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Monte Rosa Hut:
sustainable lodging in THE ALPS

The Swiss Federal Institute of Technology (ETH Zürich) teamed up with innovative, award-winning architecture firm Bearth & Deplazes Architekten, the legendary Swiss Alpine Club (SAC), and Vectorworks software to design and build the new Monte Rosa Hut—a high altitude mountain shelter that sets new milestones in sustainability as well as innovative design.

The Monte Rosa Hut, although large and grand, is but a small reflection in the vast and endless snow.
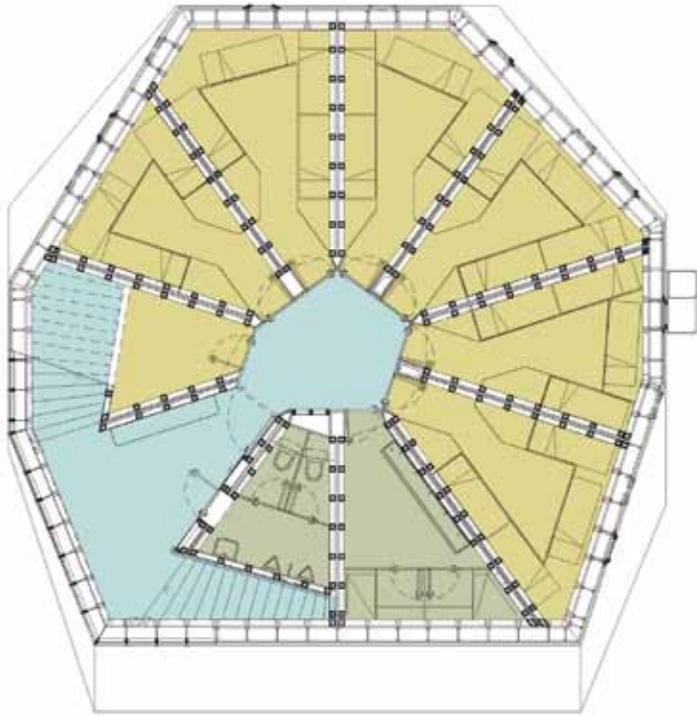
Three Mountains Come Together

At the pinnacle of technology and nature, the Monte Rosa Hut sits 2,883 meters high in the Swiss alpine sky between the Gorner, Monte Rosa, and Grenz glaciers near Zermatt. Hours away from the nearest outpost, the structure is rooted into the rocky Monte Rosa Massif mountains. The surrounding landscape has a lunar quality—vast, isolated, and eerily quiet. One sees the Matterhorn to the west, dwarfing any sign of human life. Yet the Monte Rosa Hut's glistening metal and glass walls rise defiantly in the face of endless snow and rock. The hut continues the centuries-old tradition of alpine mountain shelters—while at the same time completely redefining it.

The Monte Rosa Hut was conceived as one of fifty projects undertaken to commemorate ETH Zürich's 150th anniversary. In 2003, the head of the anniversary celebration formed the Studio Monte Rosa at the ETH Faculty of Architecture to design and build a structure that would replace the original lower elevation Monte Rosa Hut, which was in great need of repair. The new structure would serve two important purposes: to provide alpinists and hikers protection from the elements as well as a comfortable, clean space to eat, rest, and commune with fellow travelers; and to provide ETH Zürich with valuable research on effective sustainable practices.

The design and construction of the Monte Rosa Hut was realized through constant collaboration among the ETH students, the Swiss architecture firm Bearth & Deplazes Architekten, and the Studio Monte Rosa—a combined group of selected ETH students and Bearth & Deplazes architects. In conjunction with the Studio Monte Rosa, the ETH students handled the concept, design, and research phases for the project per the requirements and budget set by the SAC, while the architecture firm implemented the project. The students were challenged to create a building that could be constructed far from public power and water supply grids, yet provide enough energy and water to serve almost all of its lodgers' needs, while weathering the extreme wind, snow, and earthquakes that plague the area.

With guidance from Bearth & Deplazes Architekten, the ETH students and the Studio Monte Rosa worked diligently on the design concepts for four semesters spanning 2003-2005. In addition, they spent one more year in specialty research to optimize the hut and its components. After crafting twelve different proposals for the facility, they honed their ideas down to one groundbreaking design. The cornerstone was laid on August 16, 2008 and construction began in May 2009. The highly anticipated new Monte Rosa Hut opened to great acclaim on September 26, 2009 at a cost of 6.5 million Swiss francs.

Various size trapezoidal mattresses in bedrooms optimize sleeping space.
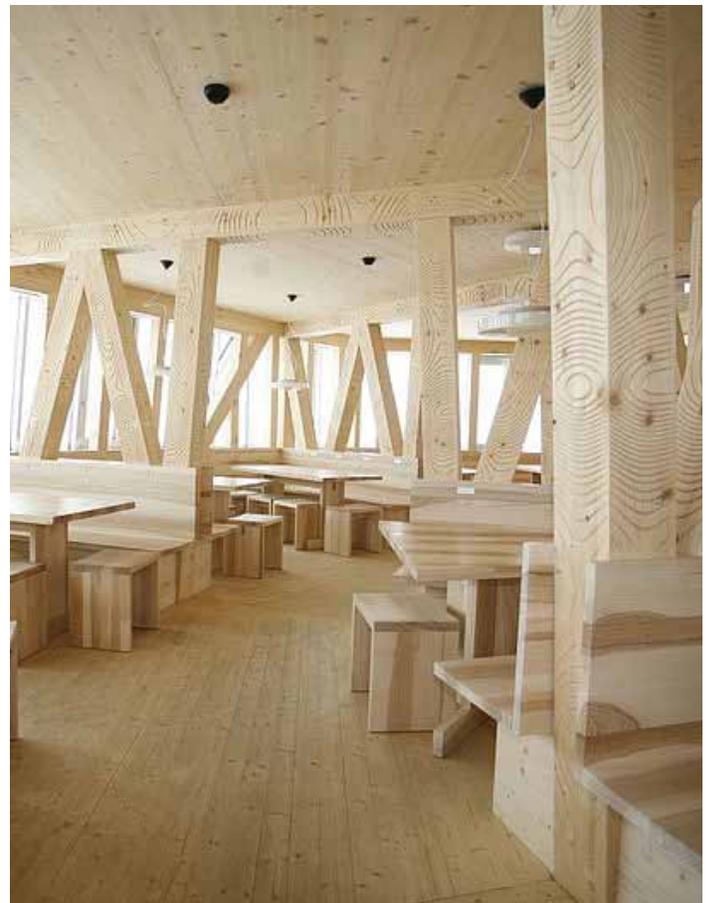
"What interested me from the outset was the location—remote from civilization, rather like Robinson Crusoe's island. We began by asking ourselves where everything we unthinkingly consume or use every day comes from. The answer, of course, is: from a highly complex social space, a technologically-advanced environment geared to everyday needs, and not a landscape viewed through the rose-tinted glasses of nostalgia or the romantic idyll of seemingly abandoned alpine huts, cottages, in high meadows."

Professor Andrea Deplazes, Professor of Architecture and Construction, Head of the ETH Studio Monte Rosa, Faculty of Architecture, ETH Zürich and Principal, Bearth & Deplazes Architekten, Chur, Switzerland

Solitary Outpost

There are no roads leading to the Monte Rosa Hut. Most visitors travel by foot over rocky, snow-covered terrain with a steep ascent at the end. A traveler can walk two to three hours from the nearest train station in Rotenboden or drop in by helicopter. Once he makes the long journey, he is rewarded with a clean and comfortable space.

The facility can accommodate up to 120 guests. It contains a simple kitchen and dining area—both fashioned from spruce and fir, which were chosen for their sustainability quotients. A large common room provides a spot for socialization. The bedrooms feature trapezoidal mattresses in various sizes made to minimize wasted space by matching the shape of the human body (broader at the top and tapering for the legs). During the specialty research phase, the ETH students used Vectorworks® software to maximize the placement and number of beds within the given space. By simulating many different scenarios for the beds and other building elements, the design team optimized the hut's entire design—which saved a great amount of development time and significantly reduced building costs.

Large blonde wooden beams with exposed joints and computer carved growth rings offer hikers an inviting space to gather and dine.

A Modern Marvel

Aesthetically, the Monte Rosa Hut's design is austere like the land-scape. Its reflective roof mirrors the grandness of its surroundings while providing valuable solar energy to the building. A ribbon of windows shadows a cascading staircase and echoes the ridges of the famous mountaintops in the distance. Inside, the generous use of wood re-minds visitors of the hut's natural setting, and the pitch of the staircase meets angled-in walls, much like the climb to get there. Even the hut's position, perched at the edge of a steep hillside, helps it blend into the vast alpine climate, like a rock outcrop.

Although the Monte Rosa Hut blends in with its natural surroundings, the design does anything but that. The building is an irregular polygon with ten interior segments created by radial cross beams, to resemble an orange with its rind roughly cut away. Its five stories are framed by asymmetrical angles. The shape was designed for efficiency—to optimize volume while reducing surface area—thus minimizing the facility's exposure to wind and snow and providing more room for guests. Ten foundations root the structure into the rock and support a star-shaped steel "table" with radial cross walls.

The design team used Vectorworks Architect software to create the complex geometry of the Monte Rosa Hut, designing 420 different wall and ceiling elements that were pieced together. A big task was handling the different geometries while keeping the detailed solutions as similar as possible, as was done with the ribbon glazing/window strip, the timber construction/woodwork, and the furnishing of the bedrooms. The program's accurate, flexible symbol libraries were very helpful to the team because the designers did not have to create the components from scratch.

The software also provided the basis for calculating project costs according to Swiss standards and enabled the students to employ a "digital chain" methodology to fine-tune the hut's components at each step of the project and move their data seamlessly from concept to design, to development, to fabrication, and finally to construction. The end result: precisely-manufactured building elements and smooth collaboration with numerous other project teams. By using the digital chain to address complexities and efficiencies, they were able to reduce the number of building elements by 30 percent and the weight by 40 percent, and also adjust design elements throughout the process.

Ribbon windows, mirroring the surrounding mountain ridge and angled staircase, stream light into the hut and enhance thermal energy.

The asymmetrical angles of the five story hut minimize exposure to snow and wind and provide more room for guests.

A Sustainable Dream

The Studio Monte Rosa and the ETH students designed everything through the lens of self-sufficiency and sustainability. This goal dovetailed with the SAC's mission, which continues to be exceedingly concerned with protecting the Swiss Alps for future generations. The SAC's 153 huts are simple accommodations built to showcase the mountains themselves. A sustainable hut that produces its own energy represents the next generation of technology and eco-friendly practices, and ensures that the mountains remain pristine for the future. The goal was to make the best building ever and to realize something that seemed impossible to create.

For the new hut, Deplazes and his team chose to use renewable building materials and pieces of the highest quality. Wood was one of the largest components. In a nod to traditional mountain huts, the architects selected local spruce and fir approved by the Federal Office for the Environment (FOEN) for the interior. They wanted to show all of the construction, so they turned the large blonde wooden beams around, exposing the mortises and dovetails. Since the joints were exposed, their formation required perfect precision. "Until now, no one has exploited the aesthetic potential of these apparently hand-made joints in digital wood construction," notes Deplazes. They used a computer-controlled robot to carve growth rings into the wood, calling to mind their natural wooden texture and the typical handiwork of the alpine hut, but at the same time evoking a more modern Pop Art feel.

The design teams were careful to select low-pollutant building materials that could be transported easily and efficiently, and could eventually be recycled or discarded with little effect on the environment. Since there was little power or water to build materials on site, many of the components needed to be prefabricated. After testing several different materials, Bearth & Deplazes Architekten selected a conventional insulation package comprised of aluminum sheeting with mineral-wool insulation and 3-ply panel spruce. At only 30 cm thick, it was the choice that insulated most efficiently and therefore lessened the heat requirements for the energy-management system.

The construction process could not have been accomplished with traditional methods because the location was off the power and water supply grids. So in addition to keeping costs low and optimizing sustainability, the designers had to contend with the challenge of building the new Monte Rosa Hut in an isolated site. Most of the Monte Rosa Hut is constructed from sections of no more than 400kg in weight that were transported to the site by a small helicopter—the transportation means determined to be most cost-effective and environmentally friendly by the students. Throughout the entire construction period, the team used the helicopter as a crane and to ferry materials to the building site approximately 3,000 times. To capitalize on the window of good weather, the building was constructed between late May and the end of September 2009.

This facility is 90 percent self-sufficient and offers hikers protection from the elements in a new-style alpine hut that rises dramatically out of the snow-covered terrain.

Self-Sufficient Solution

The design of the Monte Rosa Hut is nothing short of amazing, especially since its result is a 90 percent self-sufficient facility. The idea was to build a sustainable building as an exemplar building project. The conditions were extreme, with no electricity, no water supply, no roads, and no streets. It had to be self-sufficient and provide energy on site. It was the perfect test for the university.

The Monte Rosa Hut has its own water supply provided by the mountainous terrain. The construction team blasted through granite to create an underground tank that houses 200 cubic meters of melt water, and they built it behind the permafrost barrier to keep the water from freezing in extreme temperatures. They also built a small treatment plant to process wastewater for use as grey water for toilets, thus helping to save three times more energy than the original hut expended.

State-of-the-art photovoltaic technology produces electrical power and heats the thermal collectors. Additionally, the large and continuous bands of windows stream sun into the spiral building to enhance the visitors' own thermal energy. During periods of sustained cloudiness or when the demand is higher, a cogeneration plant that runs on rapeseed oil, a type of biodiesel, supplies the energy.

The Monte Rosa Hut has earned the MINERGIE®-P label by the Swiss Confederation and Swiss Cantons because it provides "high-grade, air-tight building envelopes and the continuous renewal of air in the building using an energy-efficient ventilation system." The facility houses a state-of-the-art research lab which measures the building's efficiency as a self-sufficient entity. It also has an energy management system so sophisticated it factors in the weather forecast and the number of guests in its calculation of energy usage. Vectorworks Architect software files served as input and output for the energy design.

The ETH Zürich controls this energy-management system remotely from Zürich - about 260 kilometers away. This constitutes a giant step for the university into a brave new world of technology. The researchers study the cornerstones of ETH Zürich's energy research strategy: efficiency (the reduction of materials and current maximization of energy), energy renewability, and electrification (using electrical power with minimum carbon dioxide emissions in buildings and transportation). "It's more than just a building, it's a research project," explains Deplazes.

"The combination of research, teaching, and practical work is of great interest to Bearth & Deplazes Architekten. The collaboration of building physics, the building materials industry, building construction, and building cultures leads to a remarkable architectural result."

Professor Andrea Deplazes, Bearth & Deplazes Architekten, Chur, Switzerland

ETH Zürich's work with the Monte Rosa Hut has solidified its commitment to addressing global climate change with cutting-edge technology. It is currently in the process of developing model-based regulation software to help it apply its findings.

Now owned and operated by the Monte Rosa Section, one of the largest sections of the SAC, the Monte Rosa Hut continues to claim a large number of awards. Although the new Monte Rosa Hut is just one of 153 shelters maintained by the SAC in the Swiss Alps, it has become an important piece of the mountain's sustainable legacy—and of modern design.

"I'd even maintain that it is currently the best hut in the Alps," remarks Deplazes. "Not because of its technology or form, but rather because we have succeeded in erecting a building that cannot be split into dichotomies such as construction and technology, or surface and structure. Things work together. It is impossible to change anything about the building without calling other components into question. It constitutes a balanced whole."

Professor Andrea Deplazes shows the irregular polygon-shaped Monte Rosa Hut with its ten segments.

Acknowledgements

Rooted in the rocky Monte Rosa Massif Mountains, the Monte Rosa Hut echoes the Matterhorn to the west.