Spring 2022

Building for the Future: Functional, Energy-Efficient, and Beautiful Buildings by Snøhetta

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Abstract

The construction industry accounts for nearly 40% of all greenhouse gas emissions, which ultimately leads to climate change. Because of a lack of global consensus and accountability on a large scale about how to combat climate change, certain countries and cities are leading the charge on mitigation, since they tend to be more progressive and homogenous. Norway is one of those countries, and happens to be the headquarters for Snøhetta, a design company, that is designing buildings that are not only energy-efficient but also functional for the space in which it resides. Snøhetta very much values the interconnection between the material world and humans. In the spaces they create, they strive for there to be a harmonious relationship between all living things, even in the future. In order for the space to still be functional in the future, they have to design for it to be sustainable, one of the company's top values. Snøhetta follows the motto "form follows environment" when designing buildings to be sustainable. That means that in order to make a functional, sustainable building, they design the form and structure of the building last, after deciding how to optimize its efficiency. Energy-efficient buildings today also have to be planned thoroughly to include features on the inside and out, as well as utilizing elements that are in the vicinity of the building to maximize their standards. Snøhetta has designed a lot of very notable buildings, but in this paper, four of their sites are analyzed according to their level of efficiency, and how well they made the space functional in regards to the context, users, and location of the space. Those sites are Powerhouse Brattørkaia, the Norwegian National Opera and Ballet, Bibliotheca Alexandrina, and the National September 11 Museum Memorial Pavilion. These sites located in Norway, Egypt, and the United States, each have energy-efficient qualities, yet the sites are deemed as sculptures and functional for the purpose of the space.

Keywords

architecture, sustainability, functionality, Snøhetta

Disciplines

History of Art, Architecture, and Archaeology | Modern Art and Architecture | Sustainability

Comments

Written for ARTH 400: Seminar in Art History

Building for the Future: Functional, Energy-Efficient, and Beautiful Buildings by Snøhetta

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ARTH 400: Seminar in Art History

April 12, 2022

"I affirm that I have upheld the highest principles of honesty and integrity in my academic work and have not witnessed a violation of the Honor Code."

Introduction

It is a fact that the climate is changing and warming because of human-caused activity. In fact, 97% of scientists agree on this.[1] And yet, what is one thing that is considered a necessity that all people need, yet accounts for nearly 40% of all greenhouse gas emissions?[2] A roof over our heads, otherwise known as the construction industry. In order to do something about this, construction and design companies are trying to integrate sustainable practices into their design in order to help the world, yet keep a high level of functionality.

Certain countries are doing better with this than others, but this is not without reason. Scandinavian countries, and in particular, Norway, are leading the charge. To start, Norway is a smaller country. With that, it allows for the demographics and ideologies between the government and the people to be relatively the same. The United States, for example, is a vast country that is a melting pot of people of all nationalities and religions. Even the climate and landscape in one area of the country is vastly different from another. Thus, it allows for there to be different thoughts and beliefs. Norway, with its size and relative similarity all throughout the country, allows for people to be in consensus. Norway has the fourth highest GDP per capita, meaning that the country has a lot of money, can afford to acquire and pursue new technologies, and not have to worry about waiting for the long term benefits of them.[3] Thus, green policies are more likely to pass. However, due to their location, they might have a slight advantage as to why they are so energy-efficient. The majority of their country is close to water, so 97% of their

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[1] "Scientific Consensus: Earth's Climate is Warming," Facts, NASA Global Climate Change, updated March 4, 2022, https://climate.nasa.gov/scientific-consensus/

[2] "Sustainable construction in the face of climate change," News & Media, World Green Building Council, accessed March 7, 2022, https://worldgbc.org/news-media/sustainable-construction-face-climate-change

[3] International Energy Agency, *Energy Policies of IEA Countries: Norway 2017 Review, (*Paris: 2017), 15. https://www.iea.org/reports/energy-policies-of-iea-countries-norway-2017-review

power already comes from hydropower.[4] Since their country is so far north, they also have to accommodate for the lack of sunlight and the uncertainty of the North Sea.[5] They have to think smartly about the ways they want to gather energy. With that, they have developed the ability to store excess energy and have developed power lines, which help them share this energy with other neighboring countries.[6] However, Norway is a very large producer of gas and oil, which contradicts them being seen as a green country. But, they have reduced their oil production by 40% since 2001, and have many many generous promises, such as reducing their greenhouse gas emissions 40% from 1990 levels by 2030.[7] So while they do produce a lot of oil and gas, they are still one of the top countries committed to bettering the environment for all by balancing effectiveness with functionality and what works for the area. Also, in Norway, several companies and policies have recently emerged that provide financial incentives for buildings to be made beyond the minimum standard and have creative innovations.[8]

Snøhetta, a Norwegian based company, has become world-renowned for valuing aesthetics, functionality, and sustainability. They have since expanded to become an international design company. Because they design all over the world, they have to account for different countries' policies and locations to maximize their design's functionality and purpose. This paper addresses projects in Norway, Egypt, and the United States to better grasp how Snøhetta designs for different locations and clients, thus being an effective design firm.

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[4] Matt Carroll, "Norway's leading the charge on a sustainable electric future," *National Geographic,* June 27, 2019, https://www.nationalgeographic.com/environment/article/partner-content-sustainable-electric-future
[5] Carroll, "Norway's leading the charge."
[6] International Energy Agency, *Norway 2017 Review,* 10.
[7] International Energy Agency, *Norway 2017 Review,* 9.
[8] Hilde Nykamp, "Policy Mix for a Transition to Sustainability: Green Buildings in Norway," *Sustainability* 12, no. 2 (January 7, 2020): 6, doi:http://dx.doi.org/10.3390/su12020446.

The United States, because of its vastness and differences, is having trouble gaining ground on any potential green investments. Because of that, a lot of the change has to come on a smaller scale, meaning cities and states. There, policies can be passed that allow for advancements in energy-efficient practices which would allow for better change in America. Egypt, on the other hand, has had a lot of political strife and hardships that make it hard for there to be consensus between the government and the people.[9] In this case, the projects that are brought to Snøhetta that should be sustainable, have to be judged on a case-by-case basis in order to see if it works in its context.

Snøhetta's Relationship with Nature

As stated, Snøhetta is a company that values sustainability and functionality. Headquartered in Norway, Snøhetta was founded in 1989 by Norwegian designer Kjetil Trædal Thorsen and American designer Craig Dykers. They have since grown to a company that has offices all over the world. Back in 1989, they were awarded their first commission: the task of designing the world famous Alexandria, Egypt library, even though neither of them had completed a building. However, the company was created in 1987. Before their first commission, their team consisted of only a handful of designers. They kept putting their name into competitions for buildings, but since their projects were ambitious for the time, since they wanted to make spaces that were for the betterment of society, they did not win any projects for two years.[10] The Alexandria Library, with its rich culture, inspired Snøhetta to have an

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[9] Dina Shehata, "Sixty Years of Egyptian Politics: What Has Changed?" The Cairo Review of Global Affairs, Spring 2018, https://www.thecairoreview.com/essays/sixty-years-of-egyptian-politics-what-has-changed/

[10] Amy Frearson, "Merging architecture and landscape "came very naturally" to Snøhetta co-founder," *Dezeen*, updated December 11, 2019, https://www.dezeen.com/2019/12/11/snohetta-interview-kjetil-traedal-thorsen-30th-anniversary-architecture/#:~:text=They%20borrowed%20the%20name%20Sn%C3%B8hetta,and%20the%20landscape%2Doriented%20approach.

interaction with the landscape and the community for every project they pursued moving forward.[11] When asked about the Alexandria Library and if it could have worked in any other location, Kjetil Trædal Thorsen replied, “No, most likely not. It was for this very particular site in Alexandria…,” thus meaning that they rely heavily on the functionality of the building when constructing it.[12] Craig Dykers even explains that you cannot have good architecture unless you understand people: “Then understanding…what supports life, which is the environment because you can’t have people without the environment to support them, and that means both natural and unnatural.”[13] This concept of functionality according to people and the environment leads into why they value sustainability and the environment.

Snøhetta emphasizes sustainability in their work, as stated on their company’s public website. There they state that commitment to social and environmental sustainability is the core to all of their projects.[14] They want to improve people’s well-being, make life better, and also let the site be an expression of the users, climate, and the history of the area.[15] Thus, while they emphasize being sustainable, they cannot do that without the interconnection between the functionality and users of the space. With that, for every project that they do, they include multiple stakeholders and experts on energy-efficient design in order to create the best design possible.[16] They also state that for every research project that they do that incorporates new techniques and technology, they do a post-occupancy study in order to understand the

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[11] Frearson, “Merging architecture and landscape.”
[12] Frearson, “Merging architecture and landscape.”
[13] The Second Studio Podcast, "Craig Dykers: "Many People Don’t Want Messiness. They Want Beauty That Is Beyond Perfection," ArchDaily, updated February 21, 2021, https://www.archdaily.com/957232/craig-dykers-many-people-dont-want-messiness-they-want-beauty-that-is-beyond-perfection
[14] Snøhetta, “Sustainability,” Process, accessed March 10, 2022, https://snohetta.com/process/sustainability
[15] Snøhetta, “Sustainability.”
[16] Snøhetta, “Sustainability.”

effectiveness. Regardless, Snøhetta makes it one of their goals to introduce new standards for the market in terms of constructing sustainably.[17] In fact, Thorsen states that they follow the motto, "form follows environment."[18] This statement means that in order to really have a well thought out energy-positive building, the design company must think about the energy-efficient methods first, and then design the form around that. Otherwise, the form becomes ineffective. Consequently, Snøhetta can be seen as a company that highly values the environment, yet makes sure that they pay attention to the functionality of the space and its relationship to the user, location, and history of the area. They make sure that they achieve this with all of their projects, including those that are in different countries and parts of the world. This can be seen in the examples from Norway, Egypt, and the United States.

Energy-Efficient Buildings/Living Buildings

It takes a lot of planning and time to design an energy-efficient building. The design process is going to be different depending on the location and purpose of the building. Regardless, the benefits of well-designed buildings are worth it since they help combat climate change and can be an inspiration for the future of design.

Looking throughout history, there has always been a development and relationship between art and the environment. Cave dwellings have been found in Guadix, in the Mediterranean, that have blended into the environment, with only a chimney present, which presents a connection with living as part of nature.[19] Other cave dwellings have been found along the Yellow River in China that were dug from clay, but retained the natural vegetation on the

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[17] Snøhetta, "Sustainability."
[18] Lizzie Crook, "Snøhetta completes office on Norwegian Fjord that produces twice the amount of energy it uses," *Dezeen,* September 5, 2019, https://www.dezeen.com/2019/09/05/snohetta-powerhouse-brattorkaia-sustainable-office-trondheim-norway/
[19] Roberto Gonzalo and Karl J. Habermann, *Energy-Efficient Architecture: Basics for Planning and Construction,* (Basel: Birkhäuser, 2006), 8-10.

structure in order to allow the plants to grow.[20] These cave dwellings show that nature has always been a thought in the design process of buildings all across the globe, even in prehistoric times. Then, Vitruvius, the architect from before the first century, wrote a famous book titled *Ten Books on Architecture* which was a treatise on architecture. In this book, he pays particular attention to the influence of the sun on the functions of buildings in the city.[21] This shows the awareness of the link between the sun's orientation and the use of the building from antiquity. Moving forward to more recently, there have been new innovations and theories put into design that further the relationship between nature and the built environment. In the 1930s, the famous Swiss designer, Le Corbusier invented the brise-soleil, which deflects sunlight from directly entering a building, which reduces the amount of heat that enters it.[22] Then, Frank Lloyd Wright became notable from the early 1900s to the 1950s when he developed the concept of organic architecture. Organic architecture is defined as having the qualities of simplicity and pose with open spaces and windows, natural color, freely expressed materials, and a natural building filled with integrity.[23] This design process helped to revolutionize the relationship with the built environment and the landscape. In addition to just having the building be a part of nature, he made sure that design was also comfortable to the user. To do that, he was credited with bringing forth the first air-conditioned building in the United States.[24] Wright also designed his first residential houses to have hipped roofs, as a way of protecting the interior from the sun and also

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[20] Gonzalo and Habermann, *Energy-Efficient Architecture,* 10.
[21] Gonzalo and Habermann, *Energy-Efficient Architecture,* 8.
[22] Dean Hawkes and Wayne Forster, *Energy Efficient Buildings: Architecture, Engineering, and Environment,* (New York: W. W. Norton & Company, Inc., 2002), 33.
[23] Stuart Graff, "Organic Architecture and the Sustaining Ecosystem," Frank Lloyd Wright Foundation, July 11, 2018, https://franklloydwright.org/organic-architecture-and-the-sustaining-ecosystem/
[24] Gonzalo and Habermann, *Energy-Efficient Architecture,* 14.

optimizing the comfort of the building.[25] His organic architecture design was known for being all-inclusive and in 1931, he stated, "All heating-, lighting-, and supply lines must be integrated in such a manner that these systems become essential components of the building itself."[26]

The whole-building design process has become increasingly common in modern architecture.[27] All systems within a building should be interconnected in order to maximize efficiency. Designers are now integrating energy efficiency into the framework of the building instead of highlighting their features. This is a way that they are showcasing that sustainability should be a part of everyday design. Now, there are certifications that exist globally that help a building become more sustainable as a whole. These include LEED certification and the Living Building Challenge. LEED certification is earned by getting points if the building addresses issues regarding energy use, waste, materials, air quality, and more.[28] The more points they get, the higher the rating. LEED certified buildings produce 50% fewer greenhouse gasses than other buildings, and ultimately save money in the long run.[29] The Living Building Challenge encourages buildings to be built and constructed as cleanly and efficiently as a flower.[30] This challenge encourages for there to be a relationship with nature because buildings should give more than they take, and the designer should think holistically about how to tackle solutions.[31] This challenge is divided into seven different performance areas, called Petals, that are equally

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[25] Gonzalo and Habermann, *Energy-Efficient Architecture*, 14.
[26] Gonzalo and Habermann, *Energy-Efficient Architecture*, 14.
[27] Hawkes and Forster, *Energy Efficient Buildings,* 25.
[28] "LEED Rating System," U.S. Green Building Council, accessed April 10, 2022, https://www.usgbc.org/leed
[29] "Why LEED?" U.S. Green Building Council, accessed April 10, 2022. https://www.usgbc.org/leed/why-leed
[30] "Living Building Challenge," International Living Future Institute, accessed March 29, 2022, https://living-future.org/lbc/
[31] "Living Building Challenge," International Living Future Institute.

impressive to collect.[32] All of the philosophies from designers in the past, combined with current sustainable design challenges, have led to Snøhetta being able to create sustainable buildings of the future that emphasize functionality with the users and the environment.

Project Analysis

By looking at and analyzing completed projects by Snøhetta throughout their history, it allows people to identify the methods and design strategies they used to create a sustainable and functional building. Analyzing projects in Scandinavia, Africa, and the United States of America allow for people to see how design can be optimized for effective use and studies.

Bibliotheca Alexandrina

The library in Alexandria, Egypt, rebuilt in 2001, serves as Snøhetta's first official project (Fig. 1). This site has a very impressive history, and Snøhetta had to find a way to balance sustainability with functionality and keeping the culture alive through it all. Founded by Ptolemy I, the history dates back over 2,300 years ago with the advance of Mediterranean culture.[33] At the time, it was the largest and most well-known library in the world. It is credited with being one of the most famous ancient sites of knowledge, having Euclid, Eratosthenes, and Aristarchus study there.[34] However, the building, and much of the city was destroyed around 48 BCE by fire and with it, we lost information regarding the location of the past library and any record of its design.[35] When the government finally allowed it to be rebuilt starting in the late 1980s, the goal was to restore it to its old glory, while still being a library, as well as create a

[32] "Living Building Challenge," International Living Future Institute.
[33] Snøhetta, *Snøhetta: Collective Intuition, (*London: Phaidon Press Limited, 2019): 82.
[34] Snøhetta, Collective Intuition, 82.
[35] Snøhetta, Collective Intuition, 82.

place that would be celebrated worldwide for its services, wealth of resources, and ability to acknowledge its history and apply it to modern day Egyptian design.[36]

Snøhetta designed the building to be 11 stories tall, with the ability to hold up to 8 million books, and includes a planetarium, several museums, a school for information sciences, and a conservation facility.[37] The library resides along the Mediterranean Sea with a tilted roof and a curved facade (Fig. 2). The tilting of the roof is meant to resemble the Lighthouse of Alexandria, which is one of the seven wonders of the ancient world.[38] The curved facade includes depictions of hieroglyphs going all the way around, which were done using local stone-cutting methods (Fig. 3). The curved shape is meant to recall the "cyclical nature of knowledge, fluid through time."[39] The hieroglyphs include characters in 150 different scripts from around the world showing how this library has impacted the whole world.[40] However, the circular form of the building may have another meaning. Since this site is meant to honor the history and knowledge of the previous site, the circle may be a symbol and representation of the heavens or Ra, the sun god of Egypt who is commonly represented by a large disk or sun.[41] Also, Snøhetta made sure to use the sunlight in the area to their advantage by creating panels on the roof that are vertical and north-facing (Fig. 4).[42] By doing this, it allows for the reading rooms to be evenly lit by indirect

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[36] Hana Alamuddin, *Bibliotheca Alexandrina: 2004 On Site Review Report,* 2004, 3, https://www.akdn.org/sites/akdn/files/media/documents/akaa_press_kits/2004_akaa/bibliotheca_alexandrina_-_egypt.pdf

[37] Snøhetta, "Bibliotheca Alexandrina," accessed March 7, 2022, https://snohetta.com/projects/5-bibliotheca-alexandrina

[38] Snøhetta, "Bibliotheca Alexandrina."

[39] Snøhetta, "Bibliotheca Alexandrina."

[40] Devon Evans, "Great Library of Alexandria: New and Improved," Carnegie Library of Pittsburgh, September 6, 2018, https://www.carnegielibrary.org/great-library-of-alexandria-new-and-improved/

[41] el-Sayed el-Aswad, "Archaic Egyptian Cosmology," *Anthropos* 92, no. ⅓ (1997): 70. https://www.jstor.org/stable/40465357

[42] Snøhetta, "Bibliotheca Alexandrina."

sunlight that would not damage any books or manuscripts. Egypt, being closer to the equator, receives more direct and harsh sunlight that Snøhetta had to account for in the design. Additionally, the interior of the building has a lot of exposed concrete as well as natural wood elements that show how they combined elements that represent the past with the future since concrete is thought of as manmade and modern and wood as natural and primitive (Fig. 5). Overall, the space is fairly open, allowing for the user to interact with the space as they so please. This allows the user to interpret the history of the space on their own terms and to let the process be natural.

Back in the 1990s when the site was commissioned, sustainable design was not 'popular' to invest in but Snøhetta made sure it was part of their design process. Three professors at Mansoura University and Cairo University, Ibrahim Hegazy, Wael Moustafa, and Hossam Ibrahim, put together a study that analyzes the building's efficiency and looks at it under 'The Living Building Challenge' to see how well it would be considered a living building as well as any improvements they could make. In the report, they state that the site gathers part of the rainwater that is collected on the roof, filters it, and then uses that water to clean the roof. That is the only source of water management on the site.[43] They also reiterate the importance of the use of natural daylight, and they specify that this site did an excellent job at managing that. The library also made sure to make all of their lighting extremely efficient by only turning on lights after 6 pm and using electric lighting systems.[44]

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[43] Ibrahim Hegazy, Wael Moustafa, and Hossam Ibrahim, "The Living Building: Integrating the Built Environment with Nature Evaluating the Bibliotheca of Alexandria according to the challenge imperatives," *International Journal of Low Carbon Technologies 12,* no. 3 (2017): 10, DOI:10.1093/ijlct/ctx003

[44] Hegazy, Moustafa, and Ibrahim, "The Living Building," 10.

However, the report did find some shortcomings in terms of energy-efficiency. To start, in the main plaza area, there were very limited plants and trees which limits the interaction between nature and people, a main principle of sustainability. Also, being on the Mediterranean Sea, the researchers state that Snøhetta should have made use of the sea water and treated the water to be used within the building or use it for optimal heating and cooling.[45] They also found that while the materials used in the construction of the project are durable, a lot of them are not locally sourced, meaning a lot of carbon was needed to transfer them to the site.[46] While it was good that the site maximized daylighting, they do not have any solar panels which would allow them to store more energy and use that when daylight is not available.[47] Overall, the researchers concluded that the building could not be considered a Living Building in its current state, but could apply to have a 'Petal' rating, which is still an impressive feat for buildings to accomplish.[48] In the case with this building, Snøhetta did not choose to make this building very energy-efficient because it was less common to do so at that time, and they wanted to prioritize the users' experience and functionality.

Functionality and the user experience was very critical for this site. On Snøhetta's website, they state that they wanted to make sure, from the start, that the user's experience was prioritized and they did that in a few ways.[49] One is by making sure the building is set up with up-to-date technology that will change over time.[50] This includes updated computers and research technology. Also, according to Snøhetta, the main plaza is meant to be a space for reflection by being gray and fairly plain, but the researchers of the 'Living Building Challenge'

[45] Hegazy, Moustafa, and Ibrahim, "The Living Building," 11.
[46] Hegazy, Moustafa, and Ibrahim, "The Living Building," 10.
[47] Hegazy, Moustafa, and Ibrahim, "The Living Building," 11.
[48] Hegazy, Moustafa, and Ibrahim, "The Living Building," 7 and 11.
[49] Snøhetta, "Bibliotheca Alexandrina."
[50] Snøhetta, "Bibliotheca Alexandrina."

and users of the building have argued that it was too plain and there needed to be vegetation, so recently they have added a few pots of geraniums, which still does not reach a suitable level of vegetation.[51] However, a majority of Alexandrian citizens appreciate the building. During the opening ceremony in 2002, the first lady of Egypt, Suzanne Mubark referred to the library as the "Fourth Pyramid" because of its commitment to be a symbol to Egypt's vitality and history, and the term has since stuck.[52] In 2011, the site served as the epicenter for the formation of Egypt's upcoming democratic movement that then overthrew the Mubark regime.[53] The site is also held in high regard because it has copies of books that are banned by the country, and has roughly an equal-gender ratio to the workforce, even though the country only has about a quarter of the percentage of the women population working.[54] The place has also held significance to all Egyptian people because in early 2011 during the Arab Spring, pro and anti government supporters joined hands to form a human shield around the library to protect it from riots.[55] The library also serves as one of the few open, accessible places in the city. Thus, the library now serves as a place where all people can come together to be unified as one. While the country can be often unstable, the library holds together the people through its symbolism and functionality in its design, and thus Snøhetta managed to fulfill their purpose, even in a different country. Because of this, the site can also allow for there to be a trade off from sustainability to more functionality and users' interpretation.

Norwegian National Opera and Ballet

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[51] Alamuddin, *2004 On Site Review Report,* 6; Hegazy, Moustafa, and Ibrahim, "The Living Building," 9.
[52] Snøhetta, Collective Intuition, 83.
[53] Snøhetta, Collective Intuition, 83.
[54] Snøhetta, Collective Intuition, 83.
[55] Snøhetta, Collective Intuition, 83.

The Norwegian National Opera and Ballet in Oslo, Norway was completed in 2008 (Fig. 6). While this building was built in Norway, a sustainable country, the main purpose of this building was to be a functional, social monument and space for all, both in regards to the exterior and interior. The building is low to the ground with white carrara marble ramps and roof that extend into the fjord. The specific choice of marble was chosen because it is a way to show that the opera is a continuous, public space.[56] The marble was also chosen because it is a very durable material and can last for a long time.[57] The roof is meant to be explored and walked on, being able to hold up to 15,000 people.[58] There are also floor to ceiling windows that wrap around the building, promoting a connection to the interior of the building. From the outside, a visitor can look into rooms on the interior including the costumes, props, and sets for the shows. The building also allows the public to have 24/7 access to the roof as well as the interior.[59] The white carrara marble also is extended to the interior, promoting this fluidity (Fig. 7). In addition to white, modern elements on the interior, there are also warm, wooden walls and floors that invite the visitor to the space (Fig. 8). When designing the opera, Snøhetta was highlighting the ancient Norwegian custom that is now law called *allemannsretten.*[60] The term means "the right to roam" which ensures Norwegian people to roam freely throughout the country.[61] Snøhetta felt that when designing this building and extending this idea of fluidity to the interior of the building, they could help Norway move towards being a democratized nation because it would expand the

[56] Snøhetta, Collective Intuition, 19.
[57] Swegon Air Academy, "Oslo Opera and Ballet House in Oslo, Norway," Case Studies, January 17, 2022, https://www.swegonairacademy.com/updates-insights/case-studies/oslo-opera-and-ballet-in-norway-target-sollutions-and-challenges/
[58] Snøhetta, Collective Intuition, 19.
[59] Snøhetta, "Norwegian National Opera and Ballet," accessed April 8, 2022, https://snohetta.com/projects/42-norwegian-national-opera-and-ballet
[60] Snøhetta, Collective Intuition, 18.
[61] Snøhetta, Collective Intuition, 18.

ability of people to roam.[62] Therefore, the purpose of the space is designed to be highly functional and allow for there to be a connection between the user and the space.

Because one of the main purposes of the space is to highlight the connectivity of the space, an important feature of the opera is a timber 'wave wall' that is right inside the foyer (Fig. 9). Since the interior and the exterior of the building were designed to be seen as 'one', at night this wall is the only thing illuminated, showcasing how the interior becomes the new facade (Fig. 10).[63] The opera is located on the Bjørvika peninsula, which has historically been the meeting point with the rest of the world.[64] Because the physical space serves as a meeting point between land and sea, as well as with Norway and the world, the opera was designed to showcase that symbolism and also promote the connection between the public and art.[65] The building was designed to be part of the landscape and a social monument, more so than being a sculpture or a piece of art because it allows for public engagement and awareness.[66] This idea is highlighted with their emphasis on exploring the roof, and looking into the interior. The site also was designed to be the keystone of Oslo's waterfront redevelopment.[67] The fjord used to be cluttered with trash and debris and this project made it the cleanest it has been in 100 years.[68] Now, the harbourfront has brought back its relationship with nature by allowing people to be on the shoreline of the fjord and interact with animals that are revisiting the area. It is now so clean that people can swim in the fjord, again bringing about a connection with the building and the

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[62] Snøhetta, Collective Intuition, 18.
[63] "Oslo Opera House / Snøhetta," ArchDaily, published on May 7, 2008. https://www.archdaily.com/440/oslo-opera-house-snohetta
[64] Rose Etherington, "Opera House Oslo by Snøhetta 2," *Dezeen*, April 9, 2008, https://www.dezeen.com/2008/04/09/opera-house-oslo-by-snohetta-2/
[65] Etherington, "Opera House Oslo."
[66] Snøhetta, "Norwegian National Opera and Ballet."
[67] Snøhetta, Collective Intuition, 19.
[68] Snøhetta, Collective Intuition, 19.

environment.[69] The harbourfront redevelopment project also included creating a traffic tunnel that reroutes busy traffic, creating a national museum, the Oslo Library, and the Munch Museum.[70] This redevelopment project has also inspired the entire country to clean up their shorelines nationally.[71]

Snøhetta took on a whole-building design approach when it came to this building. There are even subtle details that emphasize this including door handles in the interior that highlight the building's ramp-like form (Fig. 11).[72] Not only are the interior and exterior fluid, but there is an emphasis on the mechanics on the interior that allow for the building to be made sustainably. In fact, there were three goals for the building when it came to this design. According to the Swegon Air Academy, those were to "1. Reduce the demand for heating, cooling, electricity, and ventilation. 2. Supply the required heating, cooling, electricity and ventilation in the most efficient way and preferably using renewables. 3. Always consider the impact on a whole-building level."[73] To achieve these goals they had multiple factors at play. However, the main focus was put on energy-efficient ventilation and energy-efficient lighting. One system that they managed was the duct system where they implemented low-pressure drops which allows for the building to not use a lot of energy.[74] However, since it is an opera with a lot of different rooms, they have a high maximum ventilation rate because there is a lot of variation from one room to the next. For example, the instruments and equipment are very sensitive to air quality and will not perform as well if the air quality is bad.[75] Thus, they require humidity control. Overall, the

[69] Snøhetta, Collective Intuition, 19.
[70] Snøhetta, Collective Intuition, 19.
[71] Snøhetta, Collective Intuition, 19.
[72] Snøhetta, "Norwegian National Opera and Ballet."
[73] Swegon Air Academy, "Oslo Opera and Ballet House."
[74] Swegon Air Academy, "Oslo Opera and Ballet House."
[75] Swegon Air Academy, "Oslo Opera and Ballet House."

entire building has 30 different ventilation units. Another reason why they need many different ventilation units is because of the high glazing area due to the amount of glass windows.[76] While in construction, they did try to combat this by using solar protection and solar cells on the windows, but they still needed to add hidden ventilations and extra cooling elements in the balconies and foyers, since they tend to be the locations with the highest temperature differences.[77] They also installed heating systems under the marble floors and added radiators and spoilers near the windows.[78] However, the overall building utilizes district heating, which is one of the most environmentally sound solutions for a heating system in a large city.[79] Snøhetta also included a few other energy-efficient design strategies including installing LED lighting in the main auditorium to act as a form of daylighting.[80] Furthermore, they included a green courtyard in the middle of the opera as a place for people to relax.[81]

The Norwegian National Opera and Ballet in Oslo is a timeless staple that represents Norwegians. Many architectural reviews even note how impressive it is that the opera has become an expression of the culture and the people in the area.[82] It noted how well Snøhetta went through all aspects of the design process to make sure that they had a unified design.[83] However, they mention that for a building that is supposed to be a reflection of the whole country, the foyer and other gathering areas are lacking in grandiose and not designed for multiple uses.[84] They mention that there are some features that were designed more so for

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[76] Swegon Air Academy, "Oslo Opera and Ballet House."
[77] Swegon Air Academy, "Oslo Opera and Ballet House."
[78] Swegon Air Academy, "Oslo Opera and Ballet House."
[79] Swegon Air Academy, "Oslo Opera and Ballet House."
[80] Swegon Air Academy, "Oslo Opera and Ballet House."
[81] Swegon Air Academy, "Oslo Opera and Ballet House."
[82] Hilde Mortvedt, "The difficult timelessness," Architecture Norway, accessed April 10, 2022, https://www.architecturenorway.no/questions/building-reviews/mortvedt-on-opera-08/
[83] Hilde Mortvedt, "The difficult timelessness."
[84] Hilde Mortvedt, "The difficult timelessness."

aesthetics than comfort, such as the box office counters, since they allow the customers to get too close to the staff.[85] While Snøhetta tried to implement their design to the whole building, it lacks functionality when it comes to practicality, in some regards. Nevertheless, this building stands as a cultural monument to the identity of people of Norway and everyday people.

National September 11 Museum Memorial Pavilion

Completed in 2014, Snøhetta was commissioned to create the National September 11 Museum Memorial Pavilion, which bridges the reflective memorial plaza and the museum that is underground (Fig. 12). This site is different from others because it serves as a memorial and emotional transition space for all. Both Snøhetta and Handal Architects were selected in 2004, following a competition, to design the Museum Pavilion and the Memorial Plaza, respectively.[86] While they both had different projects, with Snøhetta designing the building to the museum entrance and Handal Architects designing the plaza and monuments outside, they had to coexist together to create the space. Inside, Snøhetta's design serves as the entrance to the museum, an exhibition space, a "family room" for victims of the 9/11 attacks, an atrium, ticketing information, and includes other amenities.[87]According to Snøhetta, the space was meant to highlight visitor experience as the site was intended to be "dedicated to visitors' comfort, orientation and healing… The pavilion would reflect presence within a site that reflects absence, and it would communicate hope."[88] They also state that "Our design was driven by a desire to create a place where beauty is not sacrificed to regulations, where comfort blends with safety,

[85] Hilde Mortvedt, "The difficult timelessness."
[86] "About the Memorial," Visit: The Memorial, 9/11 Memorial and Museum, accessed March 8, 2022. https://www.911memorial.org/visit/memorial/about-memorial
[87] "National September 11 Memorial Museum Pavilion / Snøhetta," ArchDaily, published on May 15, 2014, https://www.archdaily.com/507022/national-september-11-memorial-museum-celebrates-opening
[88] Snøhetta, Collective Intuition, 90.

and where security is present and effective yet discreet and unobtrusive."[89] Thus, Snøhetta had the challenge to create a project that still allowed them to have their identity and values, i.e. sustainability, while also creating a site that would come to mean so much to so many Americans. The events that occurred on September 11, 2001 changed the world forever, but especially America. Thousands lost their lives, thousands more were injured or hurt, and millions were impacted. The healing process from an event of this size does not come easily. It takes time and is different for everyone. Thus, Snøhetta had to design a place that allows people to take the time necessary for them to process and heal. The space also needs to be able to reach a broad range of people and the different stages of impact on the visitors. Ultimately, the space created here needed to be about healing.

The building, which is the only one in the memorial plaza, is meant to have a deconstructive design. This means that it is supposed to look like a partially collapsed building, mirroring how the Twin Towers collapsed.[90] This could possibly represent the idea that even though the buildings have collapsed, the community is still standing. Because of the threat of another attack on the site, there have been additional security measures that restricted the materials and methods needed to construct the site. For example, there needed to be infrastructure for blasts, ballistics, chemical, biological, and radioactive resistance.[91] One regulation was the limited use of glass and the prohibition of magnetic materials. Thus, they utilized stainless steel elements which allows for them to keep natural light in the space while

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[89] Snøhetta, Collective Intuition, 91.
[90] Gabby Hammond, "Rebuilding Ground Zero: Design of the 9/11 Memorial and Museum," *9/11 Ground Zero Tour (blog)*, October 30, 2020, https://911groundzero.com/blog/rebuilding-ground-zero-architects-behind-911-memorial-museum/#:~:text=The%20Meaning%20Behind%20the%209%2F11%20Museum%20Design&text=That%20space%20houses%20artifacts%20to,international%20architecture%20and%20landscape%20firm.
[91] Snøhetta, Collective Intuition, 90.

also maintaining safety.[92] This also allows for people to look inside the building and see the transition from the future to the past. On the inside, the building includes two structural columns from the original Twin Towers that serve as a gradual transition to the museum underneath (Fig. 13).[93] Since the main focus of this project was focused on visitor comfort, the interiors are also lined with warm, natural wood elements and an emphasis on natural lighting (Fig. 14).[94]

Although the site was meant to highlight functionality and the users' experience, it still showcases sustainability, which is one of the core values of Snøhetta. The building is LEED Gold Certified, as it incorporates "optimized minimal energy performance, daylight and views, water efficiency, wastewater re-use, and low emitting and locally sourced materials and fabricators wherever possible."[95] All of these elements are hidden within the building as not to be the main focus. Since the Pavilion as well as the Plaza outside were meant to convey a message of hope and promise of a better future, the site was planned to meet the requirements of New York State Executive Order 111 as well as the WTC Sustainable Design Guidelines, which highlights energy-efficient architecture and design.[96] Thus, it symbolizes the message of hope in terms of peace, as well as for the environment. In fact, in the plaza outside, there are rainwater collection sources underneath the plaza that serve as a source of water for the nearly 400 trees and plants that are around the site (Figure 15).[97] In essence, the plaza serves as a green roof for

[92] Snøhetta, Collective Intuition, 91.
[93] Snøhetta, "National September 11 Memorial Museum Pavilion," accessed March 8, 2022, https://snohetta.com/project/19-national-september-11-memorial-museum-pavilion
[94] Snøhetta, Collective Intuition, 91.
[95] Snøhetta, "National September 11 Memorial Museum Pavilion."
[96] "Exploring the Memorial's Sustainable Design on Earth Day (blog)," *9/11 Memorial and Museum,* accessed March 8, 2022, https://www.911memorial.org/connect/blog/exploring-memorials-sustainable-design-earth-day
[97] "Exploring the Memorial's Sustainable Design on Earth Day (blog)."

the museum that is underneath.[98] The trees themselves have a lot of symbolism, as they are a message of the nurturing and love needed in the space. There is also one special tree among the planted ones, called the Survivors Tree. This tree was found in the rubble of Ground Zero and brought back to life, symbolizing the strength and resilience of the American people.[99] Nature can be powerful, so by having a space that is sustainable can help to symbolize the power and strength of the area. Snøhetta was also presented with the challenge of designing a sustainable and purposeful building in the United States. America tends to be a bipartisan country with a lot of varying ideologies and ideas, which makes sustainable projects difficult to achieve. However, because this site is designed to bring everyone together and represents hope, sustainability was a core design element.

The design of the Pavilion was really meant to be an emotional experience for all that visited. In order to fully gauge what was needed in its design in order to make that happen, Snøhetta gathered a team of more than thirty consultants and stakeholders to make sure that it met their goals.[100] Thus, the elements of warm materials, natural daylighting, the ability to be able to peer in, and the transition to the past via the two old structural elements, reflect the design that they wanted. This site is meant to be a comforting visitor experience that bridges the gap between the past, present, and future. Physically engaging with the building helps to add to the emotional experience that the visitor is going to be going through when visiting. Some of the subtle elements that have been included will sometimes be glazed over by the visitor, but together, they all make a memorable and transformative site for people to reflect.

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[98] "Learn What's "Green" About the Memorial Plaza," The MEMO Blog, 9/11 Memorial and Museum, accessed April 10, 2022, https://www.911memorial.org/connect/blog
[99] "About the memorial," 9/11 Memorial and Museum.
[100] Snøhetta, Collective Intuition, 91.

However, since this is such a monumental space, there are different opinions and feelings on the space since it will have different effects for everyone. While a lot of the criticism has to deal with the actual museum itself, which Snøhetta did not design, there is some criticism about the Pavilion. A few reports describe it as having a 'forgettable blandness' while others say that the Scandinavian design took over the space and Snøhetta made the space about their company, more so than for the community.[101] However, they also state that the museum itself is too overcrowded and overwhelming, so it is hard to gauge how much is too much in a reflective space. Snøhetta has since stated that they made the space to be unimposing in order to allow for the visitors to be able to reflect and think on their own conditions, which is a testament as to how they designed the Pavilion. Regardless, the space will have different meanings to everyone that comes to visit it, and that is the whole purpose of a space with such monumental impact.

Powerhouse Brattørkaia

Powerhouse Brattørkaia, completed in 2019 in Trondheim, Norway, is arguably one of the most sustainable projects that Snøhetta completed (Fig. 16).[102] Snøhetta partnered with the companies Entra, Skanska, Zero Emission Building (ZEB), and Asplan Viak to create a set of energy-positive buildings, producing more energy over its lifetime than it consumes, including the construction and demolition process.[103] This series is called the Powerhouse series. With this process, almost every aspect of the design is centered around being sustainable, yet the building

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[101] Robert Bevan, "Memories in Ruins: 9/11 Memorial Museum by Snøhetta and Davis Brody Bond," *The Architectural Review*, June 17, 2014. https://www.architectural-review.com/today/memories-in-ruins-9-11-memorial-museum-by-snohetta-and-davis-brody-bond; Christopher Hawthorne, "Architecture review: At 9/11 Memorial Museum, a relentless literalism," *Los Angeles Times*, May 26, 2014, https://www.latimes.com/entertainment/arts/la-et-cm-911-museum-review-20140526-column.html

[102] Snøhetta, "Powerhouse Brattørkaia - The World's Northernmost Energy-Positive Building," Accessed February 7, 2022, https://snohetta.com/projects/456-powerhouse-brattorkaia-the-worlds-northernmost-energy-positive-building

[103] Snøhetta, "Powerhouse Brattørkaia."

seems like it is a part of the existing landscape of buildings. In order for the building to be integrated and functional in the city, it was designed to be a corporate office building, as well as serving as a connection to the local train station in the city. According to Snøhetta's website, this site was meant to serve three purposes: "The aim of the project is threefold; to maximize the amount of clean energy produced by the building, to minimize the energy required to run it, and to serve as a pleasant space for its tenants and the general public."[104] Even though the architecture was constructed with the help of different organizations, they still valued functionality and wanted the community to benefit from its construction and use. This building is along the water's edge, which is the Trondheim Fjord. If you were out on the water looking in at the city, the building would blend in with the skyline. It was designed to be integrated into the community so the height of the building is no higher than the skyline of the rest of the city and does not have any outstanding, modern design elements (Fig. 17). However, if you go to the other side of the building or are coming into the city, the building stands out for its unique, modern, and even sculptural design. There is a slanted, angular roof with a cut out circular shape in the middle of the building. Such a design conforms to the company's motto, "form follows environment," meaning that they thought about the efficiency of the building first, and then the design followed. The cut out circular shape shows that the building is "bursting with energy," and allows inside offices to be lit with daylight.[105] Since Trondheim, Norway is so far north, there are days where there is sunlight for only a couple of hours.[106] Solar energy and solar panels were going to be their main source of energy, so they had to design the architecture of the building to be optimally placed towards the sun in order to get the most sunlight possible.

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[104] Snøhetta, "Powerhouse Brattørkaia."
[105] Crook, "Snøhetta completes office on Norwegian Fjord."
[106] Snøhetta, "Powerhouse Brattørkaia."

Therefore, the roof is slanted at a 19° angle, and the solar panels are at a 90° angle towards the sun because that is the optimal tilt for the building to acquire the most sunlight possible.[107] The cut-out shape also doubles as an outdoor atrium and garden space for the employees as well as the public (Fig. 20).[108] In works of art and architecture throughout history, circles often symbolize heaven and the universe. This can be seen with works by Leonardo DaVinci, specifically *The Vitruvian Man*. In it, the circle serves as a symbol of the relationship between man and the universe.[109] This is also seen with the case of the Pantheon in Rome. The dome of the Pantheon is a perfect circle, allowing for the possibility of a perfect sphere to fit in the space.[110] The designers even wanted for everyone to recognize this by hatching out the surface so people could perceive this readily.[111] The Pantheon's perfect circle could have many different meanings, but possibly it meant that there was a connection with the celestial sphere. In this case, while they might have just included a circular form to allow for daylighting, it can also serve as a symbol of the relationship between man and nature since this building was designed with nature at the forefront of their mind, especially since the circle is not a perfect sphere.

There are multiple other features on the interior that optimize its efficiency. In regards to lighting, they also utilize a system called "liquid light" which is an artificial light system that changes the dimness level of light depending on the activity level in the building.[112] Therefore, if there is a day of the week when not a lot of people come to the office, or it is nighttime, the building uses less light or none at all. Using liquid light and natural daylighting allows the

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[107] Crook, "Snøhetta completes office on Norwegian Fjord."
[108] Crook, "Snøhetta completes office on Norwegian Fjord."
[109] Martin Germ, "Leonardo's *Vitruvian Man*, Renaissance Humanism, and Nicholas of Cusa," *Umění* LV, no. 2 (2007): 102, https://doi.org/10.2478/v10008-007-0004-2.
[110] George Waddell, *Creating the Pantheon: Design, Materials, and Construction,* (Rome: «L'ERMA»di BRETSCRNEIDER, 2008), 15.
[111] Waddell, *Creating the Pantheon,* 23.
[112] Crook, "Snøhetta completes office on Norwegian Fjord."

building to use about half of the energy needed for lighting as a building of comparable size would use.[113] The building also includes an efficient mechanical system including heating and ventilation, appliances, and water use.[114] Since the building is on the fjord, the building takes that water and uses it to heat and cool the building.[115] Utilizing local materials helps them to be sustainable.

By creating a building where "form follows environment", there were some design challenges that needed to be addressed. To start, they needed to have safe access to the roof for firefighters as well as making sure that the steepness of the roof would not let snow and ice fall to pedestrians below.[116] They combatted these issues by installing snow stoppers and safety wires for people to use. Snøhetta also wanted to maximize the number of solar panels on the roof, and since they come in a standardized size, they had to modify them to get the right dimensions and spacing. They also had to securely attach the solar panels on the roof due to high winds that they get in the area.[117] Thus, great attention was taken to all details of the building to optimize functionality for the users and the location.

Because of its energy-efficient design, it allows the building to serve as a mini power energy bank for the city and neighboring communities, giving its energy through a microgrid. The building produces 458,457 kilowatt-hours of energy per year.[118] The large space they designed for it allows the excess energy to be stored within the building, and then given out to

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[113] Crook, "Snøhetta completes office on Norwegian Fjord."
[114] Snøhetta, "Powerhouse Brattørkaia."
[115] Snøhetta, "Powerhouse Brattørkaia."
[116] Y-Jean Mun-Delsalle, "This Energy-Positive Workspace In Norway Aims To Produce More Energy Than It Consumes Over Its Lifespan," *Forbes*, February 6, 2022. https://www.forbes.com/sites/yjeanmundelsalle/2022/02/06/this-energy-positive-workspace-in-norway-aims-to-produce-more-energy-than-it-consumes-over-its-lifespan/?sh=3b6660a4371e
[117] Mun-Delsalle, "This Energy-Positive Workplace in Norway."
[118] Snøhetta, "Powerhouse Brattørkaia."

the community, or to the building during the winter months when there is less daylight that they can utilize. Because of the efficiency of this building, it has been awarded the BREEAM Outstanding certification, which is the highest possible energy-efficient standard that is given out. This certification also supports the UNFCCC Paris Agreement, which is trying to keep the global temperature rise from exceeding 1.5°C.[119]

The functionality of the space for the public and the workers was important in constructing this space. Being a connection to the local train station, they created a pedestrian bridge connecting to the back of the building.[120] The public can also enjoy the atrium space that has a public garden since there is access to it from the street. By creating a structure that blends into the skyline, as well as providing public amenities, Snøhetta made sure that the space would be suitable and functional to the public. Additionally, since this building is a corporate office building, Snøhetta designed for the employees to have an enjoyable work experience. By having a lot of windows, they get to have daylight, and those on the rear of the building also enjoy panoramic views of the fjord outside.[121] The rest of the space has a lot of warmth, even though there are so many different systems in place to regulate its energy use. There are natural wood elements as well as slits in the wall that allow for more daylight to come through (Fig. 21). By being part of the Powerhouse series, the space serves as a place where architects and designers can take inspiration in order to make their designs efficient. In order to be open and communicative with all, there is also a cafe and visitor center on the first floor which goes into details on the space's design and how they achieved this level of efficiency.[122] Thus, the building

[119] Snøhetta, "Powerhouse Brattørkaia."
[120] Snøhetta, "Powerhouse Brattørkaia."
[121] Mun-Delsalle, "This Energy-Positive Workplace in Norway."
[122] Crook, "Snøhetta completes office on Norwegian Fjord."

serves as a form of a museum, educating the public on the future of design, as well as showing the public how easily it can be achieved.

As one of Snøhetta's more recent works, the Powerhouse Brattørkaia serves as a place where all can see how functionality and efficiency are maximized. By analyzing the location of the site and considering how nature and materials work together, this site can serve as a role model for the future of sustainable design.

Conclusion

As a top design firm, Snøhetta has ambitious plans for their next projects. Everything they design is a representation of their core values and beliefs. At the root of those core values include sustainability and functionality, and the company has only progressed through time. However, they have to adapt to varying locations and policies that regulate their designs. By adapting to these various locations, they are showcasing to all how design can be modified to fit others needs, can be an inspiration for future designers, and still be beautiful.

Looking to the future, Snøhetta has been designing new sustainable projects ranging from revitalizing nature areas for humans to utilize, such as the Willamette Falls Riverwalk in Oregon, to creating an entirely new city district in Budapest.[123] All of the green projects they work on span from the United States, to the Czech Republic, to Australia, which shows how they adapt to different climates to make sure that their design will function as well as how vast their scope is.

Additionally, Snøhetta has been trying to change the entire energy-efficient design sector by working to create new building materials that would ultimately reduce the amount of greenhouse gas emissions during construction. One creation of theirs is a soundproof, fire-

[123] Snøhetta, "Willamette Falls Riverwalk," accessed April 10, 2022, https://snohetta.com/projects/336-willamette-falls-riverwalk; Snøhetta, "Budapest South Gate Masterplan, accessed April 10, 2022, https://snohetta.com/projects/543-budapest-south-gate-masterplan

resistant building material made from fungi.[124] Another invention of theirs has been a carbon-negative concrete alternative that is made from wood waste called biochar.[125] Concrete accounts for 8% of greenhouse gas emissions in the construction industry, so Snøhetta is not only trying to work with what they are presented with, but trying to combat the issue from the start.[126]

Therefore, Snøhetta's projects can be used as an instrument to teach people that architecture and design can be modified and adapted to embrace the relationship between the environment, nature, and practicality. These projects even show us how designers can modify certain sections of a building and still make a meaningful impact on the final value. Ultimately, Snøhetta adapts to varying conditions and doing so not only improves the area that they are designing for, but also changes the world for all.

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[124] Snøhetta, "Regenerative Building Materials with Mycelium," accessed April 10, 2022, https://snohetta.com/projects/587-regenerative-building-materials-with-mycelium

[125] Snøhetta, "Biocrete - a carbon negative concrete," accessed April 10, 2022, https://snohetta.com/projects/558-biocrete-a-carbon-negative-concrete

[126] Snøhetta, "Biocrete - a carbon negative concrete," accessed April 10, 2022, https://snohetta.com/projects/558-biocrete-a-carbon-negative-concrete

Figure 1. Aerial view of the Bibliotheca Alexandrina

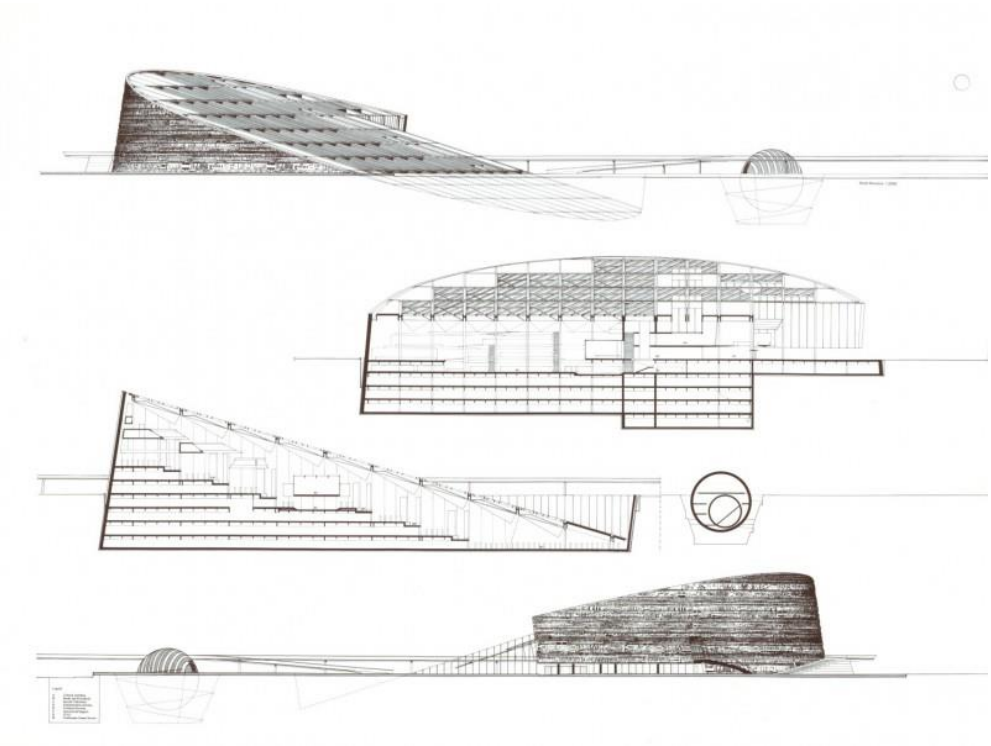

Figure 2. Plan and sections drawings of the Bibliotheca Alexandrina that highlights the tilted roof and curved facade

Figure 3. The curved facade that shows carved hieroglyphs

Figure 4. Vertical and north-facing slits in the roof

Figure 5. The interior of the Alexandrian Library showcasing the indirect sunlight, the exposed concrete, and natural wood elements with an open concept

Figure 6. The Norwegian National Opera and Ballet

Figure 7. The white carrara marble on the interior of the building

Figure 8. There are warm, wooden elements present on the interior in addition to white marble

Figure 9. The timber ‘wave wall’ that is at the front of the interior

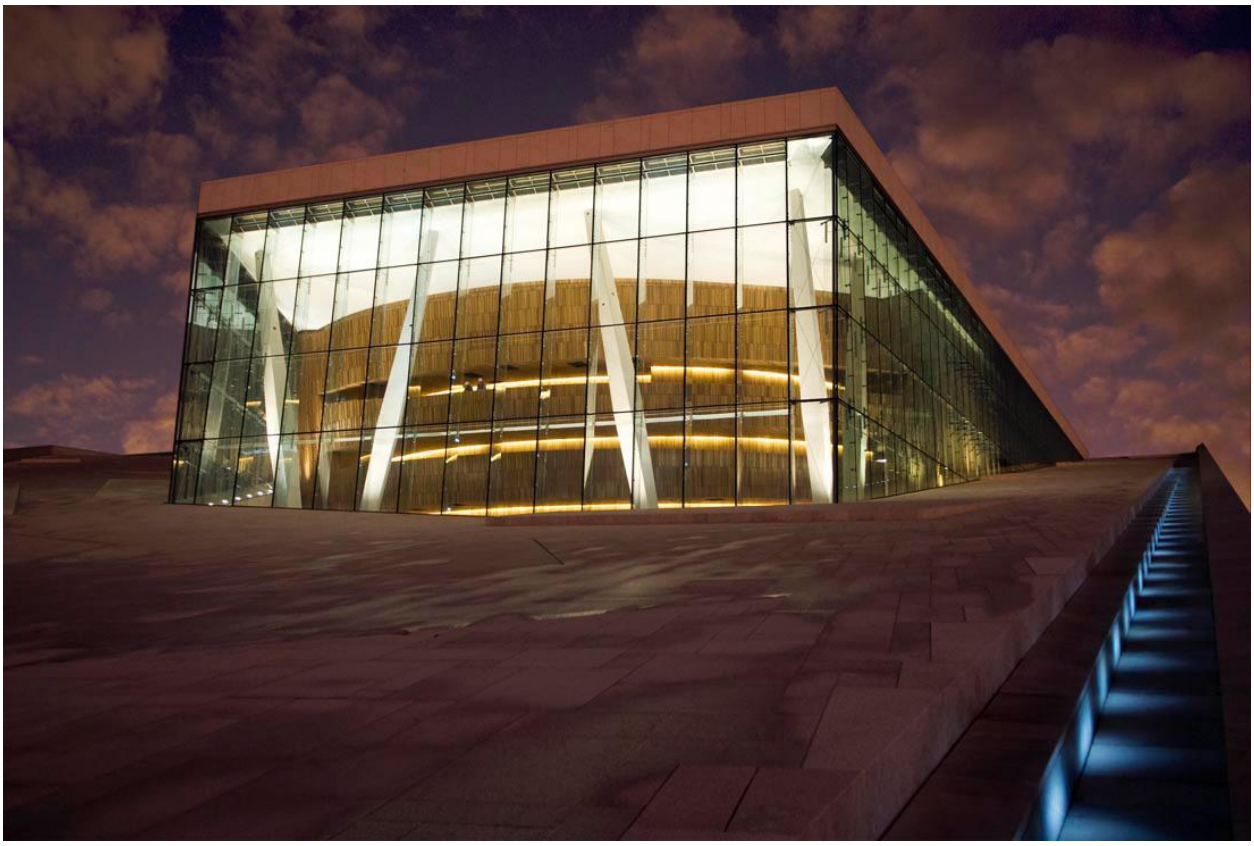

Figure 10. The ‘wave wall’ becomes illuminated at night, showing how the interior and the exterior are fluid

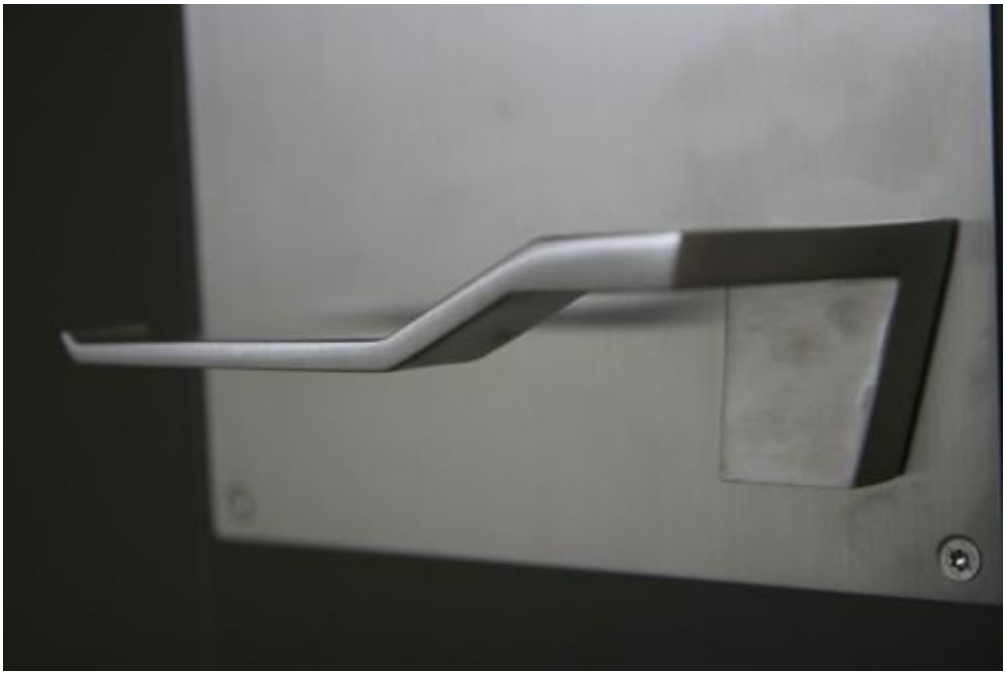

Figure 11. Door handles on the interior that highlight the exterior of the building

Figure 12. The National September 11 Museum Memorial Pavilion that highlights a deconstructed form

Figure 13. The structural beams from the original Twin Towers serving as a transition to the museum below

Figure 14. The interior of the Pavilion which showcase natural lighting and natural wood elements

Figure 15. The plaza consists of nearly 400 trees and plants to highlight the site's sustainability and message of hope

Figure 16. Powerhouse Brattørkaia, the world's northernmost energy-positive building

Figure 17. Powerhouse Brattørkaia stands on the right, showcasing how the height of the building is similar to the rest of the skyline

Figure 18. The garden and atrium space that is shown along with the cut-out shape in the middle of the building

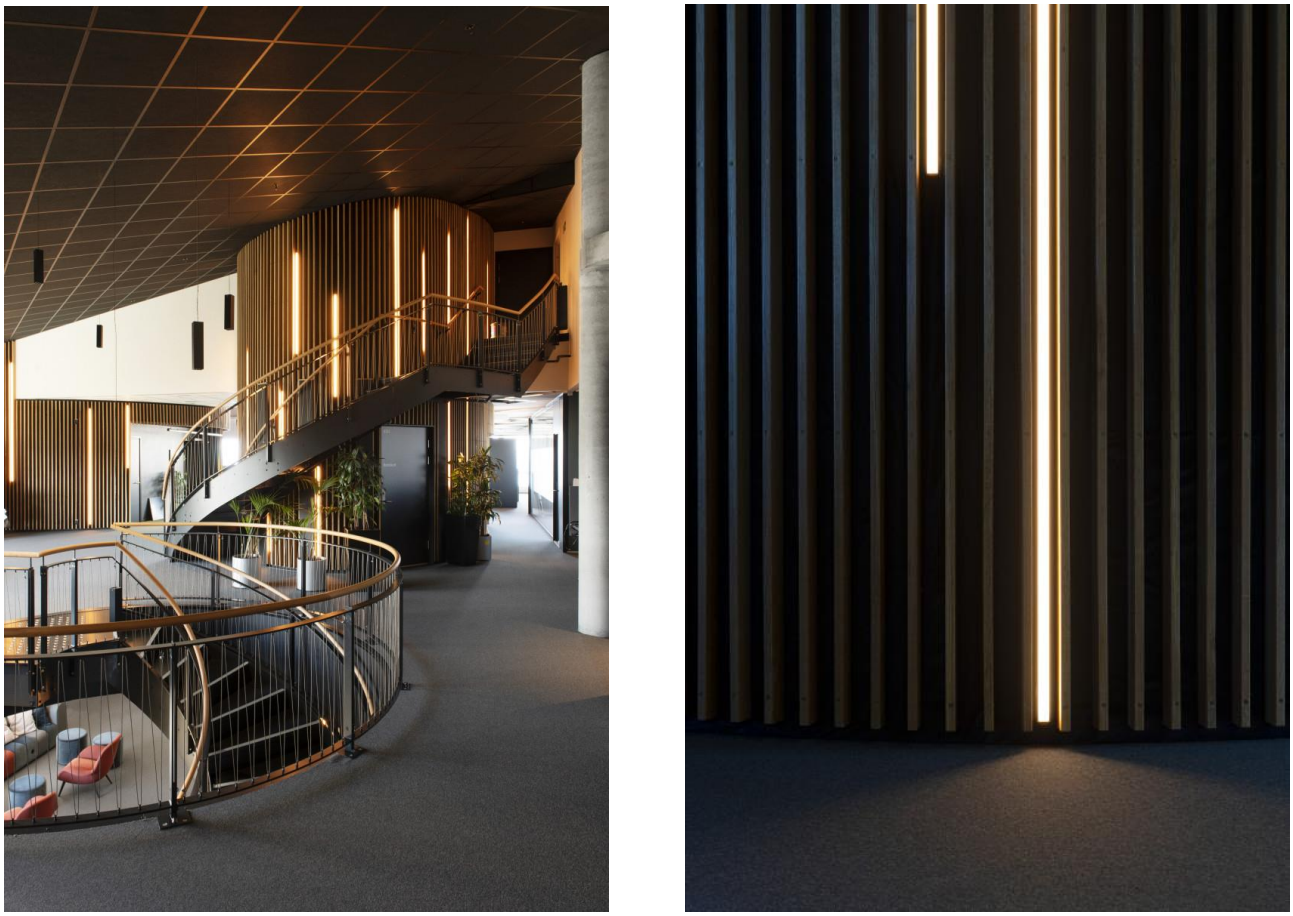

Figure 19. The natural wood elements and slits for daylighting on the interior

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