What to Consider

When Selecting a Cabinet for Harsh Environments

an Elma White Paper

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Rack-mount electronics systems serve as the lifeblood of a countless number of commercial, testing, transportation and broadcast applications. It's no surprise that, as electronics are being used in more remote, and far harsher environments, the guidelines to designing the right rack system have changed. There is an added level of sophistication in developing racks and cabinets for the increasingly-complex—and sometimes harsh—environments where electronics must now reside.

While attributes like reliability, ruggedization and durability have always been critical factors in a cabinet's design, the nature of each has changed. The amount of heat, the density of electronics and the wide-ranging demands of environmental factors far surpasses the requirements of a system designed to sit in a server room.

Designing the proper electronics cabinet platform to meet harsh environmental requirements means careful consideration of an application's specific design criteria and its associated costs. It also means weighing the pros and cons of certain design tradeoffs. Working with a knowledgeable team to navigate through the design landscape has proven to be beneficial from cost, time-to-market and development perspectives.

"The construction and design of your cabinet platform is just as important as the purpose and function of the electronics it holds."

Understanding the Landscape

In addition, available options for customized housings—even in lower quantities—has changed the face of rugged enclosures. Since the inception of modularity in electronics packaging, COTS enclosures and design concepts have matured, and can now be developed quickly and affordably to best match a specific application's requirements.

Identifying application requirements upfront, and owning up to the pitfalls that a system may be subjected to, as well as knowing how to best meet environmental considerations will go a long way in developing the proper enclosure system.

Determine the "what" and "what if" questions at the onset of the development process, not as an afterthought. The construction and design of your cabinet platform is just as important as the purpose and function of the electronics it holds.

Industry Effects

First, take stock of a few critical factors that have quietly influenced today's electronics cabinet and rack designs.

- Cloud computing and IoT: By dissembling the need to house data onsite, cloud computing has redefined networked systems. No longer bound by physical locations and constraints, data is free to move through the air to find a home and foster collaboration and deeper insights among computing systems as far apart as different corners of the world. Edge computing is not only accepted, but expected, putting even tougher requirements on electronics housings to ensure they withstand a multitude of harsh environmental and mechanical impacts. (Figure 1)

-Denser computer systems: Those familiar with SWaP (size, weight and power) know full well how shrinking component size and increased system density has brought forth new dimensions of where and how electronics can serve a purpose. Placing computers in remote locations, and in

Figure 1:
Cabinets and enclosures are being used to bring electronics into more remote, more rugged and more mobile locations that transmit data back to central networks.

finite spaces, has mandated the need for rack systems that make the best use of not just available space, but of the actual construction and features of the rack itself.

- Flexible enclosure and cabinet solutions: From a practical standpoint, replicated, standardized environments are not the same as what you'd typically find in a central office or server room. Being able to construct a housing that fits the space and application needs, while ensuring these highly compact systems can reliably transfer large quantities of sensitive data is also a critical consideration.

Environmental Impacts

As the uses and physical locations of computing systems evolved, the racks and enclosures that hold everything in place have also changed. Whereas, at one time, there was only a need for a limited number of sizes and configurations, today's computing systems are being defined by the specific environment, not always the application itself.

It's rare that an enclosure is housed in an area that is sealed off from the effects of the environment. In fact, the trend is really to put electronics into a greater number of exposed applications.

In tandem with the change in design and purpose of enclosures, a shift in the importance of some technical features has also taken place, especially in the realm of rugged, mobile electronics. A few noteworthy examples can be found in manufacturing, transportation and broadcast applications as well in test equipment.

It's imperative to understand the impacts of the environment and the application when designing electronics cabinets today.

Six Key Areas of Technical Importance\

To properly design a cabinet for today's harsh, applications, it makes sense to take stock of what your needs are, then weigh them against different options available in cabinet selection. Start with these six critical considerations to help your cabinet designer and supplier address these crucial questions.

1) Strength-to-weight ratio: What force will be exerted on this enclosure, and what material will need to be used in the construction? Are there other external elements to consider in the structure of the rack system?

2) Modularity: What level of modularity and flexibility does your application require?

3) Thermal profile: What are the ways in which your rack system can facilitate thermal management, and how varying will temperature spikes be across the life of the system?

4) Equipment accessibility: How easy does access to your cabinet need to be in order to make adjustments, reach specific areas or swap out components? Design a system knowing where access points need to be.

5) Quality of construction: Is your system exposed to temperature fluctuations, and will there also be corrosive elements, such as salt spray or contaminants? Will its construction withstand the long-term shock and vibration of the application?

6) Testing requirements: What parameters will your system need to withstand? Are there industry regulations you must meet, and how can you ensure your rack system will be properly certified?

Managing increased exposure: Rain, sun, air, dust. Moisture, heat, humidity, contaminants. However you define it, exposure includes a broad list of attributes that designers need to consider, some they may never have had to face before. With the increasing tendency to place electronics systems in virtually any spot that will hold them, how any—and all—of these elements will impact an enclosure at some point during its service life needs to be taken into account. Weighing how adversely each element will affect your enclosure will help determine which ruggedized elements are most critical. (Figure 2)

Take for example, a logging truck in the oil and gas industry where a rack is mounted to a trailer platform and travels between sea oil rigs and land destinations. To meet the application's specific requirements, the rugged construction needs to pair with cabling and shelf management requirements in an environment subjected to extremely harsh conditions. In this example, by modifying the base of a ruggedized RC cabinet to include a top and bottom isolator, Optima Stantron was able to mitigate the shock and vibration of the application. Retractable shelving, cable arms, power supplies and a drawer were all added to accommodate system load requirements.

Reducing electronic and visual 'noise': Shielding an electronics system from electromagnetic interference (EMI) once meant protecting it from certain external forces, but the sensitivity of electronics within a given system, and the proximity of each system to another, now means that the electronics must be even more protected from their neighboring systems. Attenuation, noise, signal integrity...all are affected by the layout of electronics within an enclosure as well as by other systems within range.

And aesthetics has become a reality in the world of electronics packaging. Not only does a rack need to perform its intended duties, it may need to

blend with the existing environment, depending on where it is located. IT and call centers hold this aspect in high regard, but then also require extreme EMI shielding, due to the volume of servers and electronics densely packed into one area.

Another consideration is industry standards, which can vary depending on the country where the unit will be placed. Which ones is the design required to meet? Adhering to the visual, structural and regulatory requirements of these types of applications take a certain finesse to bring it all together on time and on budget.

In a recent installation, a shielded seismic cabinet served as the basis for a robust system that incorporated a coffin-style door for added cabling space. The interior maintained the needed 19” mounting provisions, with accommodations for a side tray for the additional cabling as well as the needed EMI/RFI shielding. Low quantity and cost, fast delivery and visual appeal were incorporated, all thanks to the modular design and an experienced engineering team.

Electronics have moved closer to where we live and work, such as onto the shop floor or into the vehicles we use, bringing about a shift in how we interact with these systems. Enclosure systems in direct proximity to a human workforce need methods to minimize noise and vibration, lessen the impact of EMI on other operating systems and offer flexibility to physically operate within harsh environments.

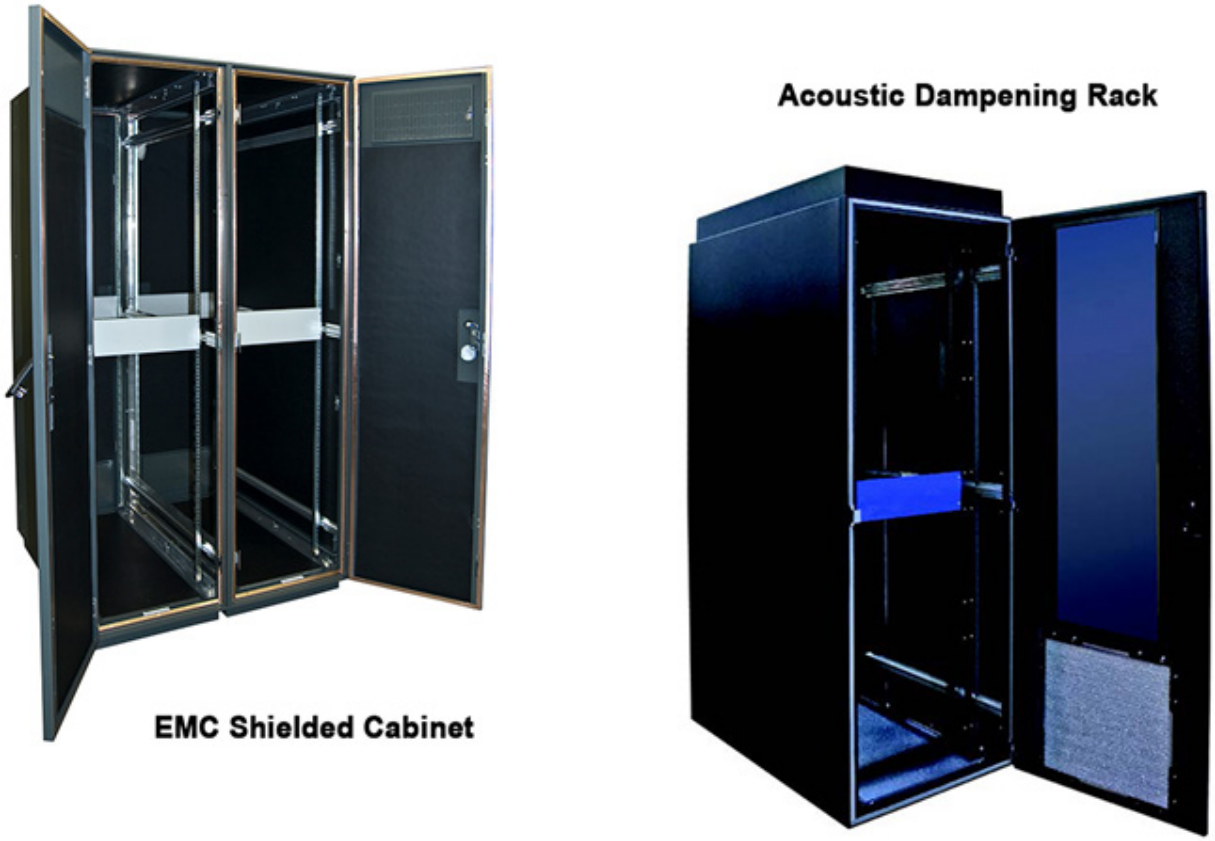

FIGURE 2: Withstanding environmental extremes and exceptionally harsh conditions is the norm for many electronics cabinets in outdoor and remote applications.

Many times, these are specialized systems are produced in small volumes. Cabinets and enclosures often can be developed quite cost-effectively to meet the application needs as well as to ensure a positive work environment for personnel. By adding special panels designed for acoustic dampening to a cabinet, for example, man and machine can work harmoniously side by side, keeping ambient room noise to a comfortable level and development costs to a minimum.

Understanding Industry Nuances

Electronics systems have moved out of the server room and into the field, too. The luxury of climate-controlled, stable environments is not necessarily an option. The cabinet needs to take over that function of maintaining a reliable operating environment, regardless of the weather or the impacts that the unit is subjected to.

Figure 3: Transportation applications, such as railway systems, need electronics that can withstand intense shock and vibration both inside and outside the vehicles.

Functionality from station to wayside.

Taking stock of where the system will operate helps to define some of the design parameters that previously may not have been considered, such as with railway operations. Will the system be wayside, meaning it will sit out in the rain, snow and sun, or will it be on train car itself, which would require significantly different shock and vibration requirements. Same industry, different environments.

Knowing these nuances also facilitates the development of cost-effective, modular electronics packaging. Recent designs of AREMA and CENELEC-certified racks for railway applications took into account the requirements of both on-board as well as off-board uses. Because they met the necessary testing parameters prior to shipment, the cabinets enable rapid development and deployment of systems, whether the application is within a train car, by the wayside or in the actual control room. (Figure 3)

Another big shift in cabinet and enclosure design is the increased environmental parameters that these systems need to endure. The unrelenting conditions of a mobile railway environment highlight why certain parameters need to be evaluated in cabinet designs. Not only is temperature a concern within a system, but the wide range of hot and cold a system can be subjected to is massive. As noted earlier, will the system reside on the car or on the track? Regardless, it all still needs to be protected to ensure that it will function reliably.

Embedded computing in motion.

From industrial environments to the medical realm, mobile electronics, in the form of mobile, rolling carts that travel across uneven floors, bump over elevator jams and even travel between buildings, are also a part of the electronics world.

Functionality, mobility, flexibility and ruggedization all had parts to play in ensuring the effectiveness of these next-generation of diagnostics recording platforms.

In this example, by using a specially designed extruded frame for a range of standard cabinet families, Optima Stantron was able to keep costs down significantly and develop several carts for product testing. The rack-mounted electronics could be selected and configured to fit the specific test requirements, without having to have separate carts, and rolled straight out to the product's manufacturing site. Added features include better cabling access, easier to remove panels as well as integrated handles and quick-release fasteners. The new system included improved mounting equipment for a computer and printer as well as provisions for three monitors.

Proper Guidance Means Effective Enclosures

Not only is the industry itself important, but so is the specific function of the system. What space will a rack system need to fit into? What are the electronics systems that will be sharing this space, and how do they affect each other?

With the proper preparation, today's cabinet can be designed to fit the right space with the right functionality and go far beyond simply mounting electronics in a rack and wiring it up.

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