



Volume 5, Issue Number 2

October 8, 2009

SMACNA Contractor Installs State-Of-The-Art HVAC System In California Biological Sciences Building



Fully welded round air-tight stainless steel distribution systems.

How does a contractor install HVAC and plumbing equipment for a state-of-the-art, multi-use biological sciences building that contains complex challenges – including confined space for utility systems and limited access to equipment, all compounded by multiple laboratory systems, poured-in-place concrete construction, and tunnel corridor requirements?

University Marelich Mechanical (UMM) met and exceeded these challenges. The company, based in Anaheim, Calif., designed, fabricated and constructed the HVAC and plumbing systems for the new four-story, 145,000-square-foot Biological Sciences building at the University of California's Irvine campus. The LEED-registered (Leadership in Energy and Environmental Design) facility is awaiting LEED Silver certification and consists of laboratories, a vivarium to house small animals, faculty offices, a 400-seat lecture hall, and a mechanical area in the basement that houses the air handling units.



Fully welded round and rectangular stainless steel distribution systems.

Each area of the \$13.9 million mechanical and plumbing project had its own unique design and demands for indoor air quality (IAQ) and conditioning. The project also had different types of equipment and areas that needed to be serviced, including confined, limited space to layout the ductwork and equipment. Also, due to the type of building and systems used, some areas did not allow access doors to reach the equipment. Instead, access was gained through the lights.

To surmount these hurdles, University Marelich Mechanical's designers and detailers used the Building Information Modeling (BIM) NavisWorks software to produce a fabrication and installation package to resolve conflicts and minimize field issues. The result was zero change orders.



Air handling units were fitted into the limited space required (120" X 36") leaving only 3 inches from the top of the duct to the slab above.

The various systems included high-plume dilution fume exhaust fans in the laboratories, air-tight stainless steel distribution systems, bundled Phoenix valve installations in the lab and vivarium, utility exhaust fan sets, bubble tight dampers, and HEPA filtration systems. The multiple labs required equipment hook-ups and exhaust hoods for bio-safety cabinets, bulk auto claves, necropsy tables, tunnel washers, cage washers, canopy hoods, bottle washers, and sterilizers.

The project required 36,185 man-hours of sheet metal field installation, detailing, and BIM coordination, and 9,162 man-hours of fabrication. System specifications and components included air handling units that provided 240,000 cubic feet per minute (cfm) of conditioned supply air, laboratory/vivarium exhaust (180,000 cfm), general exhaust (42,000 cfm), variable air boxes, distribution devices, 290,000 pounds of galvanized ductwork and 49,000 pounds of welded stainless steel ductwork.



The second floor lab the Bio Safety Level 3 Suite required special air changes monitored by a Phoenix control system.

For safety, bubble tight dampers were provided on the suite's supply air and exhaust system, designed to close and isolate the air within the suite to keep it from escaping.

The second-floor laboratory was designed for special experiments and containment of airborne contaminants, which required special air changes, negative and positive pressures, and monitoring by a Phoenix control system. The fume exhaust duct system included two dedicated 10,000 cfm roof-mounted fume exhaust fans. Bubble tight dampers, designed to close upon loss of static air pressure and keep the air from escaping, were provided on the supply and exhaust air system that served each suite.

In addition to the laboratory fume exhaust fans, the design included six additional fume exhaust fans to serve the other laboratory areas with a total of 31,000 cfm each. These fume exhaust fans were mounted on a factory-built plenum with isolation and bypass dampers. The fume exhaust duct risers serving the lab areas terminated at the roof level.



Fully welded stainless steel rooftop exhaust fans that serve other labs with a total of 31,000 cfm each. Fume exhaust fans are combined into two sets of three fan assemblies mounted on a factory-built plenum with isolation and bypass dampers.

The project used a variety of sheet metal products. The Pomona, Calif.-based SMACNA member Superior Duct Fabrication began manufacturing ductwork for this project in December 2006. The company supplied 339,000 pounds of round and rectangular ductwork consisting of galvanized, aluminum, and stainless steel, from low-pressure round fittings to large stainless steel exhaust roof plenums. The stainless steel duct was pre-fabricated and assembled in spool sections to reduce field installation time. A 190-ton crane hoisted and rigged the heavy duct to the building's roof.

Energy efficiency aspects of the job included air handlers with multiple fan wall technology that draw outside air from huge, 260–square feet, louver sections and two–story high galvanized gas station panel casings.

The benefits to the client included overcoming a challenge of access to equipment. Certain areas of the building did not allow access doors to reach equipment, so UMM gained access through the lights. This proved to be a challenge to all trades, which required intense weekly coordination meetings. Limited space requirements needed intensive field activity to coordinate installation sequencing so as not to hinder the erection of the building’s structural and enclosure components. In addition, the HVAC design was based around three 58,000 cfm air handling units. UMM’s sheet metal detailers were able to fit them into the limited space provided, leaving only three inches from the top of the duct to the slab above.

Modernizing Cape Canaveral's O And C Building



Ductwork exits the unit room wall and branches up to the high bay area where the Orion capsule is housed.

The National Aeronautics and Space Administration’s Operation and Checkout Building at the Kennedy Space Center in Cape Canaveral, Fla., recently underwent a face–lift thanks to SMACNA contractor Lapin Sheet Metal of Orlando, Fla. This historic facility will be used to house the new Orion spacecraft, America’s next generation of space exploration.

Lapin Sheet Metal provided all rectangular ductwork on the O and C Modernization Project, which was made of either single wall or double wall construction.

The challenge on this project was the precise coordination required of the mechanical, electrical, and plumbing (MEP) team and in creating and maintaining a clean–room environment.



Round air supply duct and rectangular return ductwork.

The ductwork had to be drawn and closely coordinated by the project MEP coordination team of Lapin Sheet Metal's head CAD designer Wilbur Mummey, the mechanical contractor, and the owner Lockheed Martin, with assistance from the general contractor. These experts routed and located all ductwork, including the locations of each duct support, without conflicts to existing equipment, structures, crane rails, or vacuum chambers. An additional challenge was to internally clean all supply air duct with isopropyl alcohol and cap to maintain a clean-room environment according to the specifications.

The O and C Modernization Project is the start of the most significant spacecraft development effort since the space shuttle. Orion is an advanced capsule design utilizing state-of-the-art technology that will be capable of transporting up to six crew members to and from the International Space Station and up to four crew members as well.

California Contractor Helps High School Go Green



The digital media and graphics room received heavily insulated ductwork and a rooftop mounted geothermal heat pump unit to keep noise levels to an absolute minimum.

SMACNA contractor Bell Products Inc. of Napa, Calif. is helping the Napa Valley's American Canyon High School become one of the newest energy-efficient, high-performing schools in the country.

For the innovative eight-building, 260,000 square-foot campus, Bell Products performed the geothermal HVAC system work from start to finish. The company installed geothermal heat pumps throughout the facility and tied into the bore field installed under the future athletic fields. The bore field consists of approximately 300 bores, each 350 feet deep that house a piping loop. Water is pumped through this bore field and uses the Earth as the heat exchange medium, providing a highly efficient energy exchange.

Bell Products installed a campus-wide Building Management System (BMS), a mechanical room pump station, interior and roof-mounted geothermal heat pumps, campus loop piping, architectural sheet metal flashing, coping and reglets, and aluminum louvers and damper assemblies for natural ventilation from outside air.

For the project, Bell Products fabricated and installed nearly 90,000 pounds of rectangular duct and installed nearly 10 miles of spiral duct in the school buildings.



Typical duct run with a bit of creative coordination to make the structural beam “disappear.”

Being built to stringent, sustainable standards, the high school was designed to meet the guidelines of the Collaborative for High-Performance Schools (CHPS) green building rating program and one of the strictest. CHPS guidelines govern energy and resource efficiency, including energy performance, efficient water use, materials, waste management, and energy conservation.

The facilities, which will eventually house 2,200 students, include a 2,500-seat gymnasium, an aquatic center, a 400-seat theater, and outdoor athletic fields. The school campus is scheduled to be finished during the summer of 2010 in time for the 2010–2011 school year.

“Meeting the CHPS requirements provided a challenge,” said Todd Lubash, Bell Products’ project manager. “The requirements are very specific and added overhead to office and field staff. The long-term benefit to the school district and the environment definitely outweigh the extra effort, however.”

Throughout, the campus utilizes an energy-efficient design including a one-megawatt photovoltaic system with solar panels, low-flow plumbing, natural daylighting, and the geothermal system that utilizes the Earth’s natural heat exchange capability to heat and cool the school.

The main HVAC system includes, 14 rooftop geothermal units that deliver 1,552 tons of air conditioning, 118 interior geothermal heat pumps that provide 267 tons of air conditioning, various makeup air units for kitchen areas, and exhaust fans, supply fans, unit heaters and ductless split systems.

“The HVAC system allows for individually controlled rooms,” noted Mr. Lubash. “The buildings contain rooms of various sizes, including larger common areas, multi-use areas, and theater areas, along with smaller rooms such as classrooms.”



Theater ductwork illustrates the tight coordination required with structural, electrical, and fire/life safety. As part of the CHPS program, all duct openings must be kept wrapped and sealed during every stage

of construction.

“Classrooms have smaller interior units and the heating and cooling can be individually controlled, which makes the whole building more energy efficient,” Mr. Lubash explained. “That way, a whole wing or floor doesn’t have to be heated or cooled when only one classroom is in use. You don’t have to turn on a large central plant just to cool one room.”

Bell Products also installed the ventilation systems for the 400–seat theater and the library, where three of the 14 custom–built geothermal heat pumps were installed that led to improved acoustics in the classrooms as a result of quieter mechanical systems. “Geo heat pump units are well–insulated,” Mr. Lubash said. “That, along with spring isolated mounting systems and insulated ductwork, makes for a system that not only performs well but performs quietly also.”

Building information modeling (BIM) software was used in the planning stages to help make good design decisions. The project’s architects, Quattrocchi Kwok Architects of Santa Rosa, Calif., used the Graphisoft building information modeling program ArchiCAD to develop each buildings’ schematic design.



TDC jointed ductwork and transitions are staged for installation and are completely wrapped and sealed ensuring adherence to the CHPS program, keeping ductwork free of dust and debris during the installation process.

Bell Products noted that the benefits to the client included cost savings through better coordination in the planning and drawing stages. Among other energy–efficient savings, the campus will produce 55 percent of its own electricity with the photovoltaic system and use 55 percent less potable water. The school’s energy systems will deliver 10 to 20 percent savings over California’s stringent Title 24 energy code.

SMACNA Partners With buildingSMARTalliance To Open BIM Standards

Incompatible software problems costs billions of dollars in inefficiency and causes millions of additional worker hours annually, according to a New Horizons Foundation report. Recently, SMACNA recently entered into a partnership with the National Institute of Building Sciences’ buildingSMARTalliance to further explore contractors and software developers’ common interests in identifying and addressing interoperability issues in the MEP (mechanical/electrical/plumbing) industry.

These efforts are intended to provide practitioners in the MEP industries with best practices in accordance with existing and future versions of the United States National Building Information

Modeling Standard (NBIMS). These efforts should provide guidance to software vendors interested in implementing open standards for BIM and increase sharing basic information for use in multiple activities during a facility's life cycle.

Also, joining this group along were the Mechanical Contractors Association of America (MCAA) and the National Electrical Contractors Association (NECA).

The report "Impact of Incompatible Software on HVAC and Sheet Metal Contractors" is available free to SMACNA members by entering your user name and password in the "Store" section of the New Horizons Foundation Web site at [New Horizons Foundation](#). Questions about the partnership should be directed to Tom Soles, SMACNA executive director, market sectors, at (703) 803-2988.

SMACNA And ICC Team Up To Promote Mutual Interests

SMACNA and the [International Code Council \(ICC\)](#) have agreed to jointly advance and promote the mutual interests of the sheet metal and air conditioning construction industry. This includes marketing new products and services collaboratively, supporting cooperative standards and codes development, and sharing each other's products and services with their members.

For more information about this agreement, contact Eli Howard, executive director of technical services at (703) 803-2995 or ehoward@smacna.org.

It's O.K. To Brag A Little...

Tell us about your HVAC projects! SMACNA members want to know about your successful HVAC projects. Let us tell the story of your latest work in the SMACNA newsletter of the HVAC Council, HVAC Systems Expertise.

Let us know about your work – did you reach energy efficiency requirements, meet demanding specifications, use Building Information Modeling, and deliver a top-notch project on time and under budget?

For your work to be considered, send us your best, high-resolution photos of the project, and give us the details on our submittal form. For the online submittal form, go to the [HVAC Council page](#) on the SMACNA Web site and choose HVAC Systems Expertise Newsletter Submittal Form. Then send the form and digital photos to Cynthia Young, SMACNA communications manager, at cyoung@smacna.org.

If we use your project, besides appearing in the HVAC Systems Expertise newsletter, we'll send you a customized marketing piece featuring your company's project. This marketing piece may be used as you like – as an advertisement, direct mail piece, flyer, or on your Web site.

You may also mail your submittal form and digital photos on CD to Cynthia Young, SMACNA, 4201 Lafayette Center Drive, Chantilly, VA 20151. Submit your project today!

2009 Convention Sessions Tailored Specifically For HVAC Contractors

Session: How HVAC Contractors Can Succeed With LEED

HVAC contractors will learn how to turn their LEED-AP exam success into dollars for their company at the business session “LEED Building for Sheet Metal and HVAC Contractors,” on Monday, Oct. 12, during SMACNA’s annual convention in Palm Desert, Calif.

The session will cover the role of the HVAC contractor in various LEED (Leadership in Energy and Environmental Design) rating systems. Participants will learn how to acquire LEED projects through correct use of company marketing. Project proposal strategies also will be reviewed. Attendees will gain a better understanding of integrated mechanical product selection and documentation to promote a streamlined path to LEED certification. This program is geared to HVAC contractors who have passed the LEED Accredited Professional exam and are working toward acquiring LEED projects.

Leading the session is David Hubka, LEED AP, a sustainable project manager at Total Mechanical Inc. where he guides every LEED project from conception to certification. He has designed the HVAC system of Wisconsin’s second LEED Platinum-certified building and retro-commissioned a 1.7 million square foot multi-use facility that achieved LEED Silver certification.

HVAC Forum: SmartMarket BIM Report To Be Unveiled

Attendees at the convention HVAC forum will be among the first to preview the latest “SmartMarket Report on Building Information Modeling (BIM)” on Monday, Oct. 12.

Building information modeling is transforming the construction industry, many experts say. The report focuses on the business aspects of BIM implementation. In December 2008, McGraw-Hill Construction published the “SmartMarket Report on Building Information Modeling (BIM),” which surveyed users about BIM adoption, implementation, value and impact within their firms. The next report on BIM — scheduled for publication in October 2009 — will focus on the business aspects of BIM.

In this session, Stephen A. Jones, senior director of business development at McGraw-Hill Corp., will review the key findings of this new report and highlight the business aspects of BIM in construction including return on investment, contract arrangements and impact on productivity.

Session: Building Information Modeling (BIM), Integrated Project Delivery

This session on Monday, Oct. 12, presents the case that the ideal BIM process is integrated project delivery (IPD). Contractors will learn about the current status of IPD in the industry, including barriers to implementation, and the expected future direction. The converging forces driving the AEC industry toward integration and the resulting opportunities created by IPD will also be discussed.

The presenter is Dr. Bradley T. Johnson, a senior consultant in Navigant Consulting’s Construction Practice in the Project Execution service line. He works with real estate, design and construction firms and specializes in modeling and virtual modeling services in the building and construction market.

Session: SMACNA HVAC Duct Construction Standards (ANSI)

This session on Monday, Oct. 12, will demonstrate the use of the manual “SMACNA HVAC-Duct Construction Standards – Metal and Flexible,” third edition, showing the proper range of construction options for sheet metal ductwork. As the code-adopted industry standard, this allows for the most cost effective and sustainable use of sheet metal to better meet the needs of today’s energy efficient market.

Topics will include instruction on the rectangular, round and flat oval tables, along with the proper joint, reinforcement and spacing requirements. Multiple step-by-step examples will show the selection process for each type of reinforcement (external and internal), transverse joint and seam type.

A new section within the standard on double-wall ductwork, accessory details, expanded TDC/TDF construction tables and expanded long seam and spiral seam round tables will be covered.

Session: SMACNA's "Cost Reference Manual for Labor Units"

SMACNA's "Cost Reference Manual for Labor Units" provides users with a source of labor unit data required to fabricate and install heating, ventilation, and air conditioning materials and equipment.

In this session Monday, Oct. 12, consultant Kevin L. Dougherty will discuss important features of the manual and demonstrate its use including a new electronic spreadsheet feature that calculates adjustments in the 138 labor unit tables for project types and non-typical shop and job site conditions.

All of these sessions will take place at SMACNA's annual convention at the Desert Springs JW Marriott Resort and Spa in Palm Desert, Calif., from Oct. 11-15, 2009. For more information visit the [Convention](#) section of the SMACNA Web site, or contact Mary Lou Taylor, director of meetings and convention, at (703) 803-2998 or mtaylor@smacna.org.

SMACNA Updates "Cost Reference Manual For Labor Units"

SMACNA's updated "Cost Reference Manual for Labor Units" will provide users with a source of labor unit data required to fabricate and install heating, ventilation and air conditioning materials and equipment. Scheduled for publication after SMACNA's October annual convention, the revised manual for the first time contains electronic spreadsheets for the 138 Labor Unit tables detailing the labor units required to perform particular fabrication and installation tasks.

Each table contains factors for *normal*, *difficult*, or *very difficult* conditions that are arrived at by defining the project type and specified project and/or shop conditions. The new version of this manual helps contractors make these determinations using a programmed checklist that calculates the degree of project difficulty (*normal*, *difficult*, or *very difficult*) and takes the user to the appropriate labor unit table for the designated task.

A convention session on the "Cost Reference Manual for Labor Units" is scheduled for Monday, Oct. 12, from 9:45 a.m. to 11:45 a.m., at SMACNA's annual convention in Palm Desert, Calif. A half-day chapter education program on how to use the new manual is being developed and will be made available to SMACNA chapters in January 2010. For further information, contact Tom Soles, executive director, market sectors, at (703) 803-2988.

SMACNA Releases Six Model Specifications On HVAC-Related Work

SMACNA has issued six model specifications or guides on HVAC-related work to assist members and the specifying community in correctly specifying sheet metal components and their installation. The model specifications reference CSI's MasterFormat Division 23 - HVAC and include the following

sections:

- Metal Ducts – Section 23 31 13
- Dampers – Section 23 33 13
- Duct Silencers – Section 23 33 19
- Turning Vanes – Section 23 33 23
- Duct–Mounting Access Doors – Section 23 33 33
- Flexible Connectors – Section 23 33 43

All sections reference relevant SMACNA standards. Members are encouraged to share these model guides with partners in the specifying communities for editing to fit the needs of specific projects.

These six model specifications can be found on the [Business/Project Management](#) section of the SMACNA Web site under “Contract Administration.”

Latest Contracts Bulletin Compares Subcontractor Default Insurance To Surety Bonds

Managing risks in construction can be challenging. The new SMACNA [Contracts Bulletin](#) No. 106 “Understanding Key Differences Between Subcontractor Default Insurance (SDI) and Surety Bonds” provides information on SDI and how it compares to surety bonds.

Subcontractor default insurance (SDI), first introduced in 1996, is insurance marketed as a way for prime contractors to minimize the risk of subcontractor failure. However, some subcontractor benefits provided by contract bonds are absent under current SDI policies.

SMACNA Contracts Bulletins provide a wealth of information on contracts and related issues. For more information, contact Mike McCullion, project manager for market sectors, at (703) 995-4027 or mmccullion@smacna.org.

SMACNA Chapters Affiliating With TABB

The Testing, Adjusting and Balancing Bureau (TABB) Affiliate Agreement is a contract between TABB and local union organizations made to further the TABB certification program and create opportunities for TABB certified union members.

The latest SMACNA chapter to sign the TABB Affiliate Agreement is the Sheet Metal Contractors Association (SMCA) of Philadelphia & Vicinity. This affiliation allows the SMCA to use the TABB logo, which represents a stringent code of conduct and the highest quality workmanship in HVAC installation and maintenance. The SMCA also agrees to help further program participation and acceptance in the Delaware Valley.

“With TABB making its way into more specs of major design firms, our members are the beneficiaries of greater opportunity in the field,” explained William Reardon, SMCA executive director. “Our SMCA member firms value the training and technical accomplishment of their Local No. 19 employees.”

“I would tell other SMACNA chapters that the affiliate agreement is now a legally viable document that upholds the rights of chapter organizations and ties them to the TABB Program,” he added.

With TABB working towards becoming the foremost source for up-to-date and cutting-edge HVAC education, training, and testing, this agreement helps to build on the standard for performance in the HVAC industry.

Additional SMACNA Chapters affiliated with TABB include:

- Bay Area SMACNA Chapter
- SMACNA–Los Angeles
- SMACNA Chicago
- SMACNA–St.Louis Chapter
- Indiana (entire state)
- New York (entire state)
- Associated S/M & Roofing Contractors of Connecticut

For information on the TABB Affiliate Agreement or the TABB Certification Program, visit [The Testing, Adjusting and Balancing Bureau](#), or call (703) 299–5646.

ITI's BIM Academy Opens In October

Starting in late October, the International Training Institute (ITI) is opening a Building Information Modeling (BIM) Academy in St. Louis, Mo. to offer courses on their CCS Training Software. The CCS training software is Building Information Modeling software. All courses will be held at the SMW Local No. 36 JATC in St.Louis.

The ITI has scheduled four courses in 2009, two courses each for Draft and Fabrication (Fab). In 2010, the course offerings will be expanded to include additional portions of the training software. These courses are available to all SMWIA members who have contributions made on their behalf to the ITI. The courses will focus on the use of the CCS training software and on the last day will end with a certification test. Upon successful completion of the certification test, the member will be licensed to use the corresponding portions of the CCS training software so they may utilize it as the ultimate on-the-job training tool at a signatory contractor's facility.

The Draft courses will cover the components of the CCS training software that will enable the user to create coordinated shop drawings of various building systems including HVAC, piping, electrical, and structural. The draft course will be geared towards existing detailers who must be proficient in AutoCad before attending the class.

The Fab course will cover components of the software that will enable them to produce machine code and fitting labels directly from a CCS draft drawing. The Fab course will be geared towards individuals that will work directly with the downloading and fabrication of HVAC components using CNC machines. These individuals should have a basic understanding of Autocad before attending the course.

The following are the dates for the 2009 BIM Courses:

Class	Travel in Date (Sunday)	Actual Class Dates (Monday through Friday)	Travel Out Date (Saturday)
Draft	10/25/2009	10/26/2009 - 10/30/2009	10/31/2009
Draft	11/8/2009	11/9/2009- 11/13/2009	11/14/2009
Fab	11/15/2009	11/16/2009-11/20/2009	11/21/2009
Fab	12/6/2009	12/7/2009 - 12/11/2009	12/12/2009

These costs of transportation, hotel, per diem, and wages must be covered by the individual or the individual's contractor. The ITI has negotiated a special room rate of \$89 a night at a Residence Inn by Marriott that includes a complimentary breakfast buffet, an evening reception, and complimentary transportation to and from the training center for all participants.

In order for a member to sign up for a course, visit [The International Training Institute](#), to obtain a username and password, and then sign up. Enrollment is limited and will be filled on a first-come, first-served basis. For questions and more information, contact the ITI's Michael Keane at mkeane@sheetmetal-iti.org or at (703) 299-5628.

Study Shows Building Commissioning Is Cost-Effective

A new study by Lawrence Berkeley National Laboratory quantifies the economic impact of building commissioning. The findings demonstrate that commissioning is arguably the single-most cost-effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today.

The study, "Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions," finds median payback periods for commissioning to be slightly more than one year for existing buildings and about four years for new construction.

The study also finds that commissioning results in energy savings of about 15 percent in new and existing buildings. The commissioning projects for which data are available revealed over 10,000 energy-related problems, resulting in 16 percent median whole-building energy savings in existing buildings and 13 percent in new construction, with payback time of 1.1 years and 4.2 years, respectively.

Over the past decade, Lawrence Berkeley National Laboratory has built the world's largest compilation and meta-analysis of commissioning experience in commercial buildings. [Click here](#) to see a summary of the study.

Editor: Rosalind P. Raymond rroymond@smacna.org | Asst. Editor/Writer: Cynthia Young cyoung@smacna.org

Sheet Metal and Air Conditioning Contractors' National Association
4201 Lafayette Center Drive Chantilly, Virginia 20151-1209
Tel (703) 803-2980 Fax (703) 803-3732 info@smacna.org



Copyright © 2009 SMACNA. All rights reserved.
Created by [Matrix Group International](#)