Bachelor of Science degree in Mechanical Engineering and provides customer specific applications support relating to Rittal industrial enclosure and power distribution solutions.

The Rittal Corporation is the U.S. subsidiary of Rittal GmbH & Co. KG and manufactures the world's leading industrial and IT enclosures, racks and accessories, including climate control and power management systems for industrial, data center, outdoor and hybrid applications.

425 N. Martingale Rd. Suite 400 • Schaumburg, IL 60173 • Toll free: 800-477-4000
Website: www.rittal.us



Rittal – The System.

Faster – better – everywhere.

- Enclosures
- Power Distribution
- Climate Control
- IT-Infrastructure
- Software & Services

US • 318 12/2015

Rittal Corporation
1 Rittal Place • Urbana Ohio 43078 • USA
Woodfield Corporate Center • 425 N. Martingale Road, Suite 400 • Schaumburg, IL • USA
Phone: 937-399-0500 • Fax: 800-477-4003 • Toll-free: 800-477-4000
Email: rittal@rittal.us • Online: www.rittal.us