Electric Power Distribution Modular Solutions Reduce Costs & Schedules

A White Paper by Wunderlich-Malec based on Project Experiences

Abstract

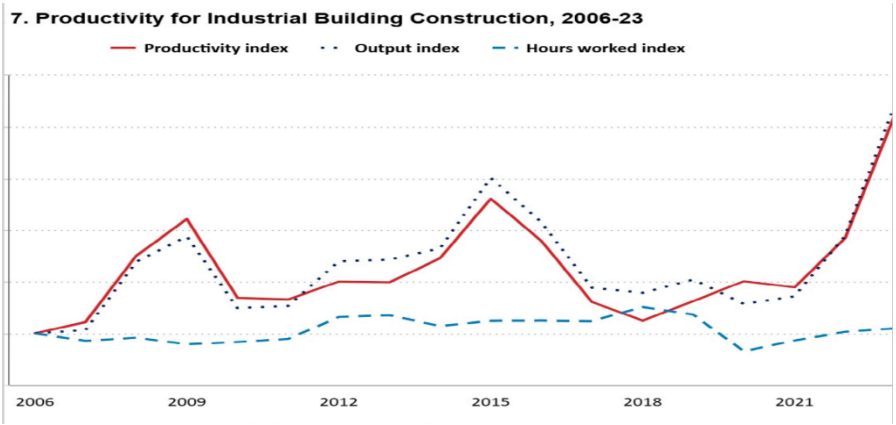
The Industrial Construction Industry in the United States had experienced declining productivity thru 2018. This decline created economic challenges for the industries construction companies while increasing costs to capital investors for their projects. There are many well documented studies by leading analysts identifying typical causes and proposed solutions to correct this onerous trend. A leading solution was the migration to increased Modular Construction techniques. Wunderlich-Malec presents this paper delineating how Modular Construction adopted for electrical, control and automation systems is a proven method to reduce total capital project construction costs, shorten project schedules while improving maintenance efficiency and quality.

True scalable savings from 30% to 60%, Reduced Labor Costs, Increased Quality, & Improved Safety

The Business Challenge

How did the Construction Industry reverse this Trend? The graph pictured below shows Industrial Building Construction productivity from 2008 through 2023. This flat 12-year trend and rapid productivity decline from 2015 to 2018 lagged other US industry trends of significant productivity Improvements. The construction industry recognized this unacceptable decline and initiated corrective actions. Beginning in 2018 this negative trend was reversed and in 2021 significant annual improvements in productivity were achieved. Many industry leaders contribute the adoption of Modular Construction techniques to projects as a main contributor to these productivity improvements.

Graph from US Bureau of Labor Statistics (BLS) September 12, 2024, for Construction Industries.



Advantages of using Modular Construction.

- Engineered design to meet client needs
- Develop and utilize innovative processes.
- Reliable supply chain vendors
- Experienced skilled labor delivers consistent product
- Reduced design change impact
- Improved documentation and records
- Improved maintainability
- Increased Safety
- Increased Quality
- Shortened project schedules
- Reduced total project costs.

"Engineered Electrical Control Enclosures with Manufactured Cabling Systems Shortens Schedule, Improves Quality and Reduces Risk"

The Solution

Recently, major utilities and data centers have utilized Modular Construction to address productivity issues in their industry. With modular construction, the advantages are real and measurable.

Modular designs meet demanding project schedules and are engineered to the client's individual needs. Any scope modifications are more effectively managed allowing a more agile project approach.

Modular construction in a controlled environment utilizes a more experienced and constant labor force, space utilization is more efficient, safety is increased, and the impact from design changes are reduced, and documentation and records are improved.

Wunderlich-Malec Modular Integrated Control Enclosures Delivered to the Site Integrated and Tested

- Process Equipment
- Power Equipment, SWGR, MCCs, VFDs
- Protection & Control Panels
- Battery Banks & Chargers
- Yard Termination Panels
- Interconnection Assemblies
- Fiber Optic & LAN Systems
- DCS, SCADA, HMIs
- Lighting
- BAS/HVAC
- Life Safety
- Security

The table below compares traditional substation electrical control enclosure construction to modular construction:

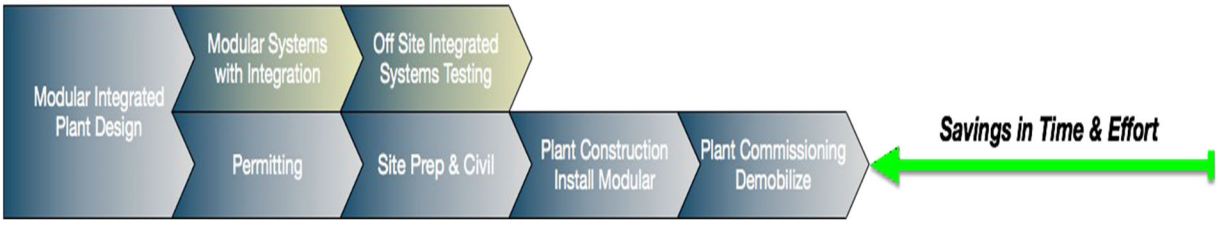
Traditional Substation Control Enclosure Construction	Substation Modular Control Enclosure Construction	Modular Advantage
Substation Electrical control enclosure built on project site	Substation Electrical control enclosure fully manufactured in factory-controlled environment	No weather delays and strict ISO9001:2015 quality control procedures throughout entire process
Protection and control cabinets built off-site and shipped to project site for craft labor installation	Protection and control cabinets, SCADA, RTU, Communication and Security cabinets are manufactured in the same factory-controlled environment and installed in the control enclosure in the same factory	All systems fully integrated in the factory. Design issues, such as, discrepancies between wiring diagrams (used by panel shops) and schematics (used by Commissioning Engineers) found and corrected in the factory
SCADA shipped from manufacturer to project site for craft labor installation		
RTU shipped from manufacturer to project site for craft labor installation		
Communication and Security cabinets manufactured off-site and shipped to project site for craft labor installation		
AC/DC station service equipment shipped from various manufacturers to project site for craft labor installation	AC/DC station service equipment is shipped to the factory and installed directly into the control enclosure	
Power, control, and communication interconnect cabling between equipment internal to the control enclosure is completed in field with craft labor	Power, control, and communication interconnect cabling between all devices is completed in the factory	
Craft labor in the field, installs cabling directly from field equipment into specific cabinets and equipment within control enclosure (PTs, CTs, control, status, alarm, trip, AC/DC power circuits)	All cabling interfacing with external equipment brought to marshalling cabinet(s) within the control enclosure for easy external interface connection. These marshalling cabinet(s) can consist of terminal blocks OR uniquely keyed plugs to interface with field devices creating a plug and play system	Individual components do not need to be inventoried, warehoused, and issued by the customer. This frees resources and reduces project costs due to labor rate differentials.
Point to point testing of interconnect wiring completed in field by craft labor	Point to point testing of interconnecting wiring completed in factory by trained factory technicians	Issues found and corrected in factory
Relay programming and testing of all protective devices completed in the field by end user and/or third-party electrical services firm	Relay programming and testing of all protective devices completed in factory by Sr. Commissioning Engineers	Issues with relays, such as, wrong type/ model and relay malfunctions found, corrected, and retested in factory. When utilizing official relay settings approved by customers, issues with settings found and corrected in factory. Design issues with schematics as compared to desired functionality are discovered and corrected in factory
Functional testing of all internal and interconnected circuits completed in the field by end user and/or third- p a r t y electrical services firm	Functional testing of all internal and interconnected circuits completed in factory by Sr. Commissioning Engineers	
All issues found during testing phases corrected in the field by craft labor or individual manufacturers traveling to site	All issues found during testing phases corrected in factory, by factory technicians, and re-tested prior to shipping. Control enclosure tested as a fully integrated system prior to site arrival	Acceptance Testing, when done in the field, is typically the last step in the construction process; however, the majority of electrical functionality issues discovered at this time. Completing full Acceptance Testing in the factory finds and corrects all issues prior to site arrival and keeps Acceptance Testing process off project schedule's critical path, eliminating the added stress and cost of last minute testing, repairs, and re-testing

Increased Overall Project Efficiency

Modular construction design and fabrication provide the above advantages and produce significant reduction in project risk and shorter project schedule as we detail in our Case Study summarized below.

Site Based Construction Phasing and Schedule

Modular Integrated Construction Phasing and Schedule with Off Site Systems Integration and Testing



A Northeast utility used Power Distribution Centers (PDC) delivered by Wunderlich-Malec using modular integrated construction techniques that save time, improve quality and reduce costs.

Modular Construction Case Study - Premise

This case study is based upon completed substations by major electric utilities in the Northeast using Modular Construction and Wunderlich Malec Integrated Control Enclosures since 2001. The principal advantages of Modular Construction are estimated based upon a standard 16 x 50 x 11-foot enclosure with twenty (20) protective relay and control cabinets, marshalling cabinets, HVAC, fire and security completely installed wired and tested at the factory prior to shipment.

Modular Construction Case Study - Cost Savings

The details below produce cost savings of 48% and while each project is unique, savings of 30% to 60% should be achieved with Modular Construction designs that will integrate the electrical, control and automation systems.

Standard Construction				Modular Construction				Modular Savings
Task	**Man Hrs.**	**Rate**	**Cost**	**Task**	**Man Hrs.**	**Rate**	**Cost**	**Savings**
Erect Enclosure on Site	720	$ 105	$75,600	Erect Enclosure in Factory	708	$ 55	$38,940	$36,660
				Modular Shipping, Rigging, Site Assemble			$55,000	($55,000)
Stack-Out Enclosure in Field (Lighting, Security, Fire, Tray, Conduit, Ground Bar)	480	$ 105	$50,400	Stack-Out Enclosure in Factory (Lighting, Security, Fire, Tray, Conduit, Ground Bar)	432	$ 55	$23,760	$26,640
Individual Cabinets Installed in Enclosure on Site	320	$ 105	$33,600	Individual Cabinets Installed in Enclosure at Factory	0	$ 55	$0	$33,600
SCADA / RTU / DFR / Communication / Security Installed in Enclosure on Site	128	$ 105	$13,440	SCADA / RTU / DFR / Communication / Security Installed in Enclosure at Factory	0	$ 55	$0	$13,440
AC/DC Station Service Equipment Installed in Enclosure on Site	320	$ 105	$33,600	AC/DC Station Service Equipment Installed in Enclosure on Site	288	$ 55	$15,840	$17,760
				Marshalling Cabinet			$25,000	($25,000)
				Modular Shipping Split Connections			$10,000	($10,000)
Interconnect Cable Pull/Terminate - Cabinet to Cabinet Internally and Field Device to Individual Control Panels	1400	$ 105	$147,000	Interconnect Cable Pull/ Terminate - Cabinet to Cabinet Internally and Marshalling Panel to Individual Control Panels in Factory	1260	$ 55	$69,300	$77,700
Relay Programming and Testing of all Protective Devices in the Field	320	$ 200	$64,000	Relay Programming and Testing of all Protective Devices in the Factory	240	$ 175	$42,000	$22,000
SCADA/RTU Programming and Testing in the Field	320	$ 200	$64,000	SCADA/RTU Programming and Testing in Factory	240	$ 175	$42,000	$22,000
Functional Testing of all	640	$ 200	$128,000	Functional Testing of all	480	$ 175	$84,000	$44,000
TOTAL - Labor	**4648**		**$609,640**	**TOTAL - Labor**	**3648**		**$405,840**	**$203,800**
Craft Labor Per Diem			$84,016	Craft Labor Per Diem $356 per day/ person			$0	$84,016
Sr. Commissioning Engineer Per Diem			$85,440	Sr. Commissioning Engineer Per Diem			$0	$85,440
TOTAL - Per Diem $356 per day/ person			$169,456	TOTAL - Per Diem $356 per day/ person			$0	$169,456
GRAND TOTAL			**$779,096**	**GRAND TOTAL**			**$405,840**	**$373,256**
				Savings				**48%**

Modular Construction Case Study - Schedule Reduction

The cost savings detailed above also significantly reduce the working days of the six (6) and eight (8) man site labor crews performing the site installation. This 16-day reduction in schedule is detailed below.

Standard Construction Workdays		Modular Construction Workdays		Modular Schedule Savings in Workdays	
Duration (Working Days) - Craft	59	Duration (Working Days) - Craft	48		11
Duration (Working Days) - Acceptance Testing	40	Duration (Working Days) - Acceptance Testing	30		10
		Transport/Rigging/Assembly	5		(5)
TOTAL - Duration (Working Days)	**99**	**TOTAL - Duration (Working Days)**	**83**	**SAVINGS (Working Days)**	**16**

Summary

Modular Construction is being used by the most innovative construction companies, facility builders, and utilities to reduce project capital and operational costs, improve quality and shorten project schedules.

This white paper represents results from a project designed to incorporate modular construction techniques on the electrical and controls portions of an industrial construction project. The 48% savings in costs and 16 days in schedule reduction shown in this example in conjunction with the additional benefits described are indicative of what can be achieved. For more information and to achieve similar results on your upcoming projects, contact Wunderlich-Malec engineering at www.wmeng.com and let us show you the way.

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