

The architecture of Refuge:
The Evolution of Alpine Mountain Huts.

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AR2A011 Architectural History Thesis
TU Delft

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17-04-2025

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Abstract

This thesis investigates the architectural and cultural evolution of mountain refuges in the Alps, tracing their development from rudimentary shelters to contemporary landmarks shaped by innovation and environmental awareness. Historically, these structures were simple enclosures built out of necessity by shepherds, traders, and early travellers. With the rise of alpinism in the 18th and 19th centuries, they evolved into more permanent refuges designed to support exploration and ensure safety at high altitudes.

The 20th and 21st centuries brought significant changes, as new materials, prefabrication techniques, and ecological considerations transformed the design and construction of alpine shelters. Contemporary examples like Refuge du Goûter and Bivouac Fanton demonstrate how modern mountain architecture balances durability, sustainability, and symbolic meaning in extreme conditions.

While existing research often separates technical, cultural, and environmental aspects, this thesis addresses the intersection of these dimensions. Through literature review, archival research, and case study analysis, this thesis answers the question: *How have mountain refuges in the Alps evolved from rudimentary shelters to cultural and architectural landmarks for modern alpinists and hikers?* It concludes that these shelters now serve not only as practical havens but also as cultural markers, representing human resilience, environmental awareness, and the ongoing dialogue between tradition and innovation in alpine architecture.

Keywords: alps, refuge, shelter, bivouac, mountain hut

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Introduction

Mountain refuges in the Alps have undergone a remarkable transformation over the centuries, evolving from rudimentary shelters built out of necessity to sophisticated, architecturally significant structures that serve as cultural and symbolic landmarks. These refuges, once simple constructions made from available materials such as stone and wood, have developed in response to shifts in societal attitudes toward the mountains, advances in construction techniques, and growing environmental concerns. This thesis explores the historical, architectural, and cultural evolution of mountain refuges in the Alps, analysing their development in relation to alpinism, tourism, and contemporary environmental challenges.

Historically, the Alps were seen as barriers rather than destinations. Traders, shepherds, and early travellers were among the first to navigate these harsh environments, constructing simple shelters for survival rather than leisure. These early structures, often dry-stacked stone enclosures or basic wooden huts, were built strategically along established routes and mountain passes. Over time, religious institutions and local communities formalized the construction of hospices. However, it was not until the late 18th and 19th centuries that a shift occurred, transforming the perception of the Alps from hostile wilderness to an arena for exploration and adventure.

The rise of alpinism in the 19th century marked a turning point in the architectural development of mountain shelters. As mountaineering gained popularity, particularly among European elites and scientific explorers, the need for more permanent and strategically located shelter grew. Early alpinists began constructing shelters not just for traversing the Alps but for ascending its peaks, laying the foundation for the network of huts and bivouacs we see today.

Throughout the 20th century, improvements in construction methods and transportation facilitated the expansion and modernization of these mountain refuges. The arrival of helicopters, prefabrication, and innovative materials enabled architects and engineers to design shelters that could withstand extreme alpine conditions while minimizing environmental impact. Traditional stone-and-wood structures gave way to lightweight, modular, and energy-efficient designs, as seen in examples such as Refuge du Goûter and Bivouac Fanton. These contemporary projects illustrate how architecture has adapted to both the technical demands of high-altitude environments and the shifting expectations of modern alpinists and hikers.

However, the evolution of mountain refuges is not solely a story of technological advancement. It is also deeply tied to cultural and environmental considerations. Today, climate change poses a significant challenge to high-altitude architecture, with glacial retreat, permafrost thawing, and water scarcity threatening the stability and sustainability of mountain refuges. These issues demand innovative design solutions that balance resilience, sustainability, and respect for the alpine landscape. The emergence of self-sufficient refuges equipped with solar panels, water recovery systems, and durable, lightweight materials reflects a growing awareness of ecological responsibility in contemporary alpine architecture.

Existing research has often focused either on the technical innovations of high-altitude architecture or the historical context of alpinism, without fully addressing the intersection of these aspects. This thesis seeks to fill this gap by providing a comprehensive analysis of both the technological and cultural dimensions of mountain refuges in the Alps.

The central research question of this thesis is: *How have mountain refuges in the Alps evolved from rudimentary shelters to cultural and architectural landmarks for modern alpinists and hikers?* To answer this question, the research follows a structured methodology, incorporating literature reviews, archival studies, and case studies of significant shelters, such as Refuge du Goûter and Bivouac Fanton. By focusing on these case studies, this research will highlight how these structures continue to serve not only as functional shelters but also as powerful symbols of human ingenuity, resilience, and our ever-evolving relationship with the mountains.

I. Historical Development of Alpine shelters

Traders and shepherds

Mountains have always had a strong relationship with culture and symbolism. Ancient texts, drawings, and images emphasize their role as ‘natural monuments.’ An interesting example of this is the depiction of Noah's Ark on top of mount Ararat. This shows that mountain peaks were not only seen as dangerous, inhospitable places but sometimes also as a place of refuge (Bodeau 2024, p. 24).

The Alps form an imposing natural barrier in Europe, separating landscapes and cultures. Crossing these mountains presented both challenges and opportunities, especially for traders and herders. For them, traveling through the Alps was a necessary hardship, exposing them to extreme weather conditions and rugged terrain (Sarda, 2023, p. 12).

Out of this necessity, the first shelters in the mountains emerged. Herders and travellers built simple dwellings to protect themselves from the harsh alpine conditions (Bodeau, 2024, p. 15). The abundance of natural stone in this environment influenced construction techniques. Many early structures consisted of little more than a few dry-stacked stone walls in an already sheltered spot (Dini & Girodo, 2018). In strategic locations, such as well-known mountain passes, hospices were established. An early example of this is the Hospice du Grand Saint-Bernard dating back to 1050. Here, traders and travellers could find temporary shelter and food, but these places were used purely out of necessity, not for leisure (Bodeau, 2024, p.16).



Figure 2. Fragment of Map of the Holy Land with Armenia, arch of Noah on mount Ararat, ca. 1240–1253. Author: Matthew Paris. Parker Library, Corpus Christi College, University of Cambridge, United Kingdom



Figure 1. H. Gottlieb, 1838. Hospice du Grand Saint-Bernard.

Tourism and alpinism

For the biggest part of human history mountain peaks were avoided since they were hardly accessible and devoid of resources. This started to change in the 18th century. Societies got wealthier and resources grew. This resulted in more leisure time and people started exploring the peaks around them. (Anderson, 2020, p.115)

With the mountains becoming more accessible high altitude tourism also started to ramp up. A very influential place for the change from basic shelters to refuges was Montanvert. Windham and Pococke were the first tourists to discover Montanvert (Bartolomucci, 2019, p.45-46). The only shelter was the one a shepherd had built under a large boulder, enclosed by dry stone walls. In 1776, another Englishman, Charles Blair, had a shelter built: Blair's Hospital. Mare-Théodore Bourrit was a French painter and admirer of the mountains but his bad physique prevented him from reaching the high peaks.

In 1796 he erected the ‘Temple of Nature’ on the edge of the glacier. Written on the pediment was ‘To Nature, by a friend of Liberty’ (Bartolomucci, 2019, p. 46).

The place would become famous around Europe. Attracting a lot of influential historical figures like the Empress Eugenie. Romantics flocked to the Alps and mountain peaks from ‘horrid’ became sublime. This new view on the mountains would spark the curiosity of thrill seekers and a new sport was born ‘alpinism’ (Bodeau, 2024, p. 23).



Figure 4. S. Birmann f. A mer de glace vue de Montanvert (J. Whattman, 1825); Souvenirs de la Vallée de Chamonix p.18

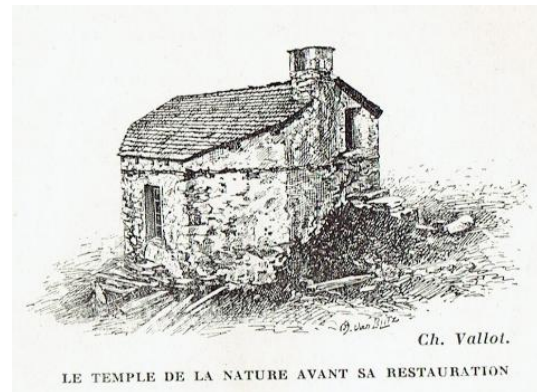


Figure 3. Drawing by Charles Vallot, illustrating the “Temple de la Nature” in its original shape.

From Basic Shelters to Official Refuges and Bivouacs

Naturally, this curiosity gravitated to the highest peaks of the Alps, with the centre and highest point being Mont Blanc. The early mountaineers started building shelters not to get through the Alps but to get on top of the Alps. These constructions were designed to sleep a few people and were found mainly around the Mont Blanc massif. (Sergei Poljak, 2024) Mont Blanc was first climbed in 1786 by Jacques Balmat, a chamois hunter and crystal collector, alongside Dr Michel Gabriel Paccard. This marked the beginning of the golden age of alpinism (Bodeau, 2024. p. 23). During their ascent, Balmat and Paccard had to spend the night on the mountain, and their shelter during this climb was nothing more than an overhanging rock. A few decades later a shelter was constructed along this route, known as the Refuge de Goutières. In 1854, it was built as a stone shelter, and in 1858, an actual hut was established. It didn’t take long for additional huts to be constructed in the Alps. The first shelter that became a real refuge was the hut on the Grand Mulet. It became guarded from 1868, making it the first refuge (Bodeau, 2024. p. 41). This also marks the beginning of a general distinction between a refuge or mountain hut, staffed, and a bivouac, unstaffed.

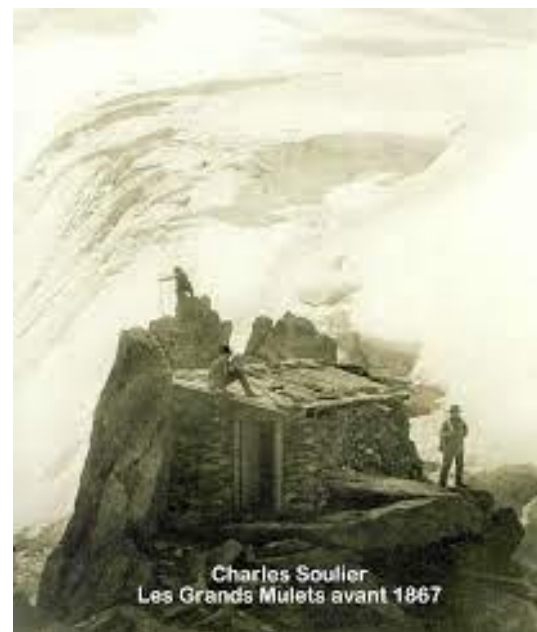


Figure 5. Charles Soulier, les Grands Mulets and the stone shelter before 1867

Supervision

Building these huts and trails took a lot of organization and resources. With alpinism growing in popularity, mountaineering clubs were formed. The Italian, German, Swiss, Austrian and French clubs were established between 1862-1875 (Bodeau, 2024, p. 27). With the arrival of these clubs, path and hut building became a way of promoting the mountains as a visual resource. More thought would be put in planning where the huts and paths would go. This would inevitably dictate what the mountaineer could or could not gaze upon (Anderson, 2012, p.194).

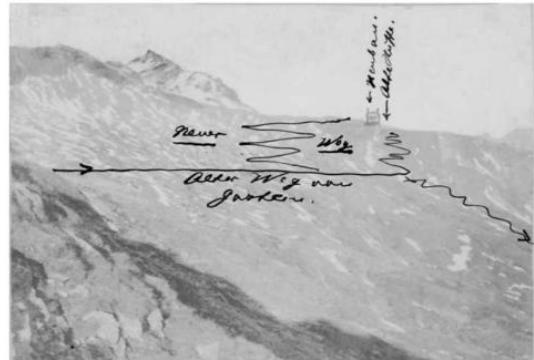


Figure 6. Geplante Wege zur neuen Hannoverschen Hütte (Planned paths to the new Hannover Hut). Photographic print on cardboard. Archiv des Deutschen Alpenvereins, München,

II. Architectural Evolution

Tradition and function

Traditionally, refuges were built with two locally available materials, stone and wood. These materials would be carried up or down by porters to the building site. It was of great importance that the materials would be sourced as close as possible to the construction site (Bodeau, 2024, p. 60). With the world becoming more industrialized the construction of refuges also became more industrialized. The use of ropeways and rock blasting would become common practice (Anderson, 2012, p. 174-176). Materials would be brought up from the valley in order to build bigger refuges. The newly built refuges would still have a very traditional look but the designing and planning became very function-focused. Instead of designing on-site the design would be calculated and detailed in the city by architects and engineers to minimize construction time and materials. Bringing this urban approach to the mountains led to a form of 'vernacular modernism'. (Anderson, 2012, p. 174)

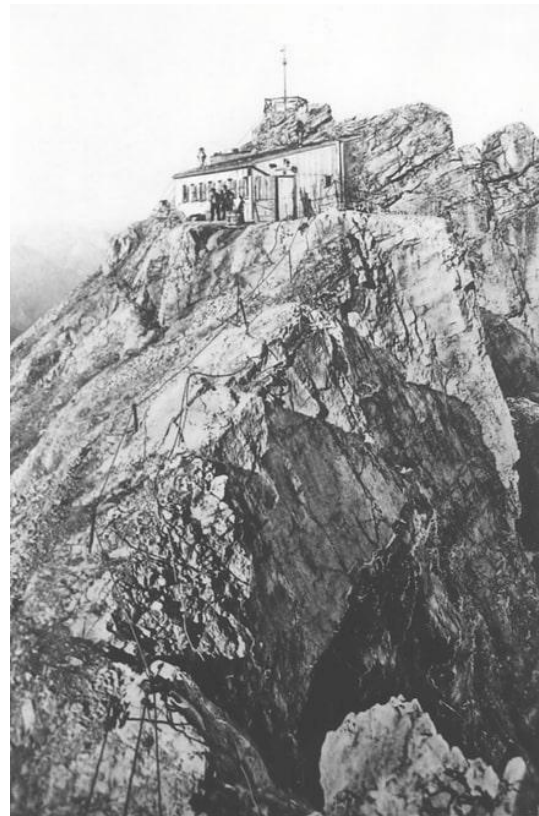


Figure 7. J. B. Obernetter, 1897, Das Münchner Haus auf der Zugspitze

Architectural innovation

Some architects would push the idea of what mountain huts could be. Charlotte Perriand was one of these architects. In 1938, she came up with the plans for the refuge Tonneau. It was a design for an experimental mountain shelter focusing on the principles of lightweight modular construction. The design consisted of prefabricated aluminium components around a tubular steel construction. Thanks to this, it would theoretically be possible to carry the materials up the mountain manually and build it in four days. The floor plan has a dodecagon shape with a sloped aluminium roof. The aluminium roof and walls provide durable protection from the harsh alpine environment. (Bodeau. 2024, p. 64)

The upper floor provides beds while the ground floor is fitted with integrated modular furniture such as retractable chairs, tables and a couch. This way, the refuge provides functional, compact shelter for eight alpinists with a footprint of only eight square meters. Even though the design was only realised in 2010 its plans would still be a source of inspiration for many projects to come. (Fabrzi, 2016)

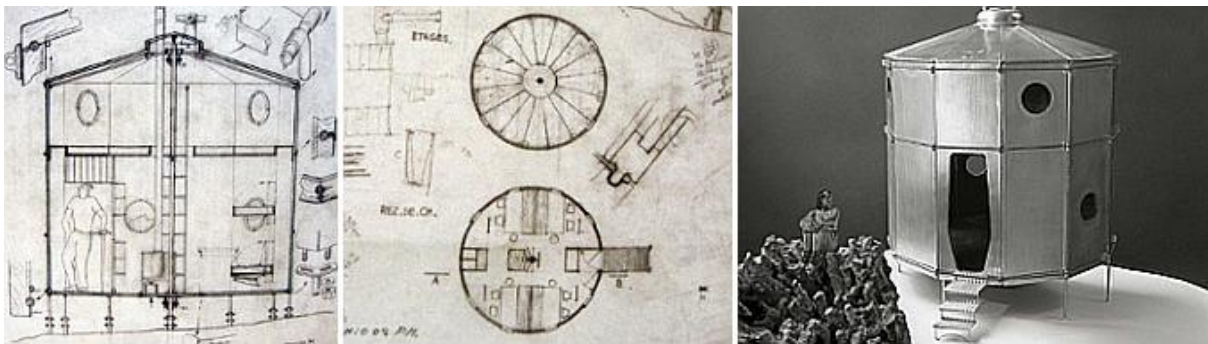


Figure 8. Refuge Tonneau mountain shelter, 1938. *Arquitectura*, Charlotte Perriand. From: [delood.com, blog.dwr.com/designnotes](https://delood.com/blog.dwr.com/designnotes)

Another architect who pushed the boundaries of what high alpine architecture could be was Paul Chevalier. Chevalier has designed some of the most famous huts in the most difficult locations. He innovated and combined the old building techniques with new building materials effective in terms of insulation and strength. Refuge Vallot is an example of how he used bituminous coatings, duraluminium, aluminium, zinc and hardboard. (Bodeau, 2024, p.63) The design made it to the cover of 'Architecture d'aujourd'hui', showing the interest of general public in these innovations.

These two architects paved the way for many designs to come. Refuges like Refuge the Goutier, the Monta Rosa Hütte and Bivouacs like bivouac Gervasutti, Luca Pasqualetti and Krintovec all follow the same principles. Modular pre-fabricated components, light but rigid structure and durable exterior cladding.



Figure 9. Monte-Rosa-Hutte.
<https://www.nemetschek.com/de/referenz/nachhaltig-hoch-hinaus-modernes-design-den-alpen9>



Figure 10. cover of :L'ARCHITECTURE D'AUJOURD'HUI n°4 1939

A new player

This new way of designing for high altitudes, together with the invention of the modern helicopter around 1950, would revolutionize the architecture of refuge (Bodeau, 2024, p. 60)(Sadra, 2023, p. 23). The use of porters and mules would disappear, and materials could be brought to the site in record time. This meant that refuges and bivouacs could be built bigger, faster and in more difficult places. A good thing because the number of tourists was growing rapidly and demand for shelter and comfort with it.

The helicopter paved the way for new innovations and refuges became the testing grounds for self-sufficiency technologies, such as solar panels and water recovery systems.

The focus on self-sufficiency and energy efficiency pushed architects to experiment with contemporary shapes and create very futuristic designs. (Sarda, 2023, p. 23)

Around this time however in the midst of all this rapid innovation another challenge started to surface. A challenge caused by the rapid industrialization of human kind, a challenge that would reshape the way people thought about narrative between mountains, high altitude architecture and alpinist.



Figure 9. Reconstruction of refuge des Grands Mulets by helicopter, massif du Mont-Blanc, E. Dessert, 1960.

III. Adaptation to Environmental Challenges

The Impact of Climate Change and Glacial Retreat

High altitude architecture is on the forefront of dealing with environmental challenges. The alps have seen some of the biggest changes in environment of the world. The glaciers in the alps during the birth of alpinism looked very different from now. Mer de Glace in Chamonix descended so low around the late 17th century that it posed a danger. Some barns were destroyed by falling seracs coming from the ever-growing glacier. The bishop of Geneva came to bless the glacier to exorcise the danger in 1690. (Bodeau, 2024, p. 19)

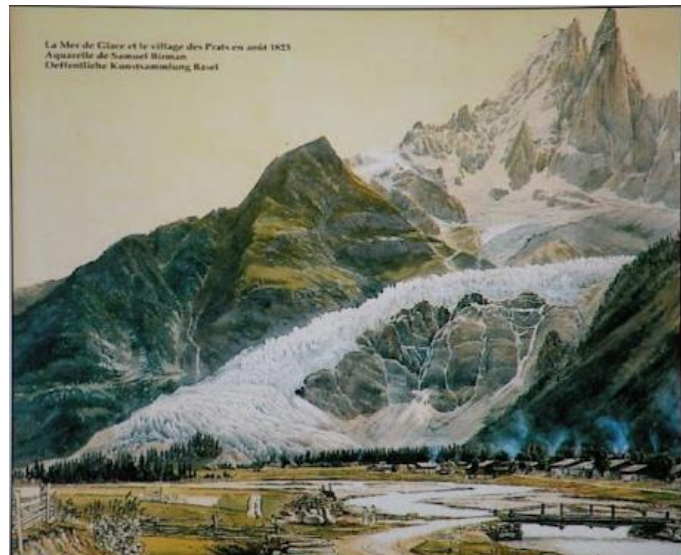


Figure 10. chamonix threatened by the ever growing Mer de Glace. S. Birman, 1823. La mer de glace.

We now know that the alps found themselves in a mini ice age and that this was the reason for the glacial growth 1575–1860 (Nicolussi, 2024). A lot of high-altitude architecture was built shortly after this period. With glaciers being imprinted in people's minds as never-retreating forces of nature. The architecture was built with this same idea in mind. Now we find ourselves in a very different period. Temperatures are rising, and glaciers are retreating fast. Glaciers are becoming more unstable, permafrost is disappearing and water is becoming more scarce (Salvalai, & Gadusso, 2025, p. 265). These problems do not only impact the natural environment but also the built environment. Many huts report to have problems with water scarcity and huts that were once famous for their panoramic views on glaciers lost their glaciers. (Buswell, & Mavrogianni, 2019, p. 276)



Figure 11. Retreat Gorner Glacier near Zermatt in 1920, 1972 and 2022. Photo: Alpine Glacier Project, D. Collins, N. Entwistle

In 1929 the Adamello war memorial hut was directly built bordering the Adamello glacier. After the Second World War the Glacier started to slide down slowly. This resulted in the collapse of the front part and cracks in other parts. To stop further damage two buttresses were added. The decline of the glacier, however continued in the 1980s resulting in more damage with new renovations in the 1990s. (Pezzo, 2006)

Similar consequences can be seen across the entire Alps. One striking example is the collapse of multiple bivouacs due to the thawing of permafrost. A well-known case is the Bivouac de la Fourche. The mountain hut lost its structural support during a rockslide, sending the entire cabin tumbling to the Brenva Glacier far below.

These events highlight the increasing fragility of high-altitude architecture in the face of accelerated climate change. As glaciers retreat and permafrost thaws, the very ground on which these structures were once safely anchored is shifting, destabilizing what were once thought to be permanent refuges. This not only presents engineering and safety challenges but also forces a rethinking of the symbolic permanence of these huts, which were built as markers of endurance and resilience in extreme environments. Today, they stand as vulnerable witnesses to a rapidly transforming Alpine landscape.

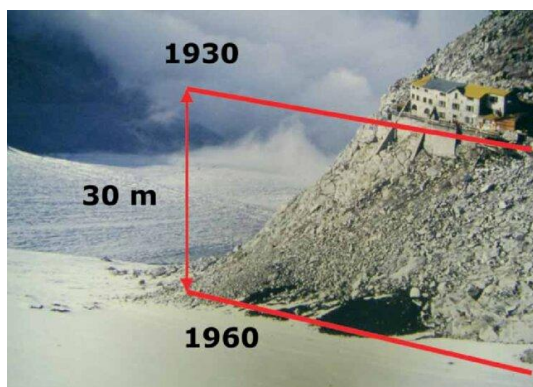


Figure 12. Retreat Adamello glacier. 1966 Archivio C.A.I. di Brescia



Figure 13. Remains of Bivacco Fourche. photo: Soccorso Alpino valdostano, 2022

Sustainable Design Approaches in Modern Refuges

It is these new conditions and a focus on sustainability that architects in their designs for new huts. Organizations such as the mountaineering clubs together with architectural bodies, are pushing for innovation (Bodeau, 2024, p. 27). In the recently launched Terraviva competition (2023), designers are asked to design a bivouac on the location and the surrounding environment. The use of innovative materials and techniques is stimulated. They, however also ask to refer to the old bivouac next to it. Mountaineers tend to be a traditional and cautious group, often well-educated and financially well-off. As frequent participants in the activity, they are generally content with the existing conditions and therefore resistant to changes or new management measures. (Muhar et al, 2007, p.15) This request for innovation, while recognizing and addressing the existing heritage illustrates the delicate balance between progress and tradition in alpine architecture. It highlights the need for adaptive design solutions that respect historical significance while ensuring resilience in the face of climate change.

This narrative between innovation, environmental awareness and tradition is seen all throughout recent projects. The challenge this poses brings in some of the worlds most influential architects and firms making the Alps once again a forefront of architectural experimentation.

IV. Contemporary case studies

Groupe H. (2014). *Refuge du Goûter*

Refuge the Goûter is the highest mountain shelter in the French alps. Located at 3835m on the route to the top of mont Blanc it replaces the old Rerfuge du Goûter. The new innovative and invironmentally-friendly refuge can welcome up to 120 people at one time.

The history of this building and the history of alpinism are undeniably linked. The refuge provides a last shelter before summiting the Mont Blanc using the legendary normal route. The new refuge is the successor to a line of older huts in the same location. First, a small, simple hut in 1854 and then a larger shelter in 1960. This shelter did not meet today's needed capacity and sustainability norms. That's why a this new refuge was needed. With the old shelter having a huge cultural and symbolic significance it was refitted to serve as a winter and emergency shelter (Groupe H).

The refuge marks a new generation of mountain architecture and is designed to not only technically work in these environments but also aesthetically. The four-story egg-shaped has to withstand huge snow loads and winds of up te 300 km/h building. Designing this sustainably was a challenge. To meet both technical and sustainability requirements successfully the design utilize a lightweight yet robust timber structure combined with a steel-clad exterior. Renewable energy, solar and biomass, and innovative technologies like remote electricity management, snow melting and wastewater management were also implemented.

Additionally, the construction posed a significant challenge, as the harsh weather conditions limited building activities to just five to six months per year. In order to build efficiently the timber components were prefabricated in the valley, making assembly easier. Having large pre-fabricated elements also limited helicopter traffic. (Groupe H.) At an altitude of 3,835 meters, the old shelter and the new refuge now stand side by side, where tradition and innovation intertwine, telling a story of decades of progress, resilience, and the rich history of alpinism.



Figure 14. Construction of Refuge du Goûter. Groupe H



Figure 15. The old and new refuge next to each other. Groupe H

Demogo. (2015). *Bivouac Fanton*.

Located at an altitude of 2667m in the rough Marmarole massif lies the bivouac Fanton. A innovative architectonic experiment that explores the relation between humans, shelter and nature. The design makes use of maritime construction methods, combining insulation, load-bearing structure and glass fibre shell into one element. This made the bivouac very light and easy to transport and mount on the three anchors.

The architecture of the bivouac is based on living on a sloped space. The bivouac is elevated on three anchor points and its shape follows the mountain slope to create balance in the landscape. The user and architecture live in symbiosis with the overhanging mountain. The main window frames the underlying void and Auronzo valley. (Dezeen, 2021) This way the bivouac functions as an inhabitable telescope that frames the valley and strengthens the experience of the landscape, while it also provides essential shelter for alpinists and hikers in the harsh conditions of the Dolomites. The bivouac embodies the tension between exposure and shelter, between the desire to explore the surroundings and the necessity to stick with a human scale.



Figure 16. Section model Bivouac Fanton. DEMOGO studio di architettura



Figure 17. View Bivouac Fanton. Pietro Savorelli + SFSight visuals

Conclusion

The evolution of mountain shelters in the Alps reflects a dynamic interplay between functional necessity, cultural meaning, and technological innovation. What once were simple, rudimentary shelters for shepherds and travellers, built out of necessity, have developed into architectural and symbolic beacons within the alpine landscape. The birth and growth of alpinism during the 18th and 19th centuries stimulated the development of mountain shelters, with accessibility and safety becoming increasingly important. The rise of mountaineering led to the establishment of shelters not only for survival but for enhancing the alpinist experience, laying the foundation for the network of modern refuges.

In the 20th and 21st centuries, innovations in construction techniques and materials, as well as the rise of sustainability and ecological awareness, have led to radical transformations in the architecture of mountain huts. From traditional stone and wood constructions to light, modular, and self-sustaining designs, contemporary shelters like Refuge du Goûter and Bivouac Fanton illustrate how architecture has adapted to both the extreme environment and changing human needs. These modern refuges highlight how the Alps' architectural landscape has evolved, transitioning from simple, functional shelters to symbolic landmarks that cater to the needs of both alpinists and tourists.

The development of mountain refuges also parallels broader shifts in cultural attitudes toward nature, sustainability, and human ingenuity. While these shelters continue to provide essential protection for those navigating the harsh alpine environment, they also serve as cultural symbols, encapsulating the values of exploration, self-sufficiency, and environmental stewardship. Furthermore, contemporary designs often emphasize sustainability through the use of eco-friendly materials and self-sufficient systems, such as solar panels and water recovery systems, reflecting a growing consciousness about ecological responsibility in high-altitude construction.

Climate change has introduced new challenges for both existing and future mountain refuges. Melting glaciers, thawing permafrost, and shifting weather patterns threaten the stability of these structures. As a result, there is an increased focus on rethinking construction techniques, foundation methods, and shelter locations to ensure long-term resilience. Traditional building techniques must be balanced with cutting-edge innovations to maintain the shelters' functionality and sustainability in an increasingly unpredictable environment.

In answer to the central research question '*How have mountain refuges in the Alps evolved from rudimentary shelters to cultural and architectural landmarks for modern alpinists and hikers?*' the evolution of these structures can be seen as a response to both changing functional requirements and broader societal trends. Mountain refuges have grown from humble shelters into cultural and architectural landmarks, embodying the intersection of tradition, innovation, and environmental awareness. They serve not only as functional havens for alpinists but also as symbols of human resilience, reflecting society's evolving relationship with nature and technology. Today, they are not only physical necessities but also cultural heritage sites and experimental laboratories that shape the future of building in extreme conditions.

This study stresses that alpine shelters are more than just practical structures; they are a reflection of broader technological, societal, and environmental developments. The ongoing challenges and innovations in alpine architecture show that these structures remain vital to human interaction with the mountains, serving both as protective havens and as experimental grounds for designing buildings in extreme environments. As climate change continues to challenge traditional construction methods, mountain refuges will likely play an increasingly critical role in shaping the future of architecture in high-altitude and extreme conditions.

While this study has traced the broad evolution of Alpine mountain refuges, future research could pursue several fruitful directions. At the geographic scale, in-depth case studies of individual massifs such as Mont Blanc, the Dolomites, or the Swiss Alps, would reveal how local geology, microclimate, and cultural traditions shape refuge design. Comparative analyses across Alpine subregions could highlight vernacular adaptations, and extending research to other ranges (e.g. Himalayas, Andes, Rockies) would give insight to trends in high-altitude architecture.

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