TÉCNICO LISBOA

Design with the Context

A Green School in Salzburg

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Project Report to obtain the Master's Degree in

Architecture

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Acknowledgments

I would like to thank

Dr. Vítor Carvalho Araújo,
Who, as a very good speaker, is able to challenge and motivate anyone.

Arch. Bak Gordon,
Who, as a teacher, taught me to 'Think Architecture'.

My parents,

Miguel Costa,

My friends.

Abstract

This report is the theoretical support and the complement to the project Model.Space.School developed during the second semester of the school year 2012/13 at the *Technische Univertisät Graz* (TU Graz) in Austria, under the Erasmus program. It is submitted to the *Instituto Superior Técnico* in Lisbon for the award of the Master's Degree in Architecture.

The project and the need to reflect about it in a report was the opportunity to deepen the knowledge on learning pedagogies as alternative to the regular school curriculum and how those pedagogies can be translated into a school design.

A personal goal was added to the Master studio goal. That was to design a school which could benefit from the understanding of an environment adapted solution.

The first part of the project work was developed individually and in group. It included the analysis of the geographical and historical context of Salzburg as a whole and specifically of Nonntal, the area of intervention. Learning pedagogies and their link to the design of the space were also debated intensively within the group. Legislation and programmatic constraints were obvious boundaries, although following the principles of sustainability were the determining drivers.

The second part of the report elaborates on and justifies all concepts that contributed for the final design of the Green School. Those were developed simultaneously and relate to layout aspects, volume, learning pedagogy, space, construction and energy.

Resumo

O presente relatório submetido para obtenção do grau de Mestre em Arquitectura pelo Instituto Superior Técnico, é o complemento teórico ao projecto desenvolvido na disciplina de Projecto de Arquitectura (Master studio) *Model.Space.School* (Modelo.Espaço.Escola), na Technische Universität Graz (TU Graz), na Áustria, durante o segundo semestre do ano escolar de 2012/13, ao abrigo do programa Erasmus.

O projecto em si mesmo e a circunstância da elaboração do relatório permitiram uma reflexão aprofundada sobre as questões relativas às pedagogias de ensino alternativas ao ensino regular e à sua aplicação arquitectónica.

Para além deste objectivo base, foi também definido pessoalmente o objectivo de projectar a escola tendo em conta exigências ambientais e de sustentabilidade, de forma a que a solução final pudesse benificiar o contexto e do contexto no qual se insere.

Numa primeira fase, individualmente e em grupo, são analisadas questões de contextutalização histórica e geográfica de Salzburgo e especificamente da zona de intervenção, (Nonntal), questões relacionadas com as actuais pedagogias de ensino praticadas e possíveis estragégias espacias para a sua aplicação. A preocupação pelo respeito por príncipios de sustentabilidade foi determinante no processo de desenvolvimento de projecto, embora constragimentos legais e programáticos também tenham sido muito importantes.

Numa segunda fase, são documentados os conceitos volumétrico, pedagógico, espacial, construtivo, energético e de implantação que fazem parte do desenvolvimento mais concreto do edifício que resulta na Escola Verde.

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Index of Abbreviations

TU Graz	*Technische Universität Graz*
UNESCO	United Nations Educational, Scientific and Cultural Organization
ICOMOS	International Council on Monuments and Sites
SWOT	Strengths, weaknesses, opportunities and threats analysis
EU	European Union
EPBD	Energy Performance of Buildings Directive
IPCC	United Nations Intergovernmental Panel on Climate Change
GHG_s	Green House Gases
SOC	State of Conservation

List of graphical elements

02 Salzburg | Framework

03 Project | Framework

04 Project | Process and Proposal

01 Introduction

01 Introduction

This report is the theoretical support and the complement to the project Model.Space.School developed during the second semester of the school year 2012/13 at the *Technische Univertisät* of Graz (TU Graz) in Austria, under the Erasmus program. It was submitted to the *Instituto Superior Técnico* in Lisbon for the award of the Masters' Degree in Architecture.

The theoretical and the practical components, report and project, complement each other but the reader should still get a clear understanding even if he/she has access to one of the components in isolation.

The fact that the whole work was performed in the context of the Erasmus program was very relevant, in a sense that different views and ideas coming from different parts of the world were captured. The wealth created by such an intense cross-cultural experience had to play a part in some way or form. Individual views on how to address problems were permanently challenged given the diversity of backgrounds of students in the program. One had to stay in a mode of permanent adaptation given people's different ways of thinking and acting.

Erasmus was like an experiment and the actual laboratory was Austria. If a particular characteristic of the Austrian culture needs to be named as the most relevant to the project, that has to be the way Austrians communicate amongst themselves and with other nationalities. The Austrians do not volunteer a comprehensive explanation when a question is asked, as it is assumed that the answer given is concrete and objective and therefore does not require details. This was a critical obstacle which took the non-Austrian members of the program some time to overcome both academically and socially.

The project was: to design a primary school in Nonntal, a location not far from the historic centre of the city which is classified as a World Heritage site.

Nonntal is still considered as part of the buffering area between the historical and the non-historical centre, therefore it still adheres to strict regulations on the preservation and construction of buildings.

The assignment required the development of critical thinking on the way children learn at school and considered its repercussions on the way space is designed.

The Master studio gave particular relevance to the choice of materials for the interior of the building and to its spatial organization. This aspect explained the fact that part of the program was led by the Institute of Interior Design. On the other hand, the program did not have constraints so the author could aspire to a more complex outcome.

The European directives on energy efficiency (Directive 2012/27/EU) and on energy performance of buildings (Directive 2010/31/EU) made the subject of sustainability more than a real responsibility, they made it a key principle.

The building followed the standards of sustainability right from the conceptual stage of development. Those standards became the pillars for all other arising thoughts.
One realization triggered by this project was that, even today, the subject of sustainability is little impressed in the minds of students of Architecture all the way to the end of their studies.
This document aspires to serve the purpose of raising awareness on the importance of the role of the Architect in designing with sustainability as 'the' principle. It describes the research that moulded the thoughts on the importance of designing a sustainable school. The historical and geographical context of Salzburg plus the physical challenges brought out by the strict climate conditions of the area deeply influenced major project decisions too.

> Green schools are more than buildings. They are places where children learn the wonders of the world and teachers prepare the next generation of leaders and citizens. (U.S. Green Building Council 2012)

1.1. Objectives

The goal of the Master studio was to design a school in Salzburg; it was also implicit/required that one had to consider the spatial design according to new learning pedagogies.
The project and the need to reflect about it in a report was the opportunity to deepen the knowledge on learning pedagogies as alternative to the regular school curriculum and how those pedagogies can be translated into a school design.
Designing a school became even more relevant because a school is the place the leaders for the future[1] start to be raised.
A personal goal was added to the Master studio goal. That was to design a school which could benefit from the understanding of an environment adapted solution.
Design with the Context, a Green School in Salzburg, goes through the decisions that contributed to the project's final proposal and it is both the pre- and post- reflection on "why I am doing it" (Zumthor 1999, p. 35) in favour of an intelligent design.

[1] Leaders for the future is an expression used by The Centre for Green Schools to describe that the children of today who are in fact those with the power to change the future.

1.2. Motivation

The author saw the assignment as the perfect opportunity to address some matters of personal interest:

1) to design with the context – harmony and preservation;

2) to consider the spatial design according to the most recent learning pedagogies;

3) to develop a knowledge on sustainable matters and principles in designing Architecture;

4) to determine through practical experience, if sustainability did determine the design of a building from the concept stage.

> I believe that architecture today needs to reflect on the tasks and possibilities which are inherently its own. Architecture is not a vehicle or a symbol for things that do not belong to its essence. In a society that celebrates the inessential, architecture can create a resistance to it, counteract the waste of forms and meanings, and speak its own language.
>
> I believe that the language of architecture is not a question of a specific style. Every building is built for a specific use in a specific place and for a specific society. My buildings try to answer the questions that emerge from these simple facts as precisely and critically as they can. (Zumthor 1999, p. 26)

1.3. Structure

01 Introduction

Chapter 1 introduces the reader to the theme, to the context in which it is developed and to the project itself.

02 Salzburg | Framework

This chapter looks at all aspects concerning the location, climate, history and legal obligations specific to the context of Salzburg that had an impact on the choices of the project.

03 Project | Framework

This part of the work was developed individually and in group. The work produced includes 1) the analysis of the geographical and historical context of Nonntal; 2) current learning pedagogies and their spatial response reflected on specific spatial designs; 3) the search for information on the behaviour of children between the ages of 6 and 10 years old since these are the ages of the children attending a primary school.

04 Project | Process and Proposal

The respect for sustainable principles was key in designing the school, even though legislation and programmatic constraints deeply influenced it too. The European directives on energy efficiency (Directive 2012/27/EU) and on energy performance on buildings (Directive 2010/31/UE) created the basis for all further thinking on sustainability. Then, with further research, specific subjects on the matter of designing a school which had to be 'green' became relevant and integrated into the content of this report.

This chapter addresses the different aspects of the theme of sustainability so that it is easier for the reader to follow the process used in the decision making all the way to the final proposal. This is sorted by concept, layout, volume, space, construction and energy concept.

05 Conclusion

This chapter reflects on:

a) the impact of the theoretical background explored and articulated in future proposals.
b) the validity of the proposal given the impact of the project on the area and its surroundings assuming it would be built.

If our designs (for private houses) are to be correct, we must at the outset take note of the countries and climates in which they are built. (Vitruvius 2006, p. 170)

02 Salzburg | Framework

2.1. Geographical Context

2.1.1. Location

Fig. 1 Geographical location of Austria

Fig. 2 Salzburg in reference to the Alps

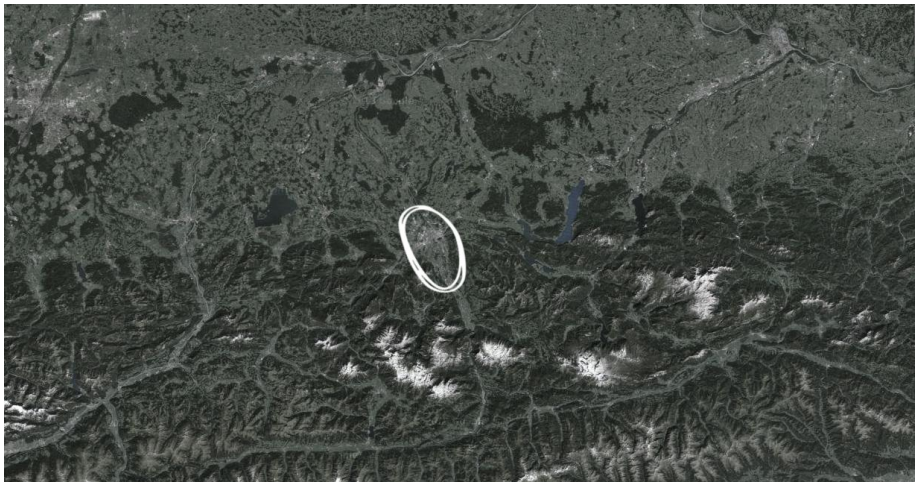

Fig. 3 City of Salzburg, Salzach Valley, north of the Alps

Like many European cities, Salzburg has a historic centre and after World War Two suffered from an urban sprawl along both sides of the Salzach River that transformed much of its surrounding farmland.

2.1.2. Climate

Austria is most influenced by two different climates, the continental in the east and the oceanic in the west. The first is characterized by cold winters and hot summers whereas the second by mild winters and moderate summers with high precipitation throughout the year. However, the climate conditions of Salzburg integrate neither models completely because it suffers from cold weather, rain, snow and wind caused by the proximity to the Alps. Thus, the best way is not to categorize Salzburg's climate even though the precise definition for it in German is *Übergangsklima* which in English means transitional climate.

The 'heating-on' period (heating systems are turned on inside the building) normally goes from mid-October to mid-April with high energy demands due to the big difference between the low outdoor temperature and the average indoor 22°C established by regulations to ensure thermal comfort. To prevent the loss of heat through thermal bridges, traditional buildings are generally built with heavy materials, thick layers of insulating material and small windows. On the other hand, big windows are very appealing because they let in the sunlight that passively heats the internal environment and causes in people a feeling of great comfort.

The high levels of precipitation and snowfall require a high pitch of the roof so that it slides off easily and does not cause exceptional weight.

The prevailing wind directions are northwest and south-southeast which are caused by the location of Salzburg in a valley, on the edge of the Alps, the formation of which follows the same orientation.

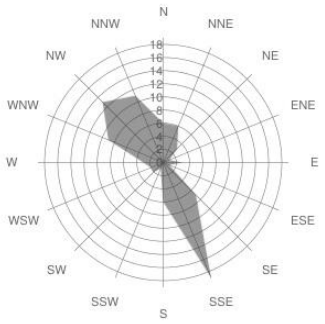

Fig. 4 Average percentage of wind direction distribution in Salzburg based on obervations taken between October 2000 and July 2013 from 7am to 7pm

2.2. Historical Context

This chapter explains how the city of Salzburg developed into what it is today from a historic perspective. It is consequently a key chapter in this report because the design of the primary school is influenced by the Old Town given the proximity of the location.

2.2.1. Medieval to Baroque Developments

There is a clear difference both on the ground and on the map between the lands of the former Prince-Archbishops and those of the people. The layout of the first is characterised by the presence of monumental buildings accessed

from large squares and they are located mainly on the west side of the Salzach River, while the lands of the people on the east side of the river show a tight street pattern accessed only by three small market places.
After a series of fires from 1167, people started changing the construction material of their houses from wood to stone so that they could resist better and longer.
In Salzburg, the Gothic period began around 1300. It motivated the rich landowners to invest in construction within the city.
A vital historic event for the urban development of Salzburg was the appointment of Wolf Dietrich von Raitenau in 1587 to the position of Archbishop, the reason being that he led a process of remodelling the entire city. Then at the beginning of the 17th century another Archbishop, Paris Lodron invested his efforts in the reinforcement of the defences of the city. Paris Lodron realized that to protect the city he had to use other tools rather than just bricks so he positioned the city as a neutral territory enabling Salzburg to stay out of the Thirty Years' War. That period of time was of wealth therefore houses were renovated, quality of construction systems improved and also their aesthetics.
Lodron was also the creator of the first University of Salzburg which grew to what it is today, one of the Universities in the city.
The Baroque period, starting in the 17th century, added a number of magnificent buildings in Baroque style like public places in the shape of squares and many fountains. Famous Italian artists were brought in to work in Salzburg and ended up leaving an Italian style in the buildings of the Old Town.
The Napoleonic wars delayed the development of Salzburg for many years until the first railway system was built at the end of the second half of the 19th century.

2.2.2. After the Second World War

In the '50s, after suffering the bombings of the Second World War and prior to the implementation of building regulations, many buildings underwent reconstruction, especially those located in the Old Town.
The Advisory Committee for Issues of Urban Planning and Building Design was created in the spring of 1955 and it consisted of a seven-member panel of art historians, architects and civil engineers. Their task was to translate into practice what the name of the committee indicated but the urge to create new housing and eliminate poverty overrode other concerns. This fact led to the marginalisation of the group so it was rarely entrusted with the assessment of projects and therefore the construction of buildings with little architectural quality took over.

The nature of tendering processes in the field of architecture and urban planning reached a low point in the 1970s because politicians exercised full control over the construction process and regularly favoured specific architects or builders in the assignment of projects for 'hidden reasons'. This phenomenon was not exclusive to the city of Salzburg, unfortunately.
The acceptance that the use of competitive tendering was the correct way to select the proposal that would provide the best solution grew slowly, mainly throughout the 1980s, out of the recognition that construction was lacking quality and the urban landscape was being destroyed. The fact that politicians had to demonstrate publicly that they followed values like equal opportunity, merit and fair competition were a 'game changer' too.
Architects had to raise awareness on the importance of good quality architecture and regional architecture. Among them were Clemens Holzmeister, Oswald Haerdtl, Wilhelm Holzbauer and Friedrich Achleitner who in 1980 created a guide entitled 'Austrian Architecture in the 20th Century'. (Kapfinger, O. And Pirker, S. Ed. 1999)

2.2.3. Architectural Reform of 1983

The first plan for the urban development of Salzburg was created in 1970 with the conversion of extensive farmland into urban land. The people protested against the initiatives of that plan in favour of the preservation of the green spaces and the conservation of the Old Town. In 1977, a significant number of Salzburgers came together to create a party named *Bürgerliste* (party of the people) and ran for power in the local elections. They did not win but continued to offer opposition against the local powers whose reputation was weakened by the unveiling of scandals related to construction. In 1982 the *Bürgerliste* was finally elected and a council was created whose priorities were to conserve the Old Town and protect the green areas. They then adopted a top-down approach meaning that the council mandated a reform which was named *Salzburg-Projekt*. One needs to emphasize that the whole process was very particular because it started with the Salzburgers themselves marching for better architecture.
Voggenhuber became Planning Councillor in 1982 when the *Bürgerliste* was elected. He was able to initiate wide reforms in architecture; he was a competent member of the construction authority with strong know-how in spatial planning and architecture. The reforms resulted in several transformations which included the enforcement of an initially very controversial extensive pedestrian area in the Old Town in June 1983. The Advisory Council (*Gestaltungsbeirat*) of the city of Salzburg was established in 1983 for the assessment of the plans for the development of buildings and large-scale projects that attracted a series of high quality projects made by

both domestic and foreign architects. Voggenhuber invited an Italian architect to join the Council because he gave great value to the reinforcement of the existent links between Salzburg and Italian architecture.
From this point onward, architecture became a matter of public and political interest and the idea of an Advisory Council was adopted by other provincial capitals of Austria, including Vienna.
"Salzburg, a community with a unique historical cityscape, but with much red tape in its construction policy and glaring eyesores of modern urban planning, was to become a model for the restructuring of a 'European city'." (Kapfinger, O. And Pirker, S. ed. 1999, p. 19)

2.3.4. UNESCO World Heritage

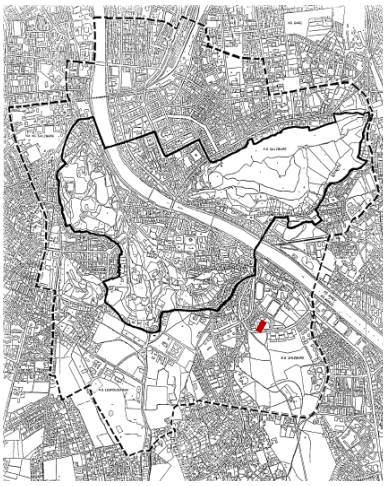

Fig. 5 Salzburg: nominated area and buffer zone

Boundary of the protected zone for inscription on the World Heritage list
Boundary of the buffer zone
Site location

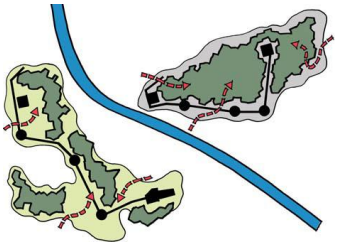

Fig. 6 Moutains in the city centre
Left bank: Mönschenberg, Rainberg and Nonnberg
Right bak: Kapuzinerberg

The geographical location of Salzburg at the feet of the Alps to the north and at the narrowest point of the Salzarch valley with easy access to water encouraged settlement in the area from prehistoric times.
Although the importance of identity preservation is long established in the minds of the inhabitants of Salzburg, who since the 19th century have carried out renovation and preservation works on both secular and ecclesiastic buildings, it was after the Second World War that most work was needed. At that time, the Federal Monuments Agency and the Commission for Preservation of the Old Town took control of monitoring all actions. This still undergoing work ensured the preservation of the authenticity of the historic centre of Salzburg to the extent that it is rare to find any other so remarkably intact urban fabric and buildings from the period of ecclesiastical city-state government which in Salzburg occurred in the early 19th century.
Under Austrian law, the historic city centre (Old Town) was classified as an entity worth protecting where all monuments of public interest are the property of the State. Legal status required all possible actions against protected buildings to be first submitted for approval at the Federal Monuments Agency (*Bundesdenkmalamt*).
All actions to restore and preserve the city were designed to raise the city centre of Salzburg to the level of World Heritage.
Salzburg was awarded World Heritage for three key reasons, specifically:

> First, it has preserved its historic street pattern and urban fabric to a remarkably high degree.
>
> Secondly, it contains a number of buildings, both secular and ecclesiastical, of very high quality from periods ranging from the late Middle Ages to the 20th century.
>
> Thirdly, it is intimately associated with many important artists and musicians, among them the pre-eminent Wolfgang Amadeus Mozart. (ICOMOS 1996, p.8)

The protected historical centre of Salzburg includes both the left and right banks of the Salzarch River, connected by the Nonntal Bridge, Mozart Footbridge, State Bridge, Makart Footbridge and Mülln Footbridge. Its qualities required a protective perimeter around it, named the buffer zone.
Although new urban developments were undertaken in the buffer zone, these still had to comply with very strict construction laws so as not to compromise the state of preservation of the historic city centre and its skyline with the mountains as background.
Nowadays, Salzburg is considered a group of buildings according to the Article 1 of the 1972 World Heritage Convention. (ICOMOS 1996)

2.3.5. Legislation

The curriculum of the architecture degree in Austria gives particular emphasis to legislation therefore this report could not exclude that aspect.
Local urban plans include the stipulation of a program for the land use and must be in accordance with the directives of the regional plan.
Development plans are created by the municipalities that regulate specifics to the areas of intervention that among other factors include the construction ratio, number of floors and maximum height of a building.
The articles highlighted above are those that focus on the construction requirements of a school in the province of Salzburg which were most relevant to the project.[2]

Construction Law

Article 25 | 3 | Positioning of buildings at the construction site

This Article regulates the distance between buildings so that they are all exposed to enough light and air. In Salzburg the distance regulated is measured from the perimeter of the building to the boundary of the property and must be at least 3/4 of the height of the eaves. The distance may be reduced to half whenever the neighbouring property is an area free of construction. However, the distance should never be less than 4 meters.
Underground constructions can be built at a distance of 2 meters to the boundary.
There are exemptions concerning these minimum clearances for industrial and commercial facilities.

Article 26 | 1

The Mayor is the highest Authority in matters concerning construction.

[2] The information in section 2.3.5 was collected from a work produced in class by other groups. The original information in German is available at:
https://www.help.gv.at/Portal.Node/hlpd/public/content/226/Seite.2260200.html

Construction Technology Law

Article 14 | Stairs and corridors

The main staircase must be fire resistant and accessible from all rooms. This escape route must be at a maximum distance of 40 meters from any point.

The tread must have a minimum length of 27 cm and the riser should not exceed 18 cm. The rule is 2 + B x H = 63 cm.

School Construction Regulations

Article 6| Classrooms

The total area of a classroom should not exceed 60 m^2 and allow for each student to have at least 1,6 m^2.

Each student has to be provided with an air space of 5 m^3.

Article 11 | Rooms for the Principal and teachers

The Principal of the school is entitled to a minimum office area of 15 m^2 with access to water.

The size of the room for staff depends on the number of teachers and should not be less than a total of 20 m^2. Each teacher should have his/her own working space.

Article 19 | Doors

Doors of classrooms must have a minimum width of 95 cm and height of 210 cm. Doors along the escape route have to open in its direction.

Article 18 | Stairs, corridors and spaces for withdrawal

If the classrooms are laid out only on one side of the building, the transition space must have a width of at least 2 meters. When classrooms are laid out on both sides of the building then the transition space must be at least 3 meters. Whenever the number of students surpasses 300, for each group of 20 students the corridor has to be widened by 20 cm.

The height of the ceiling in the corridor has to be at least 2,80 m.

The width of the tread of the step must not be smaller than 29 cm or bigger than 31 cm.

The height of the riser of the step must not be smaller than 15 cm or bigger than 16 cm.

03 Project | Framework

- 3.1. Assignment
- 3.2. Nonntal
- 3.3. Green Axis | Urban developments
- 3.4. School | Learning Pedagogies
- 3.5. Children between the ages of 6 and 10
- 3.6. Case Studies
  - 3.6.1. Primary School in Bad Blumau, Graz
  - 3.6.2. Sandal Magna Community Primary School in Wakefield, England

Regulations and guidelines exist for almost every aspect of a school building, from the requisite volume of air in a classroom to the playground space that has to be provided for every pupil, from the maximum length of corridors to the minimum width of escape routes. Similar regulations govern the behaviour of materials when exposed to fire, how to ensure greater safety in the event of glass breakage, and the number of washbasins that are necessary in a WC. No information is provided on such things as spatial and aesthetic qualities, however, nor on the influence of colour and light on children's concentration. (Building for Children 2013, p. 164)

03 Project | Framework

3.1. Assignment

12.03
Presentation of the assignment
13.03
Visit to the site in Salzburg
19.03
Presentation of the group work
20.03 + 22.03
Space Material Detail
Intensive workshop to develop specific parts of the project
26.4 + 27.04
Development of the concept
28.05
Midterm Critique
Presentation of the concept and its justification without overlooking the urban context
29.05 - 31.05
Raum Material Detail
Intensive workshop to develop specific parts of the project
25.06
Midterm Critique
A0 poster with all elements necessary to present the proposal
26.06
Final Discussion
04.07
Final Presentation

Fig. 7 Time Frame

The theme of the Master studio carried out by the Institute of Interior Design of TU Graz triggered the discussion on new ways of learning and its implications in the architectural design of a primary school.

> New educational concepts call for new time structures in schools. As learning becomes an active pursuit, it requires more time and space for discovering things, trying things out, representing things. Time and space are needed for young people to move about, to play and to relax in a stimulating environment. These things are just as important as cognitive, social and aesthetic. (Building for Children 2013, p. 171)

The goal was for the student to develop his/her critical view on the matter and afterwards, through practical experimentation, to make those ideas come to life in a specific location with real needs.

The functional program of the studio assignment was precisely the same as the one of the undergoing competitive tender for the same site location in Salzburg. The proposal of the competitive tendering included the construction of a primary school as well as the renovation and extension of part of an already existing high school (pedagogical school). The Master studio assignment concerned only the primary school. Furthermore, the unique cityscape of Salzburg (Kapfinger, O. And Pirker, S. ed. 1999, p.19) and its surrounding landscape, as stated in the brief of the public tender, could not be obstructed by the proposal.

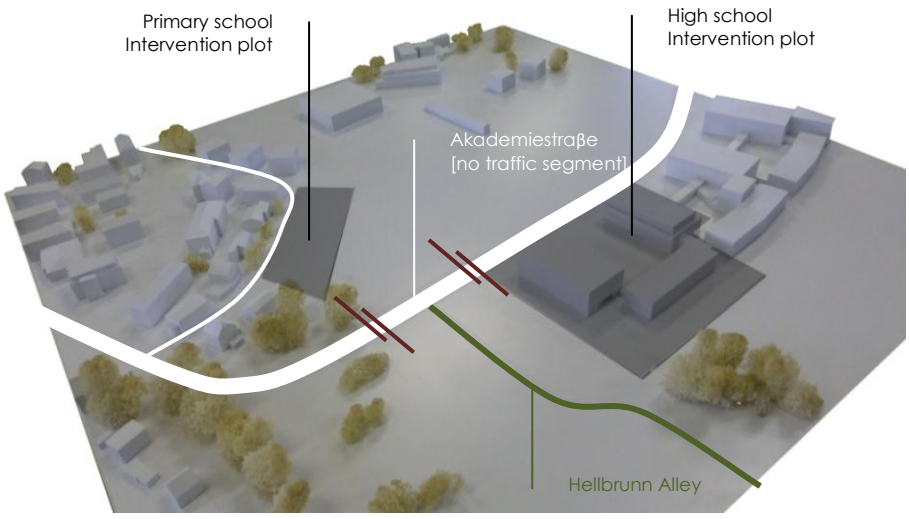

Fig. 8 Primary and secondary school plots in Salzburg (Nonntal)

According to the program of the Municipality, the school had to fulfil the requirements of a full-time school, meaning that it had to provide for a full day of monitored physical and artistic activities, during or post- regular class hours. The Master studio concept was that of an integrative full-time school,

meaning that the design should also respond to the new learning concept of a child learning through movement at his/her own pace. An integrative full-time school is not merely a working place but also combines classical classroom work with handwork, social, playing and relaxation activities, and also catering.

These requirements made the construction of a gym and a cafeteria and/or restaurant inevitable, either on primary school grounds or on the nearby high school grounds. The distance between the two schools is circa 50 meters.

With regards to the gym, two alternatives were initially offered:

1. to build a pedestrian path to connect both primary and high schools so that children could walk across and use the gym of the high school;
2. to build a gym and the changing rooms as part of the new primary school.

The Salzburg legislation prohibited the connection of the two school buildings by foot unless a bridge was to be built. This requirement seemed completely inadequate not only because there is no traffic on the way, so it would be completely safe to have the children walk from one school to the other, but also because a bridge would clash with the low rise scale of the buildings and their surroundings. As such, alternative 2 had to be the selected, meaning building a gym and supporting changing rooms as part of the primary school program of the studio. The size of the gym had to be at least 180 sqm, as legally required for children in the age range of 6 to 10 years.

Then there was the question of where to locate the cloakroom. An Austrian architect specialized in the design of schools took part in one of the studio's discussions and he suggested that there were two alternatives: either right after the main entrance of the building or before each classroom entrance. The decision was to be made based on how frequently the children would need to have access to their stored belongings, namely the winter jacket or rain coat.

Furthermore, it was mandatory to design a courtyard of 600 sqm. An indoor space that could be opened up and become outdoors whenever necessary, and could also integrate the courtyard programmatic demands.

	m^2	Number	Σm^2
Classrooms	60	10	600
Cloakroom	80	1	80
Meeting room	10	2	20
Waiting room	10	1	10
Principal's office	30	1	30
Storage	15 20	1 1	35
Common room	45	1	45
Multifunctional room	30	1	30
Library	30	1	30
Integration area	60	1	60
Music room	60	1	60
Gym (+ extra sqm for changing room)	**180**	**1**	**180**
Cafeteria	*	*	*
Courtyard	**600**		**600**
Parking places (on the street)		≥15	

*depending on the type of service

Fig. 9 Program

3.2. Nonntal

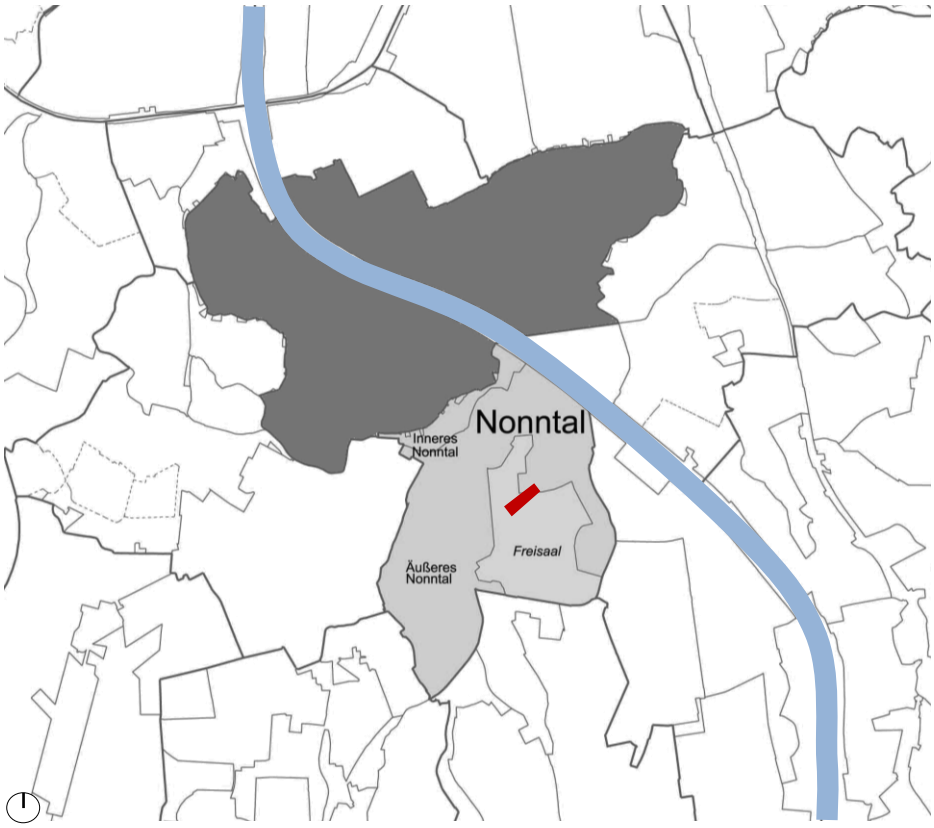

Fig. 10 Location of the intervention site

Nonntal is one of the oldest settlements in Salzburg and it has been inhabited since Celtic times.

Nonnberg (Nonn Moutain), with the monastery on the top, makes the background to Nonntal to the north, and gave the reason for the district's choice of name. 4 000 people live in Nonntal today.

Nonntal is divided into two areas: interior Nonntal is the historical section which is still part of old Salzburg and of the World Heritage site; and exterior Nonntal which is part of the buffer zone that secures the preservation of the Old Town. The first has the atmosphere of a small town of well-preserved medieval houses; the second, which was originally less urban and occupied by farms, is today a residential neighbourhood.

The Unipark (Academic compound) was a project of urban renewal finished in 2011, put into action by the Federal Minister for Education, Science and Culture with the intent of making the district of Nonntal more dynamic. The learning institutions in the Unipark are a University, two kindergartens, a primary school (the project documented in this report), a middle school, four high schools and many sports centres. Due to all this, Nonntal earned the name of University town.

The Unipark plan was part of an overall plan to reorganize the area and remove the "existing dilapidated campus buildings" (UNESCO World Heritage

Centre 2005).[3] Among other needs, it highlighted the urge to build a new primary school and part of an existing high school in Akademiestraβe (Akademie Street).

In 2012, the municipality of Salzburg put out to competitive tender both the reconstruction of the old schools and the construction of a new one. All functions and rules of this competitive tender were exactly the same as those given to the students of the Master studio of Interior Design at TU Graz.

The project documented in this report comes from the opportunity to build the referenced primary school. The ground for the new building was to be that same as that of two old abandoned buildings that made up the academic compound of the past.

Fig. 11 Prior academic compound

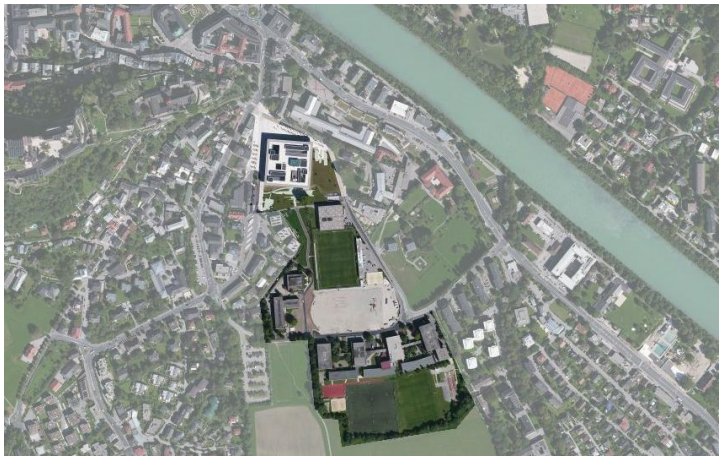

Fig. 12 Unipark; recent academic compound

[3] The State of Consevation (SOC) 2009 "Based on its review of the main projects, the mission report points out a number of instances where the Republic of Austria, the Federal State of Salzburg and the City of Salzburg lack clear mechanisms of coordinated decision-making (...). The mission report provides several examples of the questionable results which follow from this uncoordinated approach – for example, the decision by the *Architectural Advisory Board (Gestaltungsbeirat)* to accept the University Campus on formerly open sports grounds (buffer-zone)." (UNESCO World Heritage Centre 2009)

3.3. Green Axis | Urban Developments

Fig. 13 Hellbrunn Alley

Fig. 14 View of Nonnberg

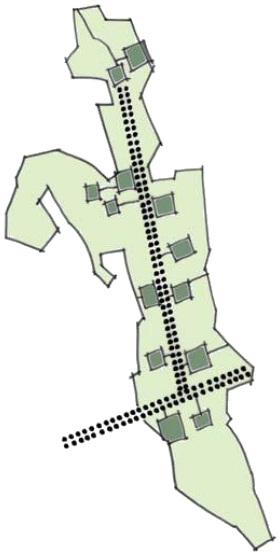

Fig. 15 Hellbrunn Park
Phase 2: Interpretation

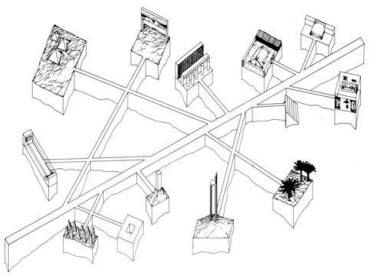

Fig. 16 Physical elements of interest | Islands

The school is located specifically in Freisaal which is in the northern part of Nonntal and also at the northern end of Hellbrunn Park. Hellbrunn Alley connects to the lawn in front of the primary school plot and to Hellbrunn Palace situated to the south.

In the 1950s, Von Victor Gruen spoke about the differences, the similarities and the qualities of city space and landscape; his contributions were relevant to raising the awareness in matters of preservation and sustainable urban developments. Those were very relevant for Salzburg as the natural landscape is a major component of the identity of this city and of other Austrian cities. (Salzburger Stadt-Landshaften 2009)

In 2009, the department of Urban Planning and Transport of Salzburg carried out a study on all spaces with cultural, ecological and historical value. The goal was to understand the potential of these areas and their soils. The first phase of the program was the SWOT analysis. Spatial and aesthetic perception, morphological conditions and usage were the factors used to classify the different units of landscape according to their particular characteristics. Then, it was possible to evaluate the pros and cons of future landscape renewal. The second phase consisted of the analysis of the data collected during phase one so that a concept for a future course of action for each and every unit of space could be established. The third and last phase of the program was to assemble a catalogue with the main priorities for realistic proposals in budget terms.

The final proposal for Hellbrunn Park has intentionally little impact on the ecological system. The trees are to be catalogued and some non permanent pieces of art are to be exhibited along Hellbrunn Alley so that it encourages the public to spend time outdoors.

It is important to mention the intentions for the intervention in Hellbrunn Park because this is the major visual threading for the school, and is also a protected green area with huge historical relevance for Salzburg.

This was originally rich farmlands due to flooding but it has suffered from numerous transformations over the years. The park underwent massive renewal and Hellbrunn palace at the southern end of Hellbrunn Alley was built. In the 18th century, the first baroque palaces were raised along Hellbrunn Alley, creating a special design that ought to be preserved. Each palace functioned as an island in the sense that they were all independent parts of a continuum and interconnected design through what are today pedestrian routes.

The first urban development in the area of Hellbrunn took place during the 20th century with the construction of the first single family dwellings and Alpen Street along the western side of the river Salzarch which surrounds the eastern side of the Hellbrunn Park as well as the area of Nonntal. The *Neue Stadt* (New

city) of the 1970s was the name given to the urban development in Hellbrunn Park between Hellbrunn Alley and Alpen Street.

3.4. School | Learning Pedagogies

The learning pedagogies described below serve as references to design the primary school in Nonntal in the sense that they offer alternative learning possibilities to children's curriculum at school, which consequently impacts the way space is designed. Recent scientific data back up the effectiveness of these new possibilities in the cognitive development of a child against the mainstream approach of frontal teaching because children learn all the time, not only when they are instructed. However, there is still no ideal answer to the way the space is to be designed.

The selected learning pedagogies refer to those used the most around the globe plus those that are most used in German-speaking countries. (Sliwka, A. 2013)

The goal was to understand the concepts behind an alternative school curriculum in order to elaborate on a spatial design solution that supported the best learning environment for children. [4]

•Social Studies
•German, Reading, Writing
•German for students with other language as mother language
•Mathematics
•Music Education
•Art Education
•Technology or Textile work
•Sport

Free Item:
•Choral singing
•Music
• Theatre
•Visual Arts
•Foreign Language
•Topics of social interest

Fig. 17 Primary school curriculum in Austria

Waldorf School | Learning by Character

The Austrian philosopher Rudolf Steiner first applied the educational concept of a Waldorf School in Stuttgart, in 1919.

Children starting school at the age of seven are put in a twelve-year program divided into three stages, each focusing on the development of social and intellectual skills through the stimulation of their talents.

Classes normally last no longer than 45 minutes and the average number of students per class and teacher is 25. However, children may be separated into smaller groups whenever they are to take practical classes.

Steiner considered that cognitive, emotional and behavioral factors were interconnected, therefore work groups consist of children assigned not only according to their cognitive abilities but also to their characters.

Artistic and creative skills are valued the same way as mathematics and other subjects.

Two foreign languages are taught from the very first year as well as arts and crafts, gymnastics, religion, computer science, music and artistic movement. Later, students are introduced to a third foreign language as well as to topics concerning economics and social awareness.

The teaching does not follow a fixed, predetermined curriculum because children are to learn at their own pace and will, regardless of their abilities and talents.

[4] The information in sections 3.4 and 3.5 was collected from works produced by other groups.

Waldorf schools are often integrative full-time schools.

Montessori school | Help me to do it myself

The educational concept of Montessori school was developed by Dr. Maria Montessori, whose work with children with psychiatric disturbances during the first half of the 20th century in Italy was the driving factor.

The Montessori school concept assumes that children have an intrinsic joy to learn. As such, children should be only motivated to keep on learning by naturally being given the opportunity to choose the topics they want to study in class. The pace should be their own and there should be neither punishments nor rewards.

This learning process is intended to help children develop a feeling of independence and self-confidence, which ends up reducing the number of teachers needed. Children are also granted the right didactic material for each situation and the freedom to sit wherever they want, even on the floor if they wish.

Montessori schools are almost always full-time schools and often offer the possibility to care for the child after school hours.

This concept was adopted by one of Maria Montessori's students and followers who adapted it to the American school system naming it Dalton School Program. (Sliwka, A. 2013)

Freinet School | Pedagogy of Work

The Freinet pedagogy goes back to the French educational reformer Célestin Freinet and his wife, who in the 1920s created a movement to reform the educational system in France. Their theories were put to the test in their own teaching practice in the south of France. The Freinet principle is rather less common in German-speaking countries.

At the core of the Freinet program, designed to create a smoother transition between life and school, lies the concept of self-willed work as the solution for everything in life. In this sense, in small classes of 15 to 20 students, children are encouraged to develop autonomy and joy in learning by working in a non-restrictive and stimulating environment individually and in groups. Based on the fact that the natural skills of a child include physical motion, cooperation and curiosity, experience is considered as valuable as books and newspapers in conveying knowledge. (Sliwka, A. 2013)

Although not every school follows a full-time program, an afternoon care service is available at almost all primary schools.

Jena School Plan| Learning in democracy

The Jena School Plan was a concept first developed in 1927 by Peter Petersen. (Sliwka, A. 2013)

The educational concept of the Jena School program is that both independent and collaborative work stimulates the social skills of a child so that he/she can become a responsible future citizen.
Children from different age groups help each other at work and at play time without ever being submitted to written evaluations. The teacher plays the role of a facilitator. This concept of learning in democracy and through experience is supposed to encourage children to grow autonomously. [5]

BIP Mehlhorn School | Learning with all senses

Started in 1997 by Gerlinde and Hans-Georg Mehlhorn the BIP Mehlhorn School is still a very young educational concept. The BIP abbreviation stands for the words *Begabung, Intelligenz, Persönlichkeit* which in English means talent, intelligence and personality, which are to be stimulated through creative learning. (Education agency of the Mehlhorn Schools)
The lessons at Mehlhorn schools are based on the curriculum of public schools and grades exist from the very first year so that children become self-aware of their own difficulties.
In addition to the regular subjects, there are also those supposed to increase creativity levels such as dance and movement, drama, chess, music and rhythm, creative writing, visual arts and computer science.
Each normal class of 16 to 20 children is granted two rooms so that regular and creative education can run in parallel.

3.5. Children between the ages of 6 to 10

Children in the age range of 6 to 10 accumulate knowledge through movement which then establishes the foundation for reading, writing and doing maths.
The entry of a child into a primary school triggers a whole new stage in his/her development; it is the introduction to new rules and daily routines.
Children begin to develop relationships with people other than their family members, overcome egocentrism[6], develop consequently a 'social self' and a constant urge of belonging. Another key aspect is that children often learn more from other children rather than from adults.
According to the theory of Piaget (Cook, J. and Cook, G. 2005) on the logical model of intellectual development, a person perceives reality differently according to his/her stage of development, which is determined by age. At the age range of 6 to 10, children are at the concrete operational stage

[5] On the basis of scientific studies on more effective and innovative ways to learn, the Centre for Educational Research and Innovation (CERI) carries out the Innovative Learning Environments project (ILE), which aims to improve the learning environment of children and young people. (Organisation for Economic Co-operation and Development 2012)

[6] According to the theory of Piaget on the sociological development.

which means that they are able to tell general outcomes from the observation of concrete matters (inductive logic) associated with a more scientific view of matters. Only later will they be able to predict a concrete outcome from the observation of a general matter (deductive logic).
One could assume that the development of concrete operations coincides with the beginning of primary school. Naturally, there is a constant need to recreate ideas formed in previous stages and keep moving forward into more advanced ones.
Six to ten year old children show differences in social behaviour specific to their sex gender. However, both boys and girls commonly prefer to play with children from the same sex and tend even to avoid contact with the opposite sex. While six year-old boys play in larger groups, willingly take risks and strive for dominance, girls prefer to play in smaller groups in a calmer environment.
Children at this age handle longer dialogues and are able to adapt their attitude and topics of conversation to the other person's. They can also control the expression of their own emotions and understand that it doesn't always reflect one's true feelings. Children understand that different situations may cause different emotions in people.
Participation in sport activities is explained by the growing control over their own body whose appearance begins to matter between the ages of 8 and 9 when feminine and masculine physical features start to show. The concern for one's image, popularity or success in doing sports can deeply affect the self esteem and the performance in school. Parents are much needed for psychological support throughout this period of a child's life due to all these challenges.

Age	Sex	Average Height (cm)
6	Boy	121,2
	Girl	120,7
7	Boy	127,9
	Girl	126,4
8	Boy	133,8
	Girl	132,4
9	Boy	138,7
	Girl	138,0
10	Boy	143,9
	Girl	144,2

Fig. 18 Average height of a child between 6 and 10

3.6. Case Studies

To study a case is the opportunity to use an already built project as a source of reflection, therefore it should follow the investigation of a new project. It also helps to consolidate some of the ideas and solutions created either because of similarities or differences.
The two cases chosen to be studied were the Primary School in Bad Blumau and the Sandal Magna Community Primary School in Wakefield because of the similarities with Nonntall, Salzburg in:

- the urban context;
- the size of the plot in sqm (around 2000 sqm);
- the functional program.

In addition Sandal Magna Community Primary School is an 'eco flagship school' (to learn in it and with it) and in 2011, its carbon emission rate was the lowest in the UK.

These case studies offer a spatial solution to the learning pedagogies described in section 3.4 as they all share the same ideological root: children are always learning.

The information on both case studies includes a brief description of the context, concept of the project and the relevant specific aspects to each one of the projects. Their selection was based on:

- the quality of the drawings and written information collected;
- both projects fit into an historical urban and natural context;
- the fact that they offer different spatial solutions to similar pedagogic concepts;
- they are sustainable projects;
- they are both full-time primary schools.

3.6.1. Primary School in Bad Blumau, Graz

Fig. 22 Forecourt in between the Sports Centre on the left and the school on the right

Fig. 19 Main entrance

Built in 2010, Bad Blumau Primary School is a project of the two architects Wolfgang Feyferlik and Susanne Fritzer who studied at TU Graz and now work in Graz. It was picked as a case to study because it was close to the urban centre of Graz and its functional requirements fell in the same line of thought as that of the Primary School in Nonntal.

On closer inspection, it was easy to identify the following points in common:

- a new building replaces an old one;
- the plots are both located amongst a rural and natural environment;
- the layout of the school plot in Nonntal suggests the construction of an elongated building which the School Bad Blumau is an example of;
- the School Bad Blumau is also a full-time school, therefore having to respond more or less to the same set of pedagogical and legal requirements.

Fig. 20 South-western façade

Fig. 21 North-eastern façade

Fig. 23 Recreation area

Fig. 24 Niches on the walls between classrooms and recreation area

Fig. 25 Atmosphere inside a classroom

Fig. 26 Classroom; view to the outside

Fig. 27 Classroom, view to the recreation area

This school is now recognized by parents and professionals as a successful school in terms of its integration into the context of the area and the quality of the learning environment.

The winning project at the public tender for the development of Bad Blumau was for the construction of two new buildings, the school and the Sports Centre for the use of the community in general.

The original school building was from the 19th century. It failed to comply with modern standards (e.g. thermal) and it was not big enough to respond to the requirements of the growing community.

The concept behind Bad Blumau is the one of greater mobility in schools.

The school is divided into two areas, one is the main building and the other is the gym. The school façades, interior organization and scale (one story high) respect the natural and urban context.

The functional organization of the building was mainly determined by the views children would have to the outside from inside the classrooms and by the need to have enough indoor and outdoor space for children to run, play and learn.

The buffer zone (recreation area), which is used for various activities, connects classrooms on the south-western side and on the opposite side, the service areas along both sides of the entrance. The cloakroom is at the entrance.

The classroom can be used for frontal tuition as well as for other more liberating activities. Each classroom has its own outdoor terrace which adds extra space to the classroom and gives children the opportunity to stay inside or to go outside during tuition and relaxation periods. Daylight was supposed to be the main form of lighting inside the classrooms.

The floor and walls are viewed as usable space for sitting down, playing and learning.

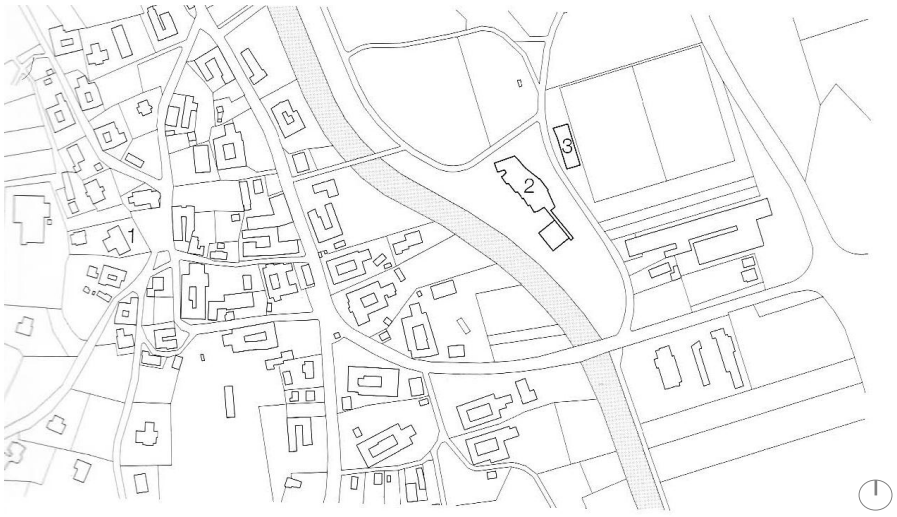

Fig. 28 School Bad Blumau site location

1 Forecourt
2 Sports Club
3 Entrance to the school
4 Cloakroom
5 Classroom
6 Terrace
7 Workshop
8 Storage
9 Recreation area
10 Mechanical services
11 Afternoon care
12 Reading recess
13 Raised area with play equipment
14 Teachers' room
15 Playground
16 Gym

Fig. 29 Plan

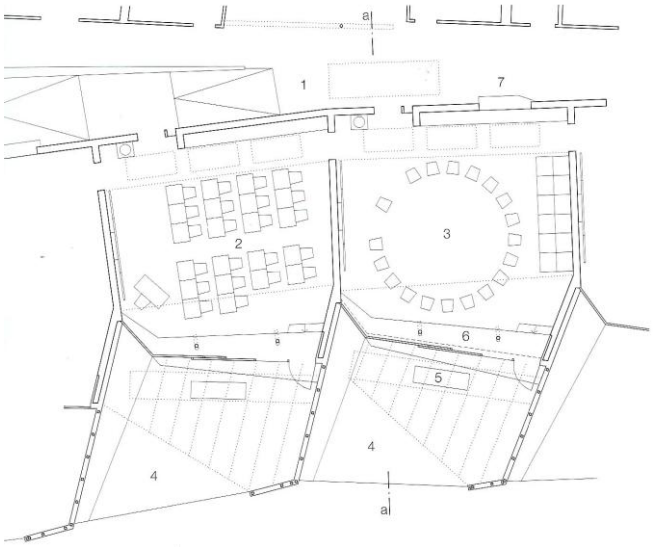

Fig. 30 Plan of two classrooms with its terraces

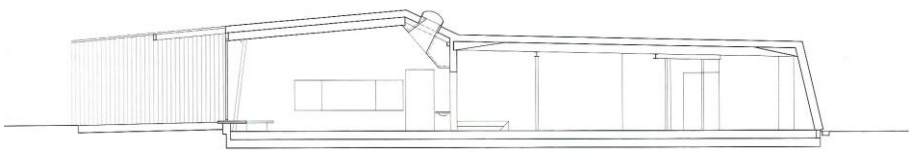

Fig. 31 Section aa'

3.6.2. Sandal Magna Community Primary School in Wakefield, England

Fig. 32 'Sreet' between buidings

Fig. 33 Building of the classrooms

Fig. 34 Classroom window

Fig. 35 School view from South-west

Fig. 36 Context

Built in 2010, Sandal Magna Community Primary School is a project of Sarah Wigglesworth Architects. It was picked as a case to study because its concept and construction reflect sustainable thinking and its functional requirements fell in the same line of thought as that of the Primary School in Nonntal.

The points in common were:

- an old building had to be replaced by the new construction;
- the history of the surrounding area had to be preserved;
- the design had to be harmonious with the urban/residential and natural context;
- the materials used were of the same type as those used to build traditionally in the area;
- the constructive solutions required were not complex;
- energy efficiency was a requirement;
- it is a long-lasting solution to house a full-time school.

In favour of a better learning environment for children, Sandal Magna Community Primary School is the outcome of the discussions held between architects, parents, locals and teachers. It is now recognized by parents, teachers and children as a successful school in terms of its integration into the context of the area, the quality of the learning environment and the respect for the sustainable requirements.

The project layout consists of three buildings fairly parallel to each other and perpendicular to the street which grants access to the property. The buildings are connected by an indoor continuum corridor. In between each building there are outdoor spaces which serve as extra external play space.

The building more to the north accommodates the classrooms and the building more to the south accommodates the offices for teachers. In between these, there is the building of the main entrance with the required service areas such as the cloakroom, community room, play rooms, toilets and hall.

The location of the buildings in relation to each other and its functional organization was mainly determined by the sun and by the need to have enough comfortable outdoor space for children to run, play and learn.

The former school building was from the 19th century and it was built in a Victorian style. Its classrooms were too big to be intimate and warm. The new design was meant for 210 students from the ages of 5 to 11, for an extra 26 children who would attend the nursery and for adults who would attend classes at the community room.

The concept behind Sandal Magna Community School is that of a safe learning environment for children. The school design follows the concept of the street layout as buildings are designed with fronts and backs.

The school buildings are separated by outdoor spaces and connected by a corridor which is transversal to all of them. These in-between spaces encourage children from different age groups to meet and learn together. The straight layout avoids hidden corners and blind spots.

Classrooms enjoy direct access to the outdoor playgrounds, views to the outside, daylight and natural ventilation.

The temperature of the indoor space changes according to its orientation, size and use of materials.

The change in size of the windows and the ceiling height is due to the building orientation and internal use.

The roofscape of the single-storey buildings is dominated by the ventilation chimneys that align with the residential context of the area to the north.

Part of the brief of the public tender was to make the building a demonstrative tool for learning about buildings and sustainability, therefore most building elements such as ventilation, soundproofing and sprinklers are all visible.

The sustainability features of the school include:

- completely natural ventilation;
- a ground source heat pump to provide heating, hot water and cooling which is powered by 100 sqm of photovoltaic solar panels;
- a masonry structure providing thermal mass throughout the classrooms;
- reuse of reclaimed bricks from the old school in retaining walls and garden features.

Fig. 37 Classroom

Fig. 38 Corridor of the classrooms

Fig. 39 Hall

Fig. 40 Sandal Magna Community Primary School site location

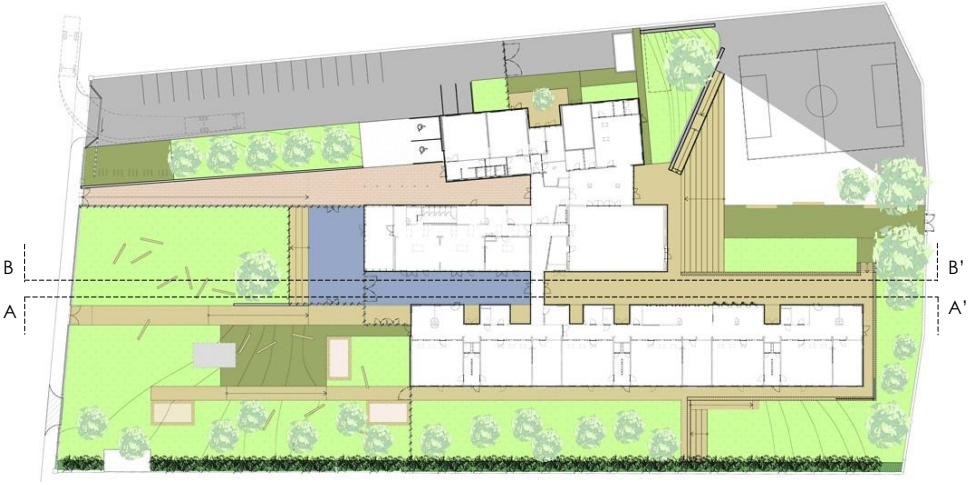

Fig. 41 Plan of Sandal Magna Community Primary School

Fig. 42 Section AA'

Fig. 43 Section BB'

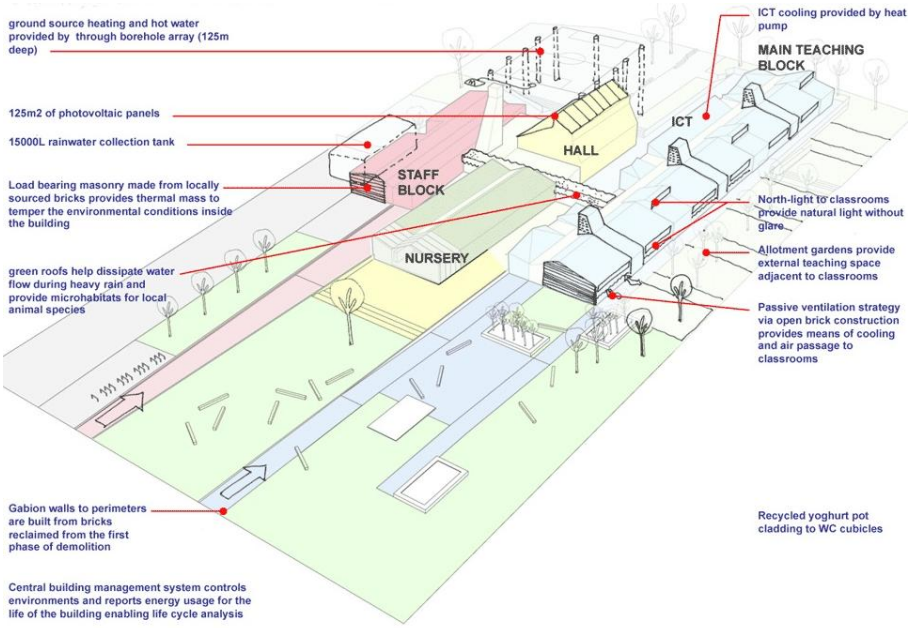

Fig. 44 Scheme of Sandal Magna Community Primary School

To build sustainably is the only way ahead of us so we must learn how to overcome the prejudice of a non existing possibility for a green good aesthetic in a building and create it instead of letting the architecture profession "fade into obscurity". (Adams, C. 2002)

04 Project|Process and Proposal

It is currently accepted across the globe that man's unsustainable activities, namely those that produce emissions of carbon dioxide into the atmosphere, cause changes to the climate and to the landscape.[7]

In their quest for continuous improvement of material comfort, such as maintaining moderate temperatures throughout the year (air conditioning, heating, etc) men and women have not hesitated to burn increasing amounts of fossil materials. Continuing on this path would take humanity to a dead-end, meaning that quality of life of future generations would be at stake, therefore taking alternative paths became a must. Two of those alternative paths are undoubtedly:

- to use renewable energies like the sun, the wind or running water;
- to reduce the levels of consumption of energy by adopting different ways of living, for example public transportation rather than cars or building with environment-friendly materials and with the right light and wind exposure.

4.1. Methodology

As is said by Maurice Cox in the documentary Archiculture:

"You don't go into architecture if you are pessimist, if you actually believe the world can't get better." (Arbuckle Industries 2013)

The work was driven by the fact that it is imperative not to have only sustainable thinking towards architecture but also that architects have to act on that thinking, otherwise they will be replaced by other professionals who will end up destroying the image of cities because of their lack of aesthetic knowledge.

The personal research process began with the reading of the Directive 2012/27/EU on energy efficiency and the Directive 2010/31/EU on energy performance of buildings edited by the European Union. In 2011, buildings in the European Union were estimated to represent 40% of the total consumption of energy therefore it is easy to conclude that they have a major impact on the environment.

In addition to sustainability concerns, two other factors made the Green solution the right response both to the program of the municipality of Salzburg and the program of the Master Studio. Those factors were:

1. Austrians are environmentally educated and feel strongly about nature;
2. The Salzburg environment context already has some balance and harmony with nature, therefore it had to be respected.

[7] The Summary for Policymakers released in September 2013, which is a summary of the IPCC's Fifth Assessment Report (AR5), states on page 14: "Human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system." (Intergovernmental Panel on Climate Change 2013)

The already existent design principals of a Green School, capable of both improving the energy performance of a building and also the way children learn, were reviewed and were to a certain extent applied to the project.
The following thoughts and experiments related to the development of a sustainable building, the passive design of which would reduce energy consumption. One had to build on the know-how gained by studying traditional architecture as well as the geographical and climate conditions of the location.

4.2. Analysis | Guidelines

4.2.1. Directive 2012/27/EU on energy efficiency

This directive establishes minimum requirements for the improvement of energy efficiency in the Member States until 2020, from the production to the consumption stages. However, the key to limit climate change, to decrease the dependence on energy imports and consequently to overcome the economic crisis is to reduce the levels of energy consumption at a higher rate than the rate of investment in renewable forms of energy. Taking the values of 1990 as the reference point, the European Union established the goal of reducing 9% of energy consumption by 2013, 20% by 2020 and 80% to 95% of the greenhouse gas emission by 2050.
On the one hand, each Member State is free to establish its own regulations and programs to improve energy efficiency, on the other hand the European Commission has the role to ensure that the programs are being followed and that the targets are being reached. In this sense, the directive highlights, among others, measures comprising the role of the Member States in saving primary energy[8], in renovating buildings so that they become more efficient and most importantly in "thinking small first" (Directive 2012/27/EU, s. L 315/7) because it is impossible to invest in applying all needed transformations at once.
In 2010 and again in 2011, it was concluded that the target for 2020 was not on track but should still be reached.[9]

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[8] "Primary energy means energy from renewable and non-renewable sources which has not undergone any conversion or transformation process." (Directive 2012/27/EU on energy efficiency, s. 153/18)
The primary energy of Salzburg will be produced by a hydroelectric power plant built on the left bank of the river Salzach. This project was approved by UNESCO after the assessment of the Heritage Impact Assessment (HIA) reported its minor impact in the environment. (UNESCO World Heritage Centre 2013)

[9] The latest Emissions Gap Report in 2012 shows that "countries unconditional pledges to reduce GHG_s emissions, if fully implemented, will deliver no more than one third of what is needed by 2020 to prevent a dangerous 2° C rise in global mean temperature above pre-industrial levels." (European Commission 2012, p.2)

4.2.2. Directive 2010/31/EU on energy performance of buildings | Implementation in Austria

The European Union needs to comply with the agreements made at the Kyoto Protocol in 1997 which include keeping the rise in temperature below 2°C and reducing greenhouse gas emissions by 20% by 2020 compared to the values of 1990 or 30% if an international agreement was established.

Since in the European Union buildings represent 40% of the total energy consumption and in the world 50% of the total carbon dioxide emissions, great effort should be put into improving their energy performance both by encouraging the use of energy from renewable sources and by reducing their energy demands. In 2007, it was even decided that 20% of the energy consumption of a building should be provided by renewable sources.

The 2010/31/EU directive promotes the need to improve energy efficiency in the European Union to the point of nearly zero-energy demands and zero-carbon emissions from both old and new buildings and addresses the stipulation of minimum values and parameters to attest their energy performance, issue energy certificates and lead inspections.

On the basis of European standards, which include taking the context into account when designing a building and in assessing its energetic response, Member States are responsible for establishing new efficient systems and programs as well as minimum requirements in evaluating the energy performance of a building. This methodology should in any case take at least the following aspects into consideration:

(a) thermal characteristics of the building including its internal partitions:

(i) thermal capacity;

(ii) insulation;

(iii) passive heating;

(iv) cooling elements; and

(v) thermal bridges;

(b) heating installation and hot water supply, including their insulation characteristics;

(c) air-conditioning installations;

(d) natural and mechanical ventilation which may include air-tightness;

(e) built-in lighting installation (mainly in the non-residential sector);

(f) the design, positioning and orientation of the building, including outdoor climate;

(g) passive solar systems and solar protection;

(h) indoor climatic conditions, including the designed indoor climate;

(i) internal loads.

Whenever relevant, the following aspects should also be considered in the calculation process:

(a) local solar exposure conditions, active solar systems and other heating and electricity systems based on energy from renewable sources;

(b) electricity produced by co-generation;

(c) district or block heating and cooling systems;

(d) natural lighting.

(Directive 2010/31/EU, Annex I)

The German Passive House standard (Passivhaus 2013) which was also widely adopted in Austria, focuses more on minimising energy consumption by adapting a building to the outdoor climate rather than ensuring its maximum optimization. In order to save energy, this model assumes highly insulated exterior walls so that the interaction between outdoor and indoor spaces is minimized and a shield against all weather conditions is created. This idea can be globally adopted but unfortunately it reveals a lack of consideration for traditional architecture and local factors. To make it clearer, the point is that the Passive House is a model built the same way all over.

It should be clear that in most Member States, most developments towards innovation and adoption of sustainable solutions in construction came as a consequence of the implementation of the first EPBD in 2002. However, Austria already had good energy performance prior to the implementation of the EPBD.

Despite the need for some adjustments in the systems for assessing the energy performance of buildings, major efforts were put into harmonizing the building codes and energy regulations specific to each one of the nine different provinces of Austria, so that the outcome was a single one. The way to assess energy efficiency is by comparing the calculated values with pre-established minimum values. If they meet the requirements, an energy certificate, the leading indicator of which is heat demand, is issued with an overall grade that for all new buildings in 2012 had to be at least B in a table of nine grades starting at A++, but is due to be A+ by 2020. In the current economic scenario, it is accepted that efficiency levels of an existing building stay constant.

An important point to make is that the Austrian government offers economic incentives to support the building industry to adapt to the new energy requirements.

4.2.3. Green School Concept

The Centre for Green Schools is an American association created with the purpose of making schools better places to work through the application of concepts of sustainability and by ensuring that the whole environment created in the school is healthy.

Rachel Gutter came up with the definition of a green school:

"That creates a healthy environment that is inclusive to learning while saving energy, resources and money." (Center for Green Schools, 2013)

The term Green School then went 'viral' and many associations and institutions all around the world opted for that same green goal when building new schools or when converting old schools.

A wider definition points out that the school should do as said before by:

- conserving energy and natural resources
- saving taxpayers money
- Improving indoor air quality
- removing toxic materials from places where children learn and play
- employing day lighting strategies and improved classroom acoustics
- employing sustainable purchasing and green cleaning practices
- Improving environmental literacy in students
- decreasing the burden on municipal water and waste water treatment
- encouraging waste management efforts to benefit the local community and region
- conserving fresh drinking water and helping manage storm water run-off
- encouraging recycling
- promoting habitat protection
- reducing demand on local landfills

(Center for Green Schools 2013)

This list of actions was created on the basis of information obtained from studies developed over the years on the way children learn. The following aspects integrate the results of those studies.

How students hear

Research by the Acoustical Society of America (ASA) in 2009 proved that there is a connection between proper acoustic performance in schools and the way children hear and consequently learn. (Center for Green Schools 2013)

How students see

It has been known for a long time that less daylight has negative implications on people but with the energy crisis of the 1970s, schools were designed with fewer windows and at the time, other than the complaints from teachers and students, no direct link was found between less daylight and students' performance (Baker, L. and Bernstein, H. 2012) "However one study found out that students with no access to natural light show a delay in seasonal cortisol production, a hormone that is positively associated with concentration abilities" (Kuller, R. and Lindsten, C. 1992).

Another well-known aspect is that students with short distance views can develop eye-strain problems. Long distance views are needed to keep eyes healthy. Another study by the Heschong Mahone Group in 2003, found out that there is also a relationship between classroom views to the outside and academic performance.

How students feel

Although it is known that people react differently to the same thermal conditions and that individuals prefer to have control over those conditions, it is normally accepted as a norm that one should look for a neutral thermal environment in schools as revealed in 2002 in a study by Schneider (22°C, 50% humidity and 2 air renovations per hour).

A study by Zuraimi et al. in 2007 revealed that neutral air-conditioned spaces may also not always be the best for student health. One other piece of research also indicated that even small temperature changes can have an impact on student performance.

How students think and learn

Performance at school is normally related to children's upbringing history. However a recent study carried out at a school in Connecticut near a construction site showed that not only socio-economic and sociological factors affect the performance of children in the long term but environmental disturbances do too (Neilson and Zimmerman, 2011).

How students move

Obesity is a growing problem during childhood (Center for Green Schools 2013) although little information still exists about the impact a specific school configuration and design would have in fighting it. However, it is known that the location of a school in a community, for example with short commuting times to the students' homes, encourages parents to let their children walk or bike.

4.3. Analysis | Intervention Area

The visit to the site location was essential to understand the atmosphere lived in Salzburg in general and in Nonntal specifically. For the visitor, the first impact is caused by the well-preserved historical buildings and the many tourists in Salzburg city centre. In Nonntal, the aspects that catch the eye are the harmony between nature and housing and the presence of students of all ages going back and forth, playing or heading towards the Old Town.
It was important to understand the visual and physical connections to the various parts of the city and surrounding mountains so that the final design could exploit its qualities. As such, the analysis was based on different scales so that the final 1:200 scale design could preserve both urban and natural links.

Fig. 45 View of the Hohensalzburg from the rooftop of the university

4.3.1. Location

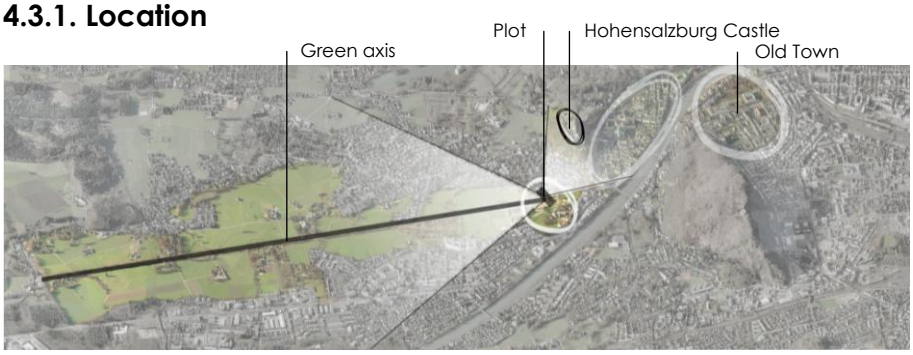


Fig. 49 From left to right: Green Axis, Nonntal, Hohensalzburg, Old Town

University - Akademiestraβe

Fig. 46 Pedestrian path

Fig. 47 School buildings to demolish

Fig. 48 Construction works

Further information is provided in chapters 3.2 and 3.3.
Hohensalzburg Castle, which is located at the top of Nonnberg, is a reference point or a landmark[10] for the people of Salzburg as well as for tourists. Other strong visual references include the mountains that physically constrain the Old Town and the Alps that almost surround the city completely.
First of all Nonntal is almost perfectly located logistics wise since it is a short walking distance from Salzburg town centre (Old Town), secondly it has very good road and pedestrian connections to any part of the city as well as good access to public transportation stops, and thirdly it enjoys a privileged view over a green axis (~5 kilometres long) with the Alps in the background. This environment conveys a feeling of respect for the truth of local and natural features.
The general conclusion at this point of the visit was that the primary school was going to sit on the border between the green axis and the city. As such, it had to balance the two different realities.

[10] Kevin Lynch in The Image of the City defines landmark as "another type of point reference, but in this case the observer does not enter within them, they are external." (1990, p.48)

4.3.2. Impressions

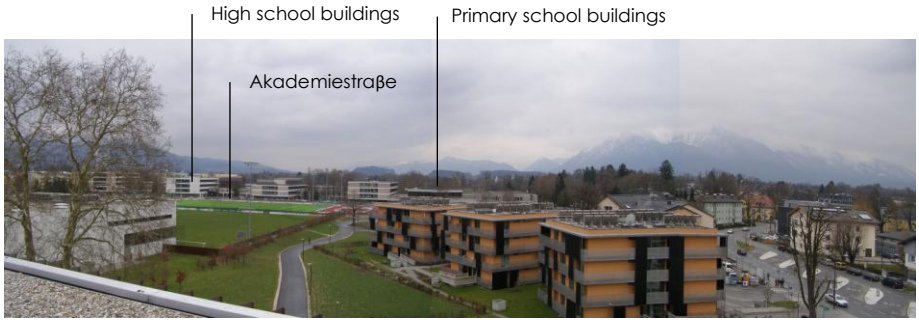


Fig. 54 View of the Unipark Nonntal from the rooftop of the University

Akademiestraβe

Fig. 50 Secondary school buildings

Fig. 51 Building to demolish

Fig. 52 View to the green axis from the school plot

Fig. 53 Pedestrian path

The Salzarch River is not visible from the site location but the river-side road is the easiest and fastest way to reach Nonntal by car. Nonntal currently sits on one of the river's neighbouring fields on its western side.

The two functional morphologies of buildings in the area include housing and schools. While houses tend to follow a design of pitched roof with two stories on average, the school buildings are built in concrete, free of decoration and have clear linear façades.

Even though the area is populated mostly by families with children due to the proximity to schools for all age ranges, the place still radiates a strong feeling of serenity, in part due to the fact that cars are not allowed on the academic compound (Unipark). The regular traffic circles the neighbourhood and local traffic is almost exclusively teachers, locals and parents who drop off their children at school.

There is a clear sense of safety, therefore children walk between home and school; they also play outside freely. One feels more of a countryside environment rather than a city environment.

Prior to the construction of the Unipark, the academic compound was formed by a cohesive group of school buildings along Akademiestraβe. Those buildings had a particular, recognizable image and were functionally and physically interdependent. Recently the buildings started to be demolished, renovated or replaced by new buildings which have no recognizable identity because they are all different from each other. The high school buildings and two others located on the primary school plot are still part of the previous model that are still due to be replaced.

As a result of the demolition of the old buildings, the green areas within the park are now a continuation of Hellbrunn Alley up to the primary school.

Despite the works, it was easy to ascertain the truth of the place: there is complete harmony between people and nature.

4.3.3. Connections

Distance (km)
Mirabellplatz 2,0
[Old Town in the east bank]
Main Train Station 3,0
Hellbrunn 3,4

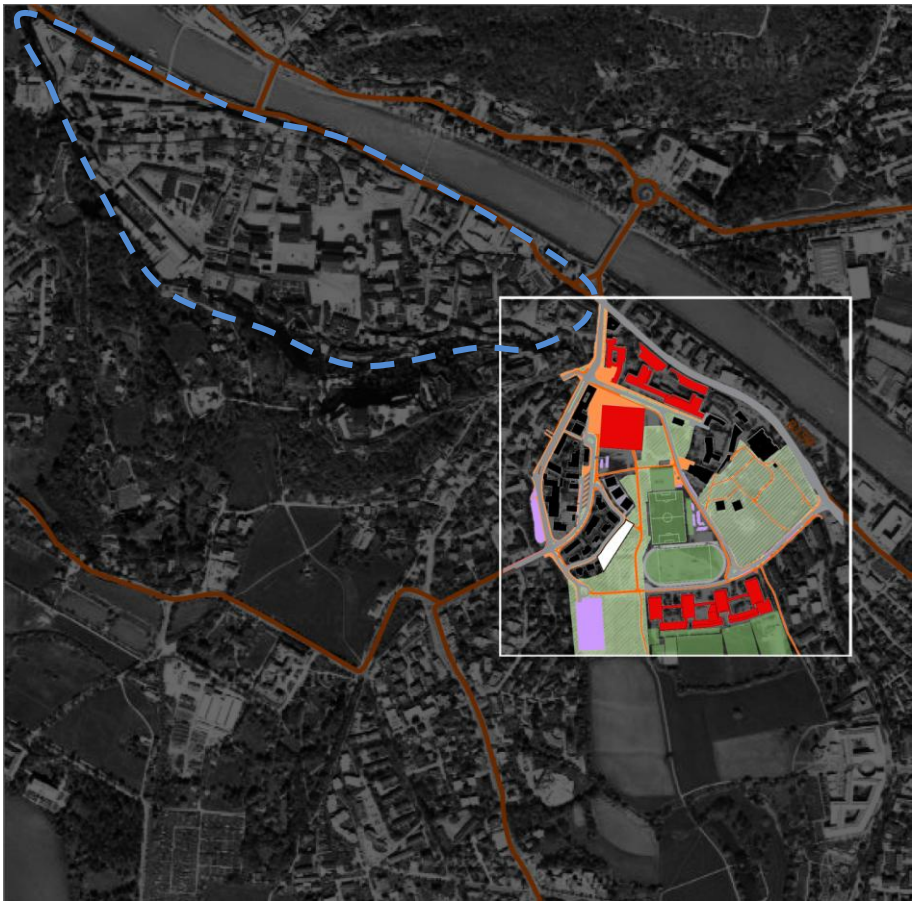
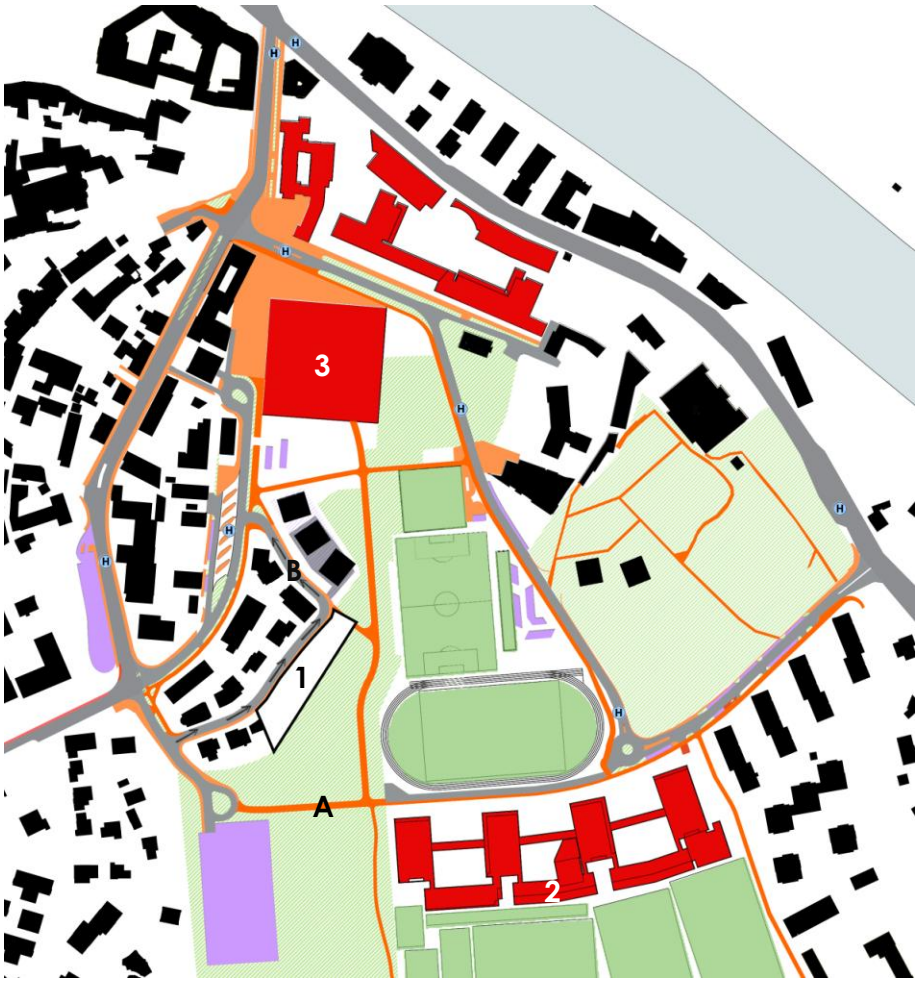


Fig. 55 Physical connections

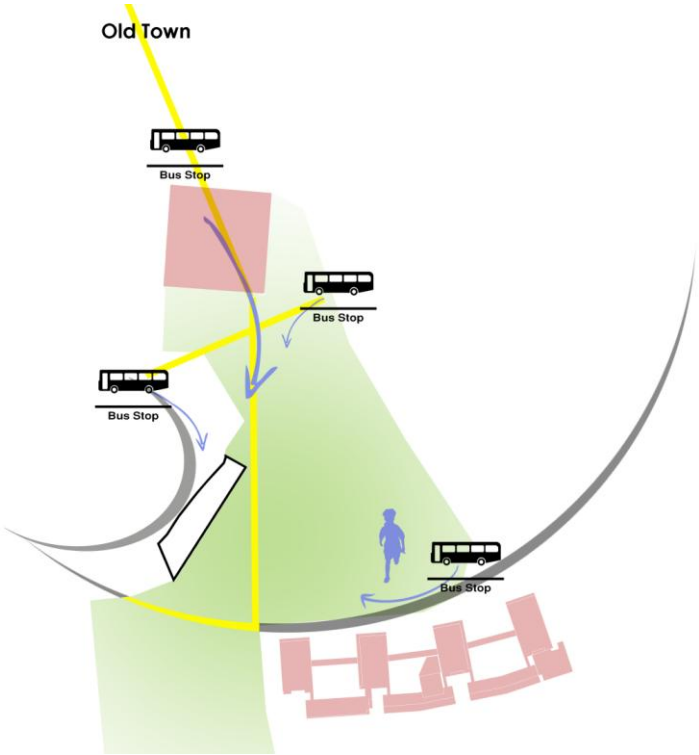
Most children walk to school or take the bus. The bus-stops are close to the school and the pedestrian and bicycle paths which connect both are safe and short.

A clear understanding of which were the main routes used by children to get to school helped to determine the best place to locate the main entrance of the building.



A Akademiestraße
B Mühlbacherhofweg
1 Plot
2 Secondary school
3 University
Education
Sport Centres
Green Areas
Roads with car access
Parking
Pedestrian and bicycle paths
Pedestrian paths
Viktorkeldorferstraße
[One way street]
Bus stops (Haltstelle in German)

Fig. 56 Analysis of the study area



Pedestrian paths
Main access by car
Green areas
Children's movement upon arrival on Campus

Fig. 57 Children's flow

4.3.4. Plot Restrictions

Viktor –Keldorfer Straβe

Fig. 58 One way street, parking on one side

Fig. 59 Building to demolish

Fig. 60 Housing

Fig. 61 Only car access to the school

Fig. 62 Intersection with Mühlbacherhofweg

Fig. 63 Plot

The grey area circled red in Fig.63 shows the construction plot. Although the program of the competitive tender required for the perimeter of the building to keep a distance of 4 meters from the actual plot boundary, the Master studio program discarded it so that there were less physical constraints.

The outer dashed red line marks a boundary between the intervention area and its surroundings so that natural ventilation and daylight was assured to all surrounding houses. The distance between the perimeter of the school building and the dashed red line had to equal a minimum ¾ of the height of the building.

A house right at the boundary of the school plot on the southwest side forces the distance between school perimeter and gable to be kept. There are no restrictions to building on the boundary line of the other sides of the plot because they are open land.

Parking on the street is permitted, the reason being that an underground car park to serve the school cannot be built by law. Viktor-keldorfer Straβe is the only street with car access neighbouring the school plot; it is narrow, therefore only a one-way street.

The lawn lateral to the school on the opposite side to the street side cannot be used as a playground for the children of the primary school because it is outside the school grounds.

4.3.5. Conclusion

Fig. 68 Potential

- The green lawn had enormous potential but could not be used by the primary school as extra playground area.
- The law would not allow the building of a physical connection between primary and high schools other than with a bridge.
- Both primary and high schools would undergo distinct interventions which would increase the already existent aesthetic and physical disconnections within the academic compound.
- The design of the school should highlight the views over the castle, green axis and mountains.
- It would not make sense to preserve those two building still standing on the primary school plot because they were part of a set of buildings from the past that were either demolished or transformed.

Akademiestraße - University

Fig. 64 View of Kapuzinerberg

Fig. 65 Intersection with Mühlbacherhofweg

Fig. 66 University

Fig. 67 View of Hohensalzburg

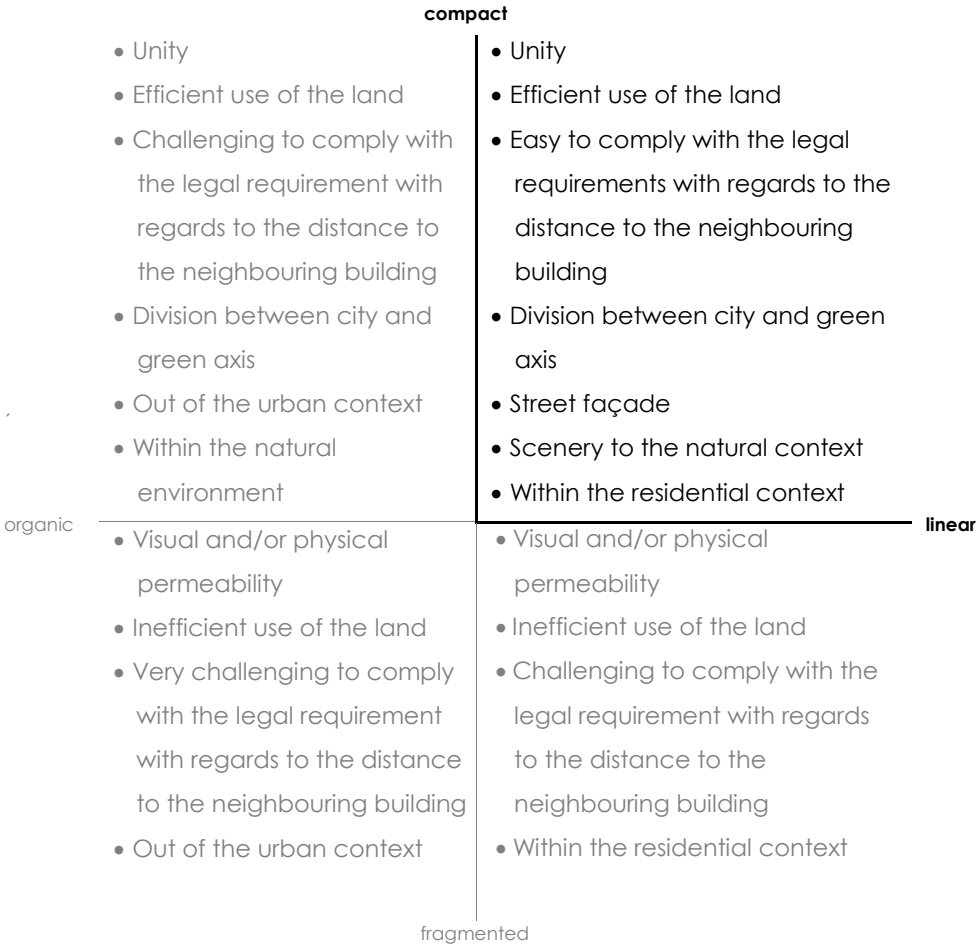
4.4. Conceptual Approach

Plot

The physical and legal limitations of the plot, the scale of the surrounding buildings and the natural context of the area suggested a low rise building, compact but elongated. However, further investigation had to be carried out to consolidate this interpretation.

The following table synthesizes the pros and cons of each possible design:

- organic and compact;
- organic and fragmented;
- linear and fragmented;
- linear and compact.



The sequence followed to decide between the different design options was:

1) As opposed to the organic design, the linear design would match and therefore integrate into the regular urban street pattern of Nonntal.
2) The fragmented linear design offered a visual and/or physical permeable solution between city and green axis. On the other hand, the compact linear design had the power to become the scenery for the

green axis and the scenery for the residential neighbourhood as it would also become the connection between the two realities.

3) The playground had to be outdoors and the school had to keep a distance away from the building on its south-western side. The playground could keep the distance between school and neighbouring building in an obvious fashion if the building was to be compact and pushed to the opposite side of the plot.

In fact, based on the reflection presented above, the linear and compact design came out to be the chosen solution. Correspondingly, the parking spaces would be on the street in order to have the school building utilizing the full plot.

Learning pedagogies

The overall concept chosen to serve as the guide was that of learning through movement, experimentation and interaction. The intention was to improve the intellectual capacities of a child between the ages of 6 and 10 by developing his/her intrinsic abilities; as was studied by Piaget, Maria Montessori and others in our days and in the past. The question stood: How?
The design had to translate into the creation of the physical environment most suitable for the learning pedagogies described in chapter 3.4, and also in line with the Austrian curriculum for regular schools.
This information is addressed below and it is organized by school pedagogy, its relevant aspects and the specific response to them.

Waldorf School pedagogy

A class may be separated into smaller groups whenever they are to take practical classes:
The project has to have classrooms of different sizes to house groups of sizes.

Montessori School pedagogy

Mixed age groups:
Play space has to enable the contact between children of different age groups.

Children are able to learn wherever they want:
Each group of twenty children has to have a permanent classroom but they are still free to learn wherever they feel most comfortable. All common spaces are to be open and of free access. Among others there would be a library, a music room and a multifunctional room. In this sense there would be no corridors but areas where one can stay or wander around.

Jena School Plan pedagogy

The teacher plays the role of the facilitator:

The teachers' area is to give easy access to the children but not of mandatory transit.

BIP Mehlhorn School pedagogy

In addition to the regular subjects there are also those supposed to increase creativity levels such as dance and movement, drama, chess, music and rhythm, creative writing, visual arts and computer science:

The gym is to serve as a stage for physical and intellectual activities as well as for parties and sports events.

Freinet School pedagogy

Small classes of 15 to 20 students, children are encouraged to develop autonomy and joy in learning by working in a non-restrictive and stimulating environment:

A central recreation area (buffer area) aims at encouraging children to come together to play and learn.

The ultimate interpretation is that:

Movement	Experimentation	Interaction
↓	↓	↓
Needs space	Needs matter (to experiment in and with) and freedom	Needs opportunity

Case studies

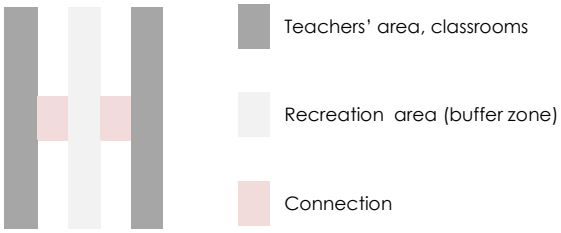
The Primary School in Bad Blumau and the Sandal Magna Community Primary School are concrete examples of the concept of learning through movement, experimentation and interaction because they have:

- enough outdoor and indoor space to let movement happen;
- different spaces with different capabilities and atmospheres to allow experiments and create opportunities to socialize.

Sandal Magna Community Primary School was even intended to be an 'eco flagship school'. Taking the risk of being too simplistic, the design of the two schools can be communicated with two diagrams.

The design of the School in Bad Blumau is summarized into:

The design of Sandal Magna Community School is summarized into:



In both cases, the buffer zone is placed in between other functions as it is in fact a form of distribution path, a 'street'. In Sandal Magna Community Primary School there are actual outdoor streets in between the different buildings. The idea of a street inside a school then became very appealing and ended up being reinterpreted. In Nonntal, the 'street' became the central space (outdoors and indoors) of the design and its spine.

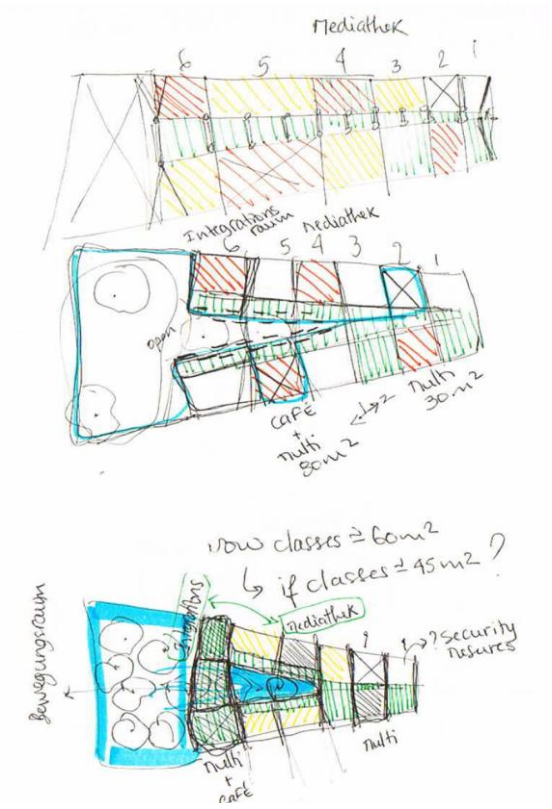


Fig. 69 'Street' concept reinterpreted

Further aspects present in the case studies and important to the specific situation of a sustainable school in Nonntal are the following:

- the classrooms have direct visual access to the outdoor green space;
- the classrooms have natural light capabilities which diminish the need for artificial lighting;
- the building has natural ventilation;
- the construction materials chosen are responsible for a good thermal gradient.

4.5. Strategy

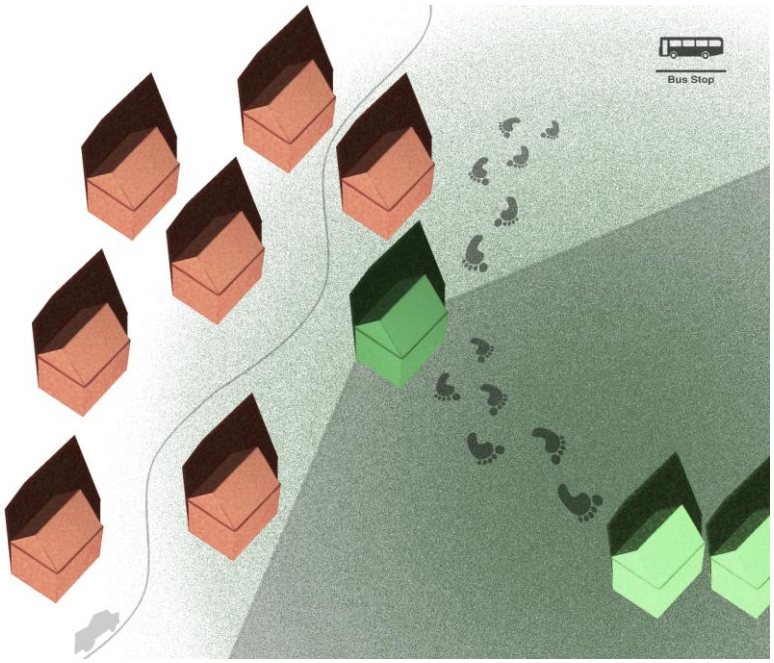


Fig. 70 Schematic analysis

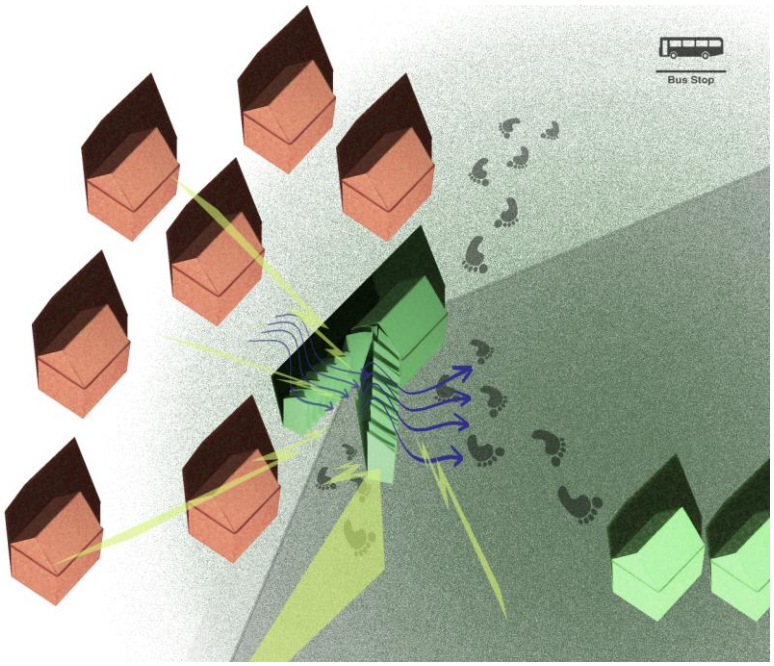


Fig. 71 Schematic strategy of the intervention

The concept had to be developed on the basis of the overall information collected so far from the analysis made both individually and in group. It was important to respect the relationship between urban centre and nature, geographical location and climate, locals and students, children and the learning environment. Furthermore, the shape could also relate to the surrounding houses; after all, harmony was a key factor.
The concept was that part of the roof would slide in order for the interior space below to be alternatively indoors or outdoors according to the will of the teachers and the children and obviously according to the weather too. This covered/open space would become the multifunctional buffer zone between service areas and classrooms, whose scale would permit permanent physical and intellectual activities at all times.
Meeting the previously mentioned standards on energy efficiency before 2020 was also one of the targets established.

> Briefly as mentioned before:
> The Directive 2012/27/EU on energy efficiency states that the European Union has to reduce energy consumption by 20% by 2020 and 80% to 95% of the greenhouse gas emission by 2050 taking the values of 1990 as reference.
> The Directive 2010/31/EU on energy performance of buildings is more specific and establishes guidelines for the European countries to follow so that the temperature rise is kept below 2°C and the green house gas emission is reduced by 20% by 2020 or by 30% if an international agreement were established, also with the 1990 values as reference.

The design strategy established was then:
- to let the building embrace its role as the intermediary between two very different realities (green axis and city);
- to take advantage of the preferential wind direction which is on average perpendicular to the longer side of the school plot, so that the different pressures produce natural ventilation and remove the need for mechanical/electrical devices ;
- to organize the layout according to the journey of the sun during the day so that the heating needs would be naturally fulfilled as much as possible;
- to place the classrooms facing the green area since it is known that this way children are able to focus more and therefore learn more easily;
- to have independent functional and climatic areas within the school building;
- to minimise the heat losses through the building envelope;
- to create space that could allow children to run and play freely both outdoors and indoors;

• to place the main entrance within direct reach of the street to allow parents access without having to walk around the building;
• to place the gym away from the classrooms to prevent children in class from being distracted by the noise.
The goal to be reached with this strategy was to create a primary school that would fit the Nonntal and Salzburg landscape, that could be the most energy efficient possible and above all a great place for children to learn.

4.6. Layout

The building would comply with legal and climatic requirements as well as with the personal defined strategy by adopting a low rise, elongated and compact design.
The organisation of the building would fall into a system created by a grid which was on the basis of the division of the space into different functional spaces and temperature zones.
The functional zones would be:
• playground;
• children's area with library and refectory;
• entrance, cloakroom and teachers' rooms;
• gym and changing rooms.
The different and independent temperature zones would be:
• classrooms;
• service areas;
• buffer zone;
• public core which included the entrance, teacher's rooms, cloakroom and gym.
In order to save as much energy as possible, each zone would be treated differently according to its functional demands in terms of light access and air ventilation.
The buffer zone would work as an intermediate between outer and inner space, public and private space within the children's area, children's and teacher's space.
Even though the program of the competitive tender required the playground to be at least 600 sqm in size, the Master studio program made it possible to include the covered/open area together with the permanent outdoor space in the calculation of total playground area.
The gable of the school building at the north-eastern side would follow the alignment established by the limit of the neighbouring buildings so that it would be possible to keep a visual axis created by the road.
The following factors determined the location of the school entrance at the street-facing façade, the teacher's offices above it and the cloakroom at the foyer:

- there was only one neighbouring street with car access to the north;
- most children arrived from the north where the Old Town and most bus stops are located;
- during school time, children at the primary school were not to use the secondary school facilities since they had their own restaurant and gym;
- whenever parents had to meet teachers, they should be able to reach them easily, without having to wander around the school.

Other critical factors and elements were:

- Austrian law requires that the entrance area becomes a buffer zone in between two doors so that heat doesn't escape easily, due to the difference in temperature between indoors and outdoors mainly in the winter;
- the fire escape staircase had to have a direct access to the outside of the building as required by Austrian law too. A fire escape staircase had to serve a maximum distance of 35 meters which meant that in this case two were required.
- the entrance core could become a fire escape exit too because it was to be enclosed and become completely insulated from the rest of the building.
- the parking places were to be on the street, along the sidewalk on the opposite side of the building. This decision was made so that the school could enjoy more space. The street was narrowed to force drivers to slow down while passing by the school so that it was safer for children.

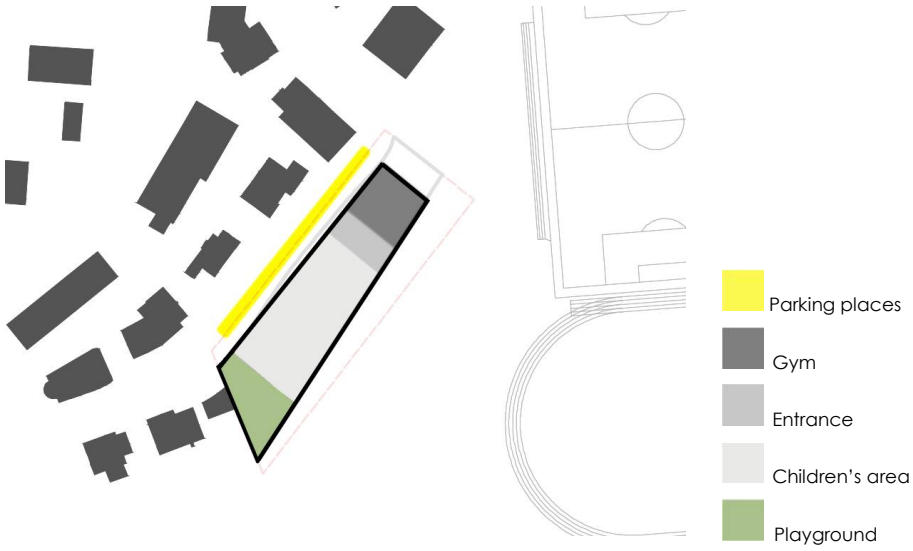


Fig. 72 Functional zones

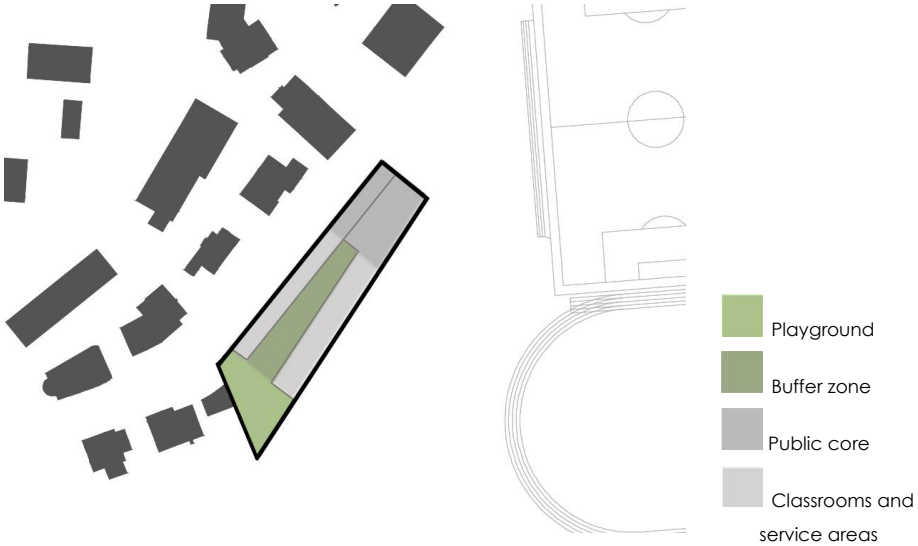


Fig. 73 Schematic site plan

4.7. Volume

The final volume results from the extrusion of a simplified shape of pitched roof house because the surrounding buildings and the traditional mountain dwellings fall mostly into the same type of design. An almost perfect design harmony would be created with the surrounding houses, which would create less of a separation with the city landscape. The concept that the school is supposed to be a child's second home was also present.

The pitched roof design is adequate to the climate conditions as it makes it easy for snow and rain to slide off easily. Furthermore, the roof had to be able to resist high bearing loads that result from the weight of the snow and the overlapping layer of the roof that slides on top of the fixed one.

The structure which was born from the grid supports the roof and enables its various parts to move independently from one another. This structure creates a rhythm that contributes not only to an easy construction solution but also for the definition of the space.

The four façades were to be different from one another in terms of glass/opaque percentage to respond to natural lighting needs and to offer resistance to wind. The exterior coating material was pre-aged soft wood boarding, which would carefully integrate into the landscape.

The two originally parallel segments, that on the street facing side which accommodates the service areas, and the other one on the green axis facing side which accommodate the classrooms, had to become divergent in order to create the buffer zone. These would be united at the public core.

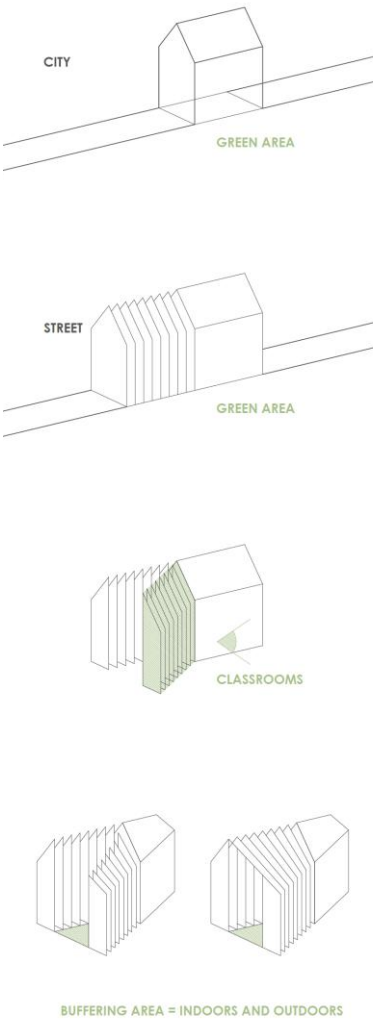


Fig. 74 Evolution of the volume

4.8. Space

Fig. 75 Buffer zone; chilren's area

Fig. 76 View of the ground floor; children's area

In architecture, space and non-space are not complete opposites because the qualities of the non-space, which include all elements of enclosure such as walls, floor and ceiling, determine the quality of the space.

> Space is perceptible first and foremost in a physical-sensual way. Again and again there is the sensuality of the material - how it feels, what it looks like, its smell. Is it hard or soft, flexible, cold or warm, smooth or rough? What colour is it and which structure does it reveal on its surface? (Deplazes, A. 1999)

At this stage of the development, most decisions were made on the basis of models, sections and sketches which were the most adequate instruments to understand space and recreate atmospheres.

The wooden finishings to the floors and ceilings provided a warm, continuous and familiar atmosphere for the communal and private spaces whereas the concrete volumes of the classrooms and service areas were to be felt as the limits to the buffer zone.

The building was articulated into two levels by staircases which are also used as fire exits; one integrated the public core, the other the children's area.

4.8.1. Gym

The gym was designed as a place to be used for assembly, physical education, music, drama, and for parents' meetings and social events. It was not to be used for general circulation and is acoustically isolated from teaching areas. Its height had to be at least 4.8 m for most of the area to permit climbing frames to be attached to one of the walls.

Natural ventilation and sunlight were ensured by the glazed façade facing north.

The stands of the gym were located on the second floor and are accessible from the staircase in the entrance core. The goal was to facilitate the parents' access whenever there was an activity worth showing.

4.8.2. Entrance, Cloakroom and Teachers' Area

As a measure of security, there is only one way into the school which helps to prevent a stranger from entering the school. When one enters the school, one has the gym on the left hand side and the children's classrooms and playground areas on the right hand side and the cloakroom ahead on the ground floor.

The administrative area is on the second floor with a glass wall facing the entrance area below which enables teachers to control who enters the school. Furthermore, it is accessible from the children's side as well as from the

Fig. 77 Buffer zone with open roof panels

Fig. 78 Buffer zone with open/closed roof panels

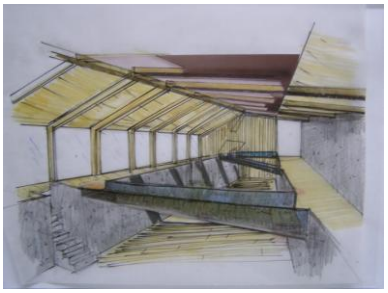


Fig. 79 Atmosphere inside the buffer zone

Fig. 80 First floor

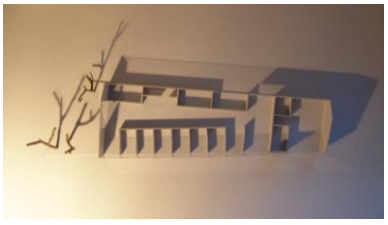


Fig. 81 Ground floor

lobby so that parents don't have to go through the whole school when they want to talk to the teachers.

4.8.3. Children's Area

Structure

The roof was very important to the design of the project because it had to slide in order for the space below to be either indoors or outdoors. This stimulated the creation of a permanent structure which after multiple trials was left uncovered so that it could integrate into the design, enrich the quality of the space and enhance the rhythm already present in the interior organization of the whole building. Also, the fact that the structure was permanent not only facilitated the construction of the building but also filtered light whose intensity and quantity was dependent on the time of day, path of the sun and degree of openness of the roof panels. The space also experiences a rhythm marked by a constant change in the contrast between light and shadow.

Staircase

The staircase "…offers us the chance to link conveniently the vertical multiplication of areas for human movement by dividing the difference in height into small units that human beings can negotiate." (Gut, D. 2005, p.224) However, the reality is that the staircase is on its own an obstacle and proof of that is that on average a person expends seven times as much energy climbing a stair as walking on a flat surface.

> The design and choice of materials for vertical access are derived directly from the structure of the building or from a permanent component in this. Removal or repositioning during the ongoing design process becomes ever more difficult and practically impossible in an existing building without changing or destroying the entire concept. (Gut, D. 2005, p.224)

The location of a staircase in a building can also determine the future capability of the building to adapt to new and different needs, since it is normally a fixed element and with a high power to change one's perception of the space. Higher or lower flexibility is obviously also determined by the material or materials used.

The location and physical expression of the staircase were determined by a series of factors that included 1) the will to integrate the element into the grid system; 2) the will to prevent it from being perceived from the façade; 3) the need for it to support the roof and 4) the senselessness of having in such a small area, the fire exit staircases every 40 meters with direct access to the exterior, plus others.

A straight flight of stairs is easy and economic to build. Furthermore, the rhythm of stepping is not interrupted in a straight run, which may prevent the permanent risk of a falling by helping to prevent a misstep in the first place.

Learning Areas

The buffer zone was created as a continuation of the playground inside the building and it is the central element of the pedagogical concept since students no longer learn only in classrooms but also in communal spaces. So, it became imperative that the corridor could fulfil more than its original purpose to permit access to some place in other ways inaccessible. The width of the corridors was widened so that they could become working areas as well. They were connected by bridges whose protection was built as a continuation of the concrete wall with the height of one meter to encourage children to play and run all over in safety without the risk of falling down from the upper floor. At first there was the idea to let children see through the protection but later it made more sense not to introduce another material which would break the perception of continuity in the interior space.

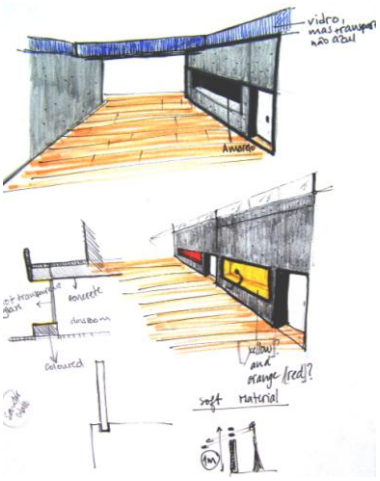


Fig. 82 Sketches

The niches on the walls on the ground floor and the existence of pillows on the floor of the second floor provide places where children can retreat, sit and learn.

The bookcases in the library are integrated into the Architecture.

Despite the regular and rigid shape of the classrooms, their size (circa 55 sqm) enables multiple desk layouts and if their door is left open, children know that the space outside can be used as an extension of the learning space.

Fig. 83 Atmosphere of the ground floor

Playground

The playground is accessible only from inside the school therefore safety is ensured. The area is divided into sub-areas according to its pavement which might be a hard or green surface. The green surfaces are intended to motivate children to learn from true contact with nature and can be either a vegetable garden or grass. Trees which create shade can be seen as a place of refuge against the sun on a very warm day.

The playground is surrounded by a protection that serves as a bench as well.

4.9. Energy Concept

Vernacular architecture lies in the creation of sustainable climate-adapted solutions that are elementary but intelligent to shelter and protect people against adverse climate conditions.

Current debates suggest that vernacular architecture ignores the need to respond to the passing of time and of generations. As such its conceptions become inadequate to the requirements of our current climate and of the current comfort needs of people and therefore non-sustainable. Yet, the principles behind vernacular architecture can inspire new design if one is able to learn from experience.

The goal was to learn from it and adopt its principles in the design of the primary school in Salzburg. The energy concept developed was the application of the knowledge acquired mostly from studying traditional Japanese architecture, because it is the one that most reflects the culture of respect people hold for nature.

In vernacular Japanese architecture the materials used to build a house were those available close to the construction site, which were then assembled in the best way possible to protect people from adverse weather conditions. When it was cold one only had to sit on a warm surface to feel warmer, there was no need to heat the whole house because it meant wastage, especially because houses didn't have good, or in some cases any, insulation. Besides, one needs to consider the fact that different people respond differently to the same situation depending on their culture. Japanese houses still favour natural ventilation with the goal to avoid overheating in summer whereas in Austria and in many European countries houses are built to be comfortable and warm during winter by keeping heat inside; the heat then stays in the summer too.

As in the traditional Japanese houses, the school in Salzburg is divided into different zones which correspond to different degrees of privacy and exposure to nature. However, in opposition to the Japanese model whose divisions are separated by sliding panels/walls which permit high flexibility in the definition of a space and cross ventilation to go through, the school is constructively static and heavy in order to have a higher thermal inertia. The zoning concept is also adopted to differentiate areas not only in terms of space, but also in terms of usage and thermal needs. Thus, different spaces also become different thermal zones.

4.9.1. Construction

Sustainability means that resources and structures that are available and are essential for man to live today will still be available for future generations to enjoy a similar, or ideally better, quality of life. Sustainability means 'do not exhaust, sustain'. A sustainable building is one that complies with those principles. (Lee ed. 2011, p.12)

Durability means that the qualities of an object are maintained for the longest period of time possible. Durability In construction is obviously about materials and techniques. Even though sustainability and durability are contrasting, they are also complimentary. (Lee ed. 2011, p.12)

The primary school in Salzburg was to be durable and minimize waste on the account of the adoption of a simple construction system and materials that could be recycled once they are no longer in use: wood, concrete and wood fibers.

Wood used for timber construction in Austria, namely in mountain dwellings, is cultivated, harvested and supplied locally. There is no need for long transport processes which implies low consumption of fuel and other energies.

The purpose of this type of construction was to enable a symbiotic interrelationship between building and site which would benefit the physical, intellectual and emotional well-being of students and teachers instead of creating an isolated environment.

The exterior envelope was conceived with insulation material held in between exterior and interior layers of timber boards treated differently. The beams that supported the structure of the roof defined the rhythm of the space and were made out of massive wood.

The interior walls and slabs were conceived in concrete due to its thermal mass; it is a material that stores excess heat during overheating periods and releases it later during under-heated periods. Nevertheless, insulation was applied as well because those interior elements divided an outdoor/indoor space (buffer zone) from interior spaces (classrooms and service areas).

Even though the panels of the roof (sliding panels) were long and wide, they needed to be light in order to slide easily and firm in order to bear heavy loads. The solution was to use a system of I-joist and wood fibre insulation developed by an English company named STEICO.

The extremities of the I-joist used only on the roof were made out of spruce timber whose groove permitted the web made from structural fibreboard to fit perfectly. The insulation had the quality of retaining heat in the winter by locking air in its porous structure; its high density could block heating in the summer; it could also improve acoustic performance. Furthermore, these products of STEICO are certified to come from managed/controlled forestry. The use of additives is minimised even though they are naturally sourced and

Fig. 84 Section of the children's area; structure that supports the roof

Fig. 85 Children's area; open roof; structure

Fig. 86 Children's area, sliding panels

Fig. 87 Section of the children's area; interior atmosphere

the preferential bonding agent is 'Lignin' which is a natural constituent of timber.

The height of the ceiling and the size of the sliding panels required the use of an electrical system to drive their movement; it was clearly impossible to do it manually. The electrical mechanism would integrate the sliding panel.

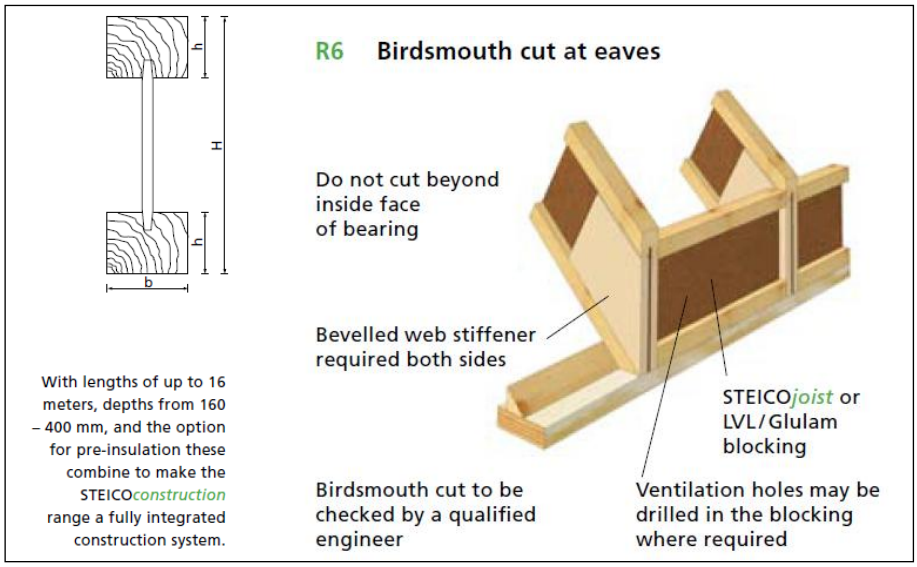


Fig. 88 I-joist by Steico

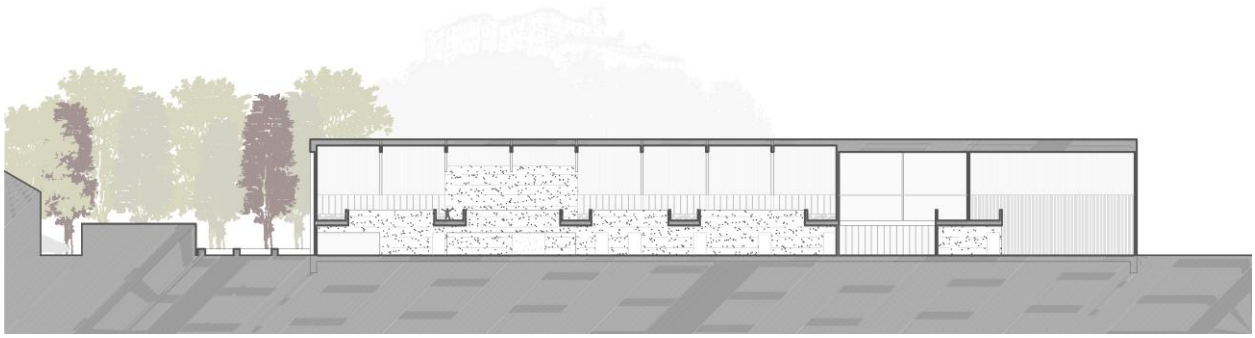


Fig. 89 Section; north-west side

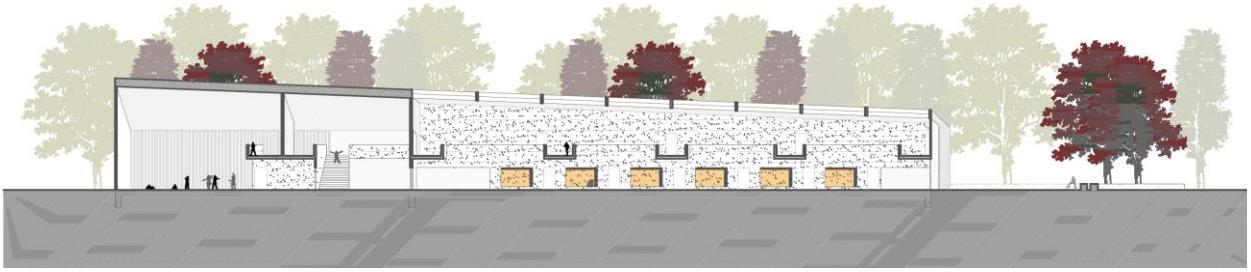


Fig. 90 Section; south-east side

4.9.4. Lighting

The position and angle of the sun varies throughout the year. In summer the sun is higher in the sky whereas in winter it is lower, therefore the summer sunlight is to be avoided and the winter sunlight is to be exploited to the utmost. This is a very straightforward 'technique' for the inner space to benefit from the sun's thermal contributions.

Fig. 91 Sun at the shortest and longest days of the year

Before children start their classes in the morning, classrooms are to be heated by the sun that comes directly through the windows; the classrooms are then warm and comfortable in time for the classes.
The north-western façade receives the least sun therefore the service areas, which have little utilization and for short periods of time, are located on this side.

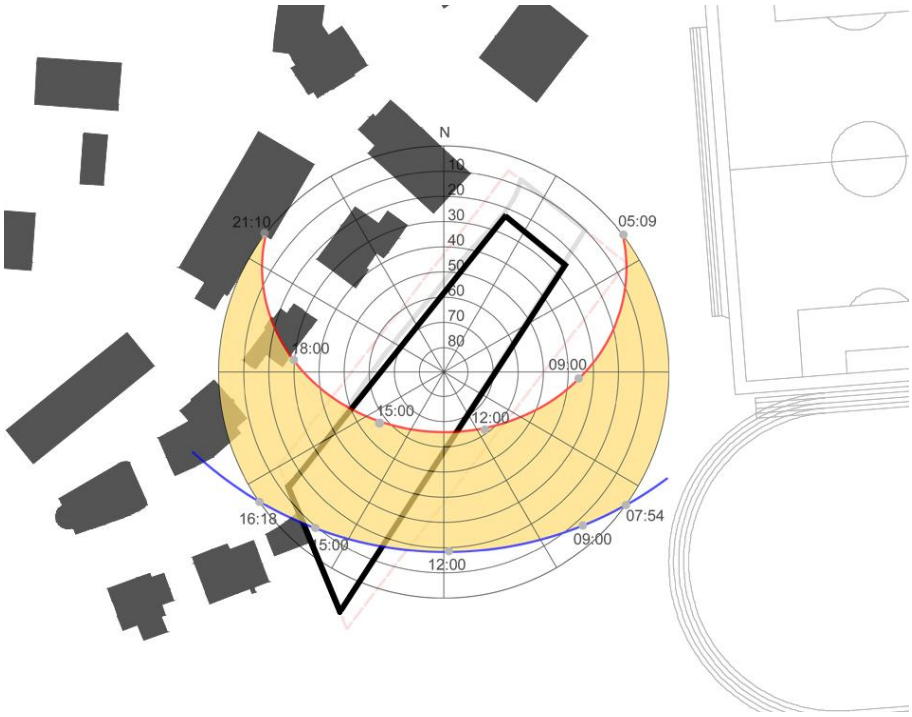


Fig. 92 Time of the day and inclination of the sun in degrees: longest day of the year (21st of June); shortest day of the year (21st of December)

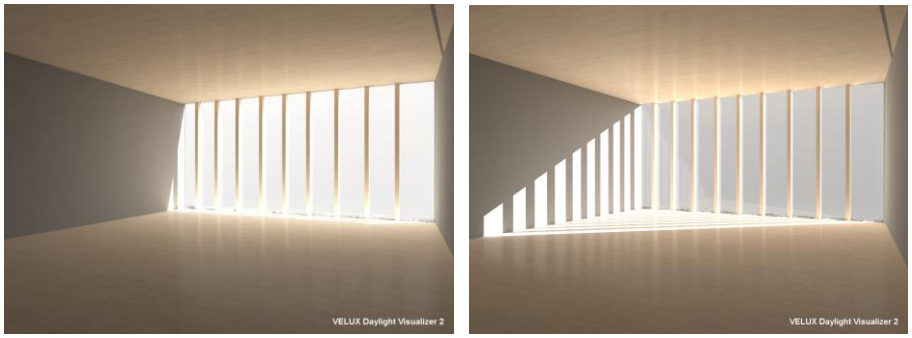


Fig. 93 Classroom on the ground floor at noon on the 21st of June (on the left) and on the 21st of December (on the right)

The following lighting studies made with the 'Velux Daylight Visualizer' were intended to test how the design responded to the need for natural light in the building. Those studies were carried out for the exact geographical location of the school plot (latitude: 47,99; longitude: 13,05):

- for the shortest day of the year (December the 21st);
- on the ground floor which was the place that received the least light;
- at midday which is the time of the day when children normally end classes and start the afternoon activities, which may or may not be carried out inside a classroom.

The results show the illumination of the different spaces. The illumination is the total luminous flux incident on a surface per unit area and it is measured in lux whose normal value for a classroom is between 500 and 600 lux.

The use of vertical slats in the sunrise-facing façade was an attempt to protect against uncomfortable sunlight and enable visual comfort inside the classrooms. However, the lighting studies concluded that the slats caused light to be reduced too much. In the end the solution was to apply wooden frames to let more light enter the space; these equally defined the rhythm of the façade.

Fig. 94 and Fig. 95 illustrate what was just said.

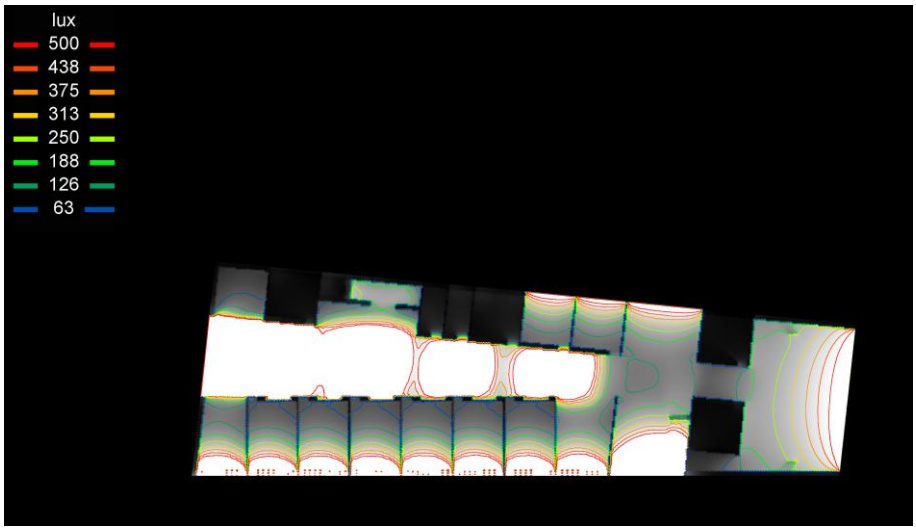


Fig. 94 21st of December; ground floor; open roof; wit vertical slats on the windows

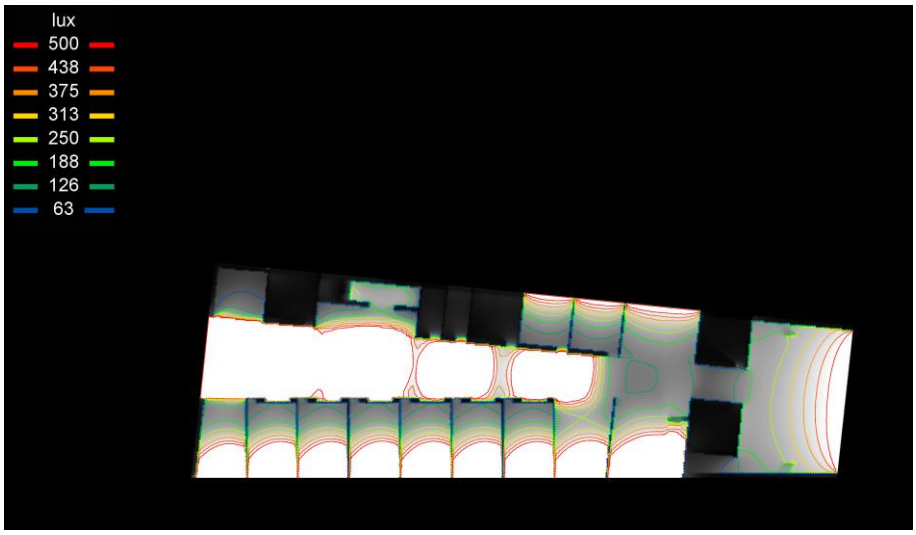


Fig. 95 21st of December; ground floor; open roof; without vertical slats on the windows

Originally it was thought that during winter, the roof would be closed (obviously due to the low temperatures).

The next step was to measure the lighting levels of the buffer zone when the roof was closed. The result was that light was insufficient to create in the buffer zone a similar brightness to that required in the classrooms. As such the objective to make the buffer zone an extension of the classroom was no longer met.

The quest was for sustainability meaning that with regards to lighting to avoid turning on electrical bulbs, therefore the solution envisioned was to have some of the roof panels made of glass. The mix of glazed and wooden roof panels would guarantee that enough natural light would reach both floors in good levels.

Fig.96 and Fig.97 show the previously described lighting study.

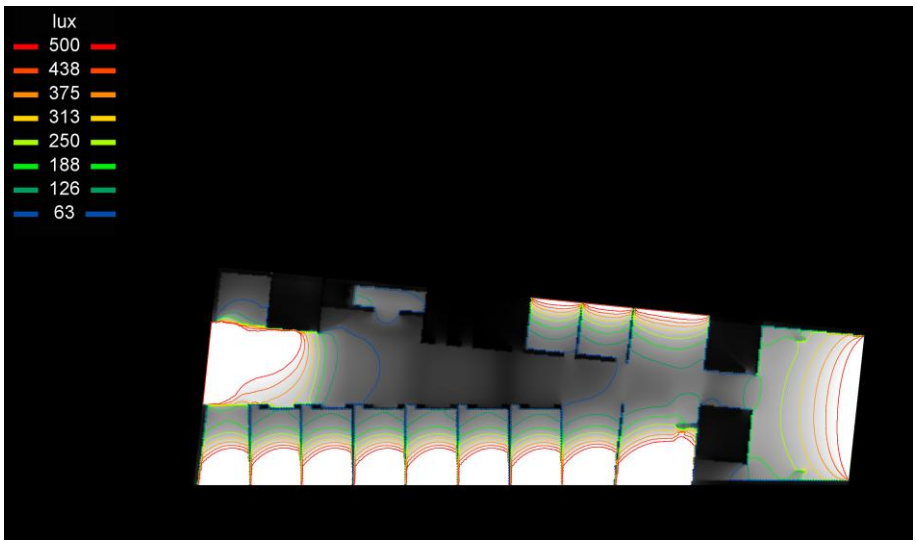


Fig. 96 21st of December; ground floor; closed roof (wood panels); no vertical slats on the windows

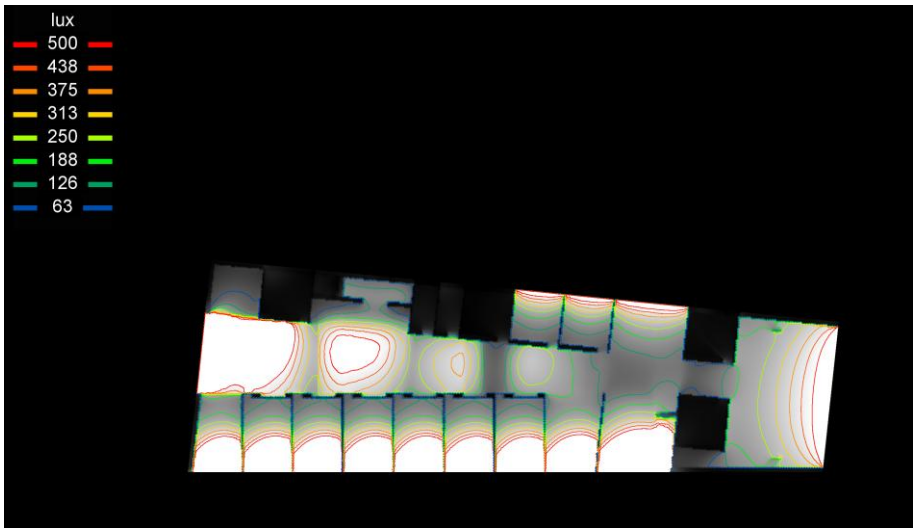


Fig. 97 21st of December; ground floor; closed roof (glass and wooden panels); without vertical slats on the windows

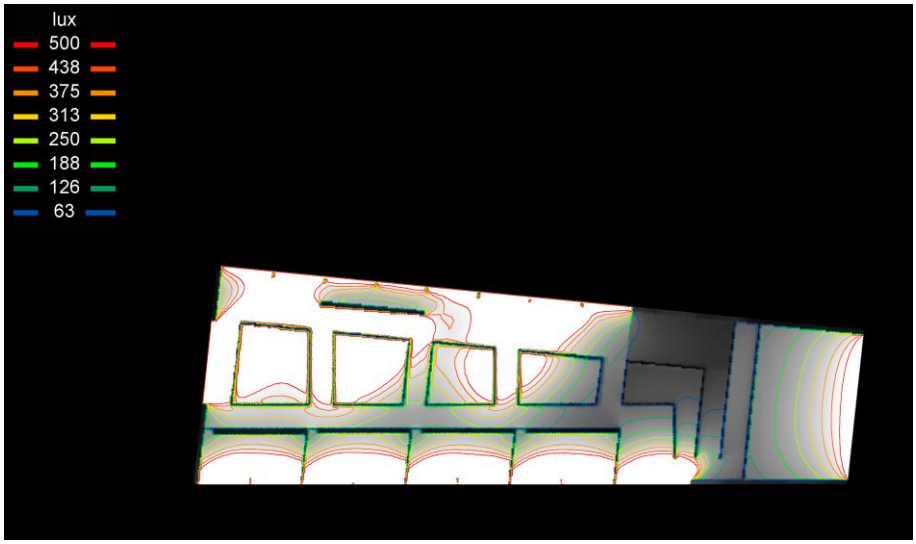


Fig. 98 21st of December; first floor; closed roof (glass and wooden panels); without vertical slats on the windows

Fig. 99 Sun light at noon on the 21st of June; north-west view

Fig. 100 Sun light at noon on the 21st of June; south-east view

4.9.2. Ventilation

Traditionally, houses in cold and/or windy regions of the globe require protection from wind whereas those in warm and humid areas require maximum energy optimization which can be offered through wind utilization.
In Salzburg, the average air temperature measured between October 2000 and July 2013 from 7am to 7pm was 11°C. The lowest air temperature was measured in January (0°C) and the highest was measured in July (22°C).
Even though the scenario was not the best because the orientation of the plot favoured the main wind directions, the goal was still to take advantage of the wind to create natural ventilation and provide thermal control while keeping low energy requirements.
The solution was to open and close the windows and roof panels whenever necessary and in order to minimize energy losses, to make sure that each space represented one thermal unit which was independent from the rest of the building.
The wind circulation was made by thermal lift, meaning that the air went out of the building by going through the vertical space of the buffer area after it was heated; or by means of natural pressure differences across the entrance area.
A way to shield the wind was to have trees planted on the lawn in front of the school.

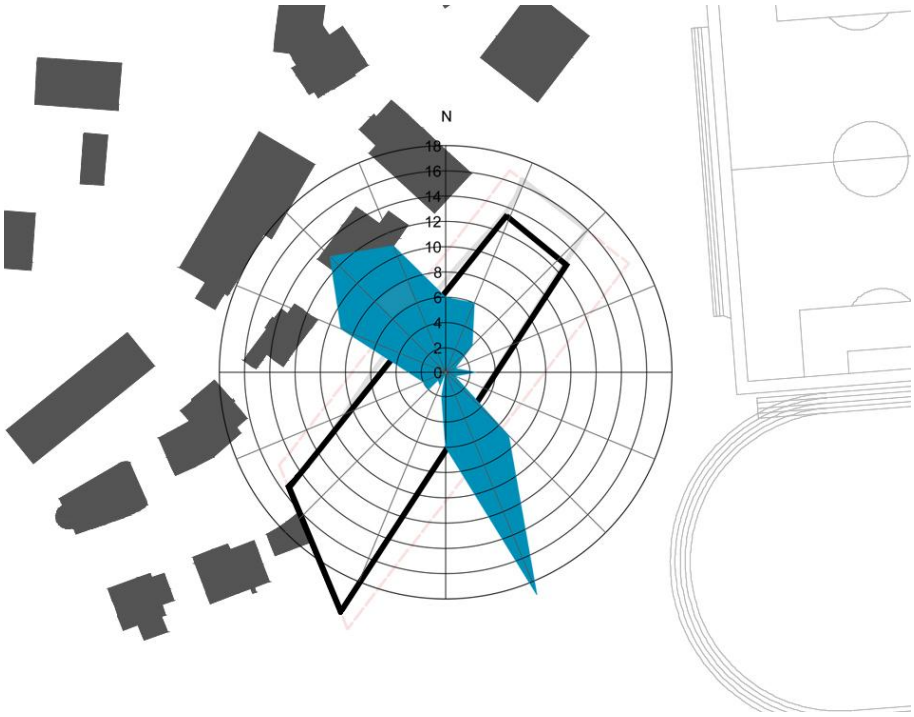


Fig. 102 Average percentage of wind distribution in Salzburg based on obervations taken between October 2000 and July 2013 from 7am to 7pm

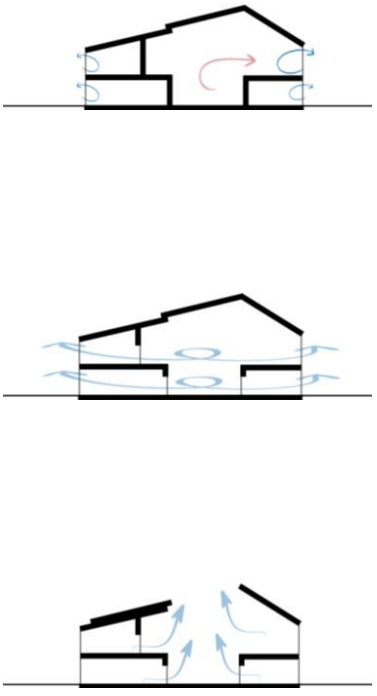


Fig. 101 Natural ventilation in the children's area

4.9.3. Thermal

As a measure to save energy, the school was divided into different and independent temperature zones because not all spaces are used permanently even though regulations tend to require the different rooms of a building have the same constant temperature and humidity. This meant that if the indoor spaces were to be thermally independent, the temperature of a space was not to be affected by the temperature of another.

The façade facing north-west is more opaque and highly insulated in order to prevent the building from losing heat since it receives minor light exposure and it is a barrier against the main and major wind direction. The opposite façade which faces south-east is mainly glazed as a way to let the sun enter the rooms and heat the building.

The roof was designed with no overhang to avoid creating shade over the interior spaces during summer when the sun is higher in the sky.

The buffer zone receives heating contribution from the south through one glazed façade and from above through the glazed roof panels.

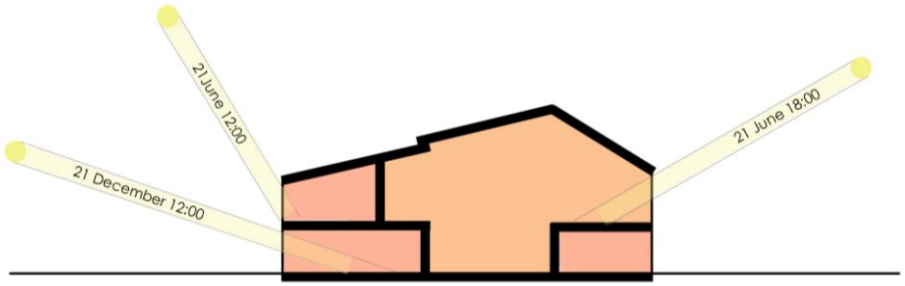


Fig. 103 Temperature zones, children's area

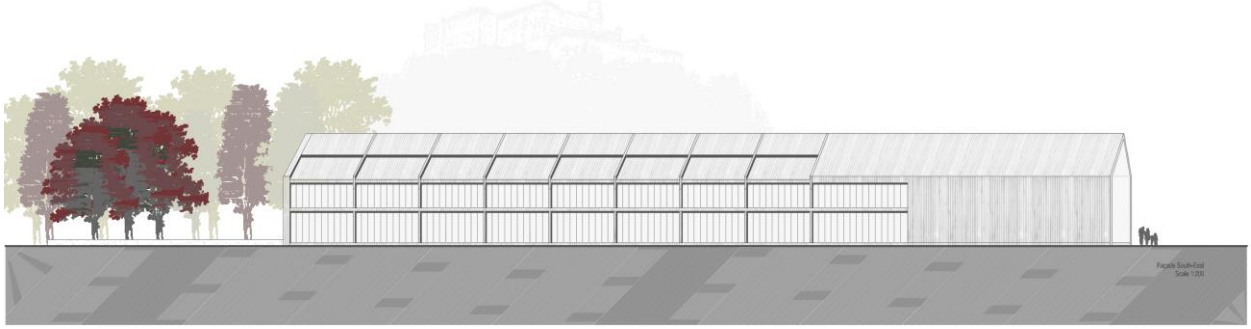


Fig. 104 South-east façade

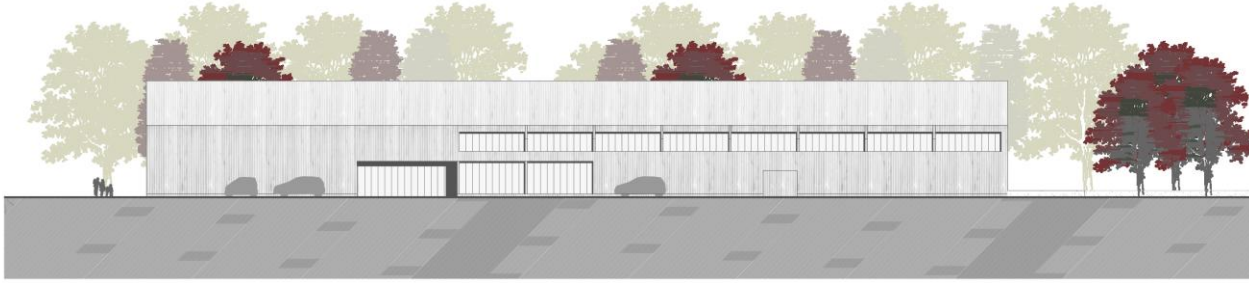


Fig. 105 North-west façade

4.10. Final note

I value function and sense over form but the goal in mind throughout the development of a project needs to be that of balancing between factors (function, sense, form and also others) rather than compromise. Put in a different way the development of a project is not like a continuous path from start to end but one of stop and go. In the project presented in this report, there was a permanent questioning and testing of all favourable options so that the optimal solution was adopted at the end.
One hiccup was that the language taught in the Master Studio was exclusively German. This caused delays in the development of the project throughout the overall process and had implications on the final proposal.

> "There is no manifest reason why an environmentally responsive and sustainable design should not be culturally stimulating and aesthetically expressive. Sustainability and its implicit aesthetics ought to be rightly regarded as a prime inspiration to enrich and deepen our emergent culture of architecture, rather than as some kind of restriction upon, or as something separate from, the fullness of its aesthetic and poetic potential." (Lee ed. 2011, p.108)

Man connects the colour green with nature and ultimately life. (Heller, E. 2007, p.106) Green is the one term that is easily associated with the true quality of the present design.
Above all I had this assumption in mind to go through the different stages of the project. The school to be designed for Salzburg had to integrate the local nature as well as following the principles of sustainable architecture and follow EU directives and other legal requirements. The 'Green School in Salzburg' is more than a check list of requirements that integrate the plan of action of a Green School, whose definition already exists.

05 Conclusion

05 Conclusion

To do a project and its respective report instead of a thesis was the option taken because I could test theories, learn from the results, rethink principles and report them, as the architect needs to do in real life. Furthermore, the way to get the most out of the ERASMUS program both academically and socially/culturally was through a project that had to respond to the real needs of the local community. A primary school for the children of Salzburg was such a project. A good understanding of those needs was only guaranteed by being there/living there and so interacting with the locals to learn the most from their culture.

For me architecture starts with a question, then the hypothesis needs background research to be constructed, tested and interpreted in order for a conclusion to be drawn and communicated.

The report goes through the process that contributed for the project's final proposal and it is divided into three main chapters which refer to different subjects addressed. The main chapters were:

02 Salzburg | Framework: **Context**

It is a deep dive into all aspects concerning the location, climate, history and legal requirements specific to Salzburg and that had an impact on project decisions.

The plot is located in the Unipark in Nonntal, which is in the buffer zone of the historical centre of Salzburg, classified by UNESCO as a world heritage site (ICOMOS 1996).

03 Project | Framework: **School**

The work produced includes key elements relating to the behaviour of children aged 6 to 10, to learning pedagogies and to precise examples of primary school design (case studies).

The overall concept chosen to serve as guide was that of learning through movement, experimentation and interaction (Sliwka, A. 2013).

The ultimate interpretation was:

Movement	Experimentation	Interaction
↓	↓	↓
Needs space	Needs matter (to experiment in and with) and freedom	Needs opportunity

In both case studies selected, the Primary School in Bad Blumau and Sandal Magna Community Primary School, translate the concepts mentioned above. A buffer zone is placed in between different areas (or even in the centre) and in itself serves one or more purposes (e.g. recreation) apart from being a distribution path (Building for Children 2013), a 'street'.

04 Project | Process and Proposal: **Sustainability**

The European directives on energy efficiency (Directive 2012/27/EU) and on energy performance in buildings (Directive 2010/31/UE) created the basis for all further thinking on sustainability and made the subject of sustainability a real responsibility.

The following considerations were very relevant:

1) it is now impossible to dodge the need to build sustainably because it is mandatory to offset climate change and its effects. A study by IPCC (United Nations Intergovernmental Panel on Climate Change) released in September 2013 shows scientific evidence that man is responsible for climate change, namely because of GHG_s emissions.
2) An architect needs to perform his/her job in accordance with the European directives on energy performance of buildings which require a significant improvement in energy efficiency. In 2010 buildings represented 40% of the total energy consumption in the European Union (European Commission 2010) and between 2004 and 2009 they represented 50% of the total carbon dioxide emission in the whole world (Jones, W. et al. 2009).
3) I fully agree with Kenneth Frampton's statement (Lee ed. 2011, p.108) that there is no manifest reason why a sustainable design should not be appealing.

The project and the report led me to the following conclusions:

1) It is crucial to first of all understand the context of the location in which the building is to be built in order to balance all important factors instead of compromising; Salzburg and Noontal.
2) The learning pedagogies to be followed in a school shall serve as guide to the design of the space. In the Nonntal school, the buffer zone (the 'street') became the central space of the design and its spine. It can alternate being an outdoors or an indoors space given the sliding roof introduced. This outdoors/indoors space proved to be the ultimate space because it guaranteed a safe and controlled environment inside the school walls that at the same time benefits the children in terms of intellectual development and satisfaction since the physical and visual links to the exterior continue to exist.

3) Major focus needs to be given to the real truth of designing with sustainability rather than to the addition of technical apparatus post design, e.g. solar panels.
4) The school in Salzburg improves the learning environment and give children the opportunity to hear, see, feel, think, learn, move and experiment better (Center for Green Schools 2013) by enjoying from a nature related design by making use of:
    - long views to the exterior (Heschong Mahone Group 2003)→ positioning and orientation of the building
    - natural lighting (Directive 2010/31/UE and Kuller, R. and Lindsten, C. 1992)→ positioning and orientation of the building, local solar exposure conditions, sliding roof panels
    - passive heating (Directive 2010/31/UE)→ positioning and orientation of the building, local solar exposure conditions
    - passive cooling (Directive 2010/31/UE)→ natural ventilation, positioning and orientation of the building, sliding roof panels
    - thermal comfort (Directive 2010/31/UE)→ insulation, thermal inertia of materials, personal control
    - acoustic comfort (Directive 2010/31/UE)→ functional organization, insulation
    - passive solar systems and solar protection (Directive 2010/31/UE) → slats on the windows, shade

    Additionally, even though sustainable principles limit the design of a building it is still possible to accomplish a good design without the prejudice of its aesthetics.

The two case studies selected, the Primary School in Bad Blumau and Sandal Magna Community Primary School, gave me the confidence that the design I was to adopt in Nonntal was appropriate because both schools (different learning pedagogies) resulted in different spatial organizations that still made use of the environment to improve the school environment.

The topic of the source of energy to power the building was thought of but not addressed in the project and the report.
In any case, with the construction of a hydroelectric power plant in Salzburg, whose project was attested by the Heritage Impact Assessment and then approved by UNESCO (UNESCO World Heritage Centre 2013), the city will produce electricity from a non-pollutant source. This project will be a response to the Directive 2012/27/EU on energy efficiency. The electricity produced from this non-pollutant renewable source will be used

to power the school in Nonntal. The main needs would be for lighting and heating as well as to move the sliding panels of the roof above the buffer zone.

The colour green is associated with nature therefore green is the one term that is easily associated with the true quality of the present design. The 'Green School in Salzburg' is more than a check list of requirements that compose the action plan of a Green School whose definition already exists.

The end result was:

Context + School + Sustainability → the Green School in Salzburg

The objectives were met but there is still room for further deeper development of the project, namely constructively and technically.

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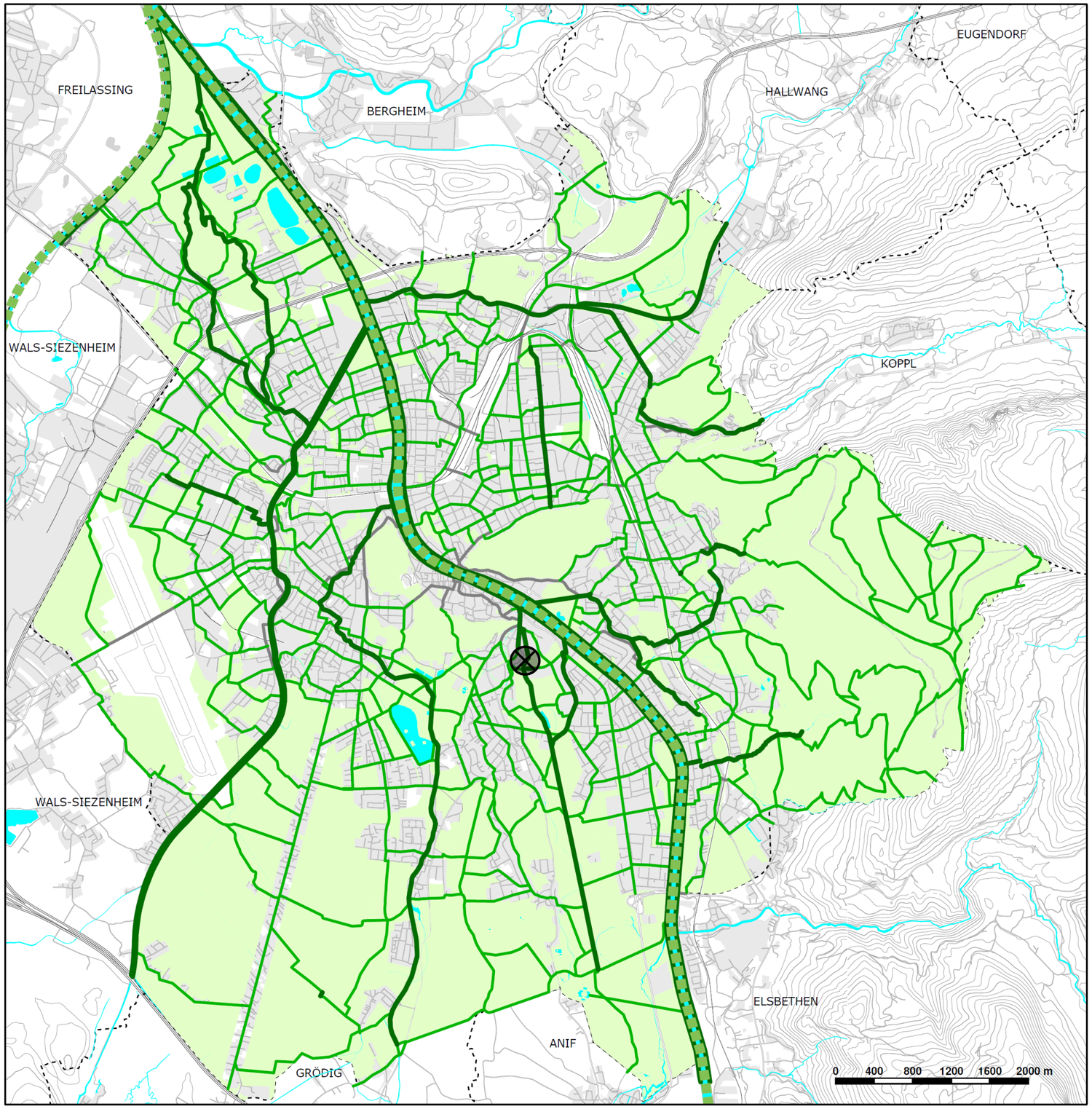
Appendix

I. Salzburg | Green Structure
II. Salzburg | Structure of Public Transportation
III. Salzburg | Primary and Secondary Schools Influence Area
IV. Figure-ground-diagram
V. Roof Plan
VI. Ground Floor Plan
VII. First Floor Plan
VIII. Sections
IX. Renders
X. Photos

Appendix



STADT : SALZBURG Magistrat
Stadtplanung
und Verkehr

Räumliches Entwicklungskonzept 2007

Gemeinderatsbeschluss vom 17.12.2008

Plannummer: 2.19

Grünes Netz

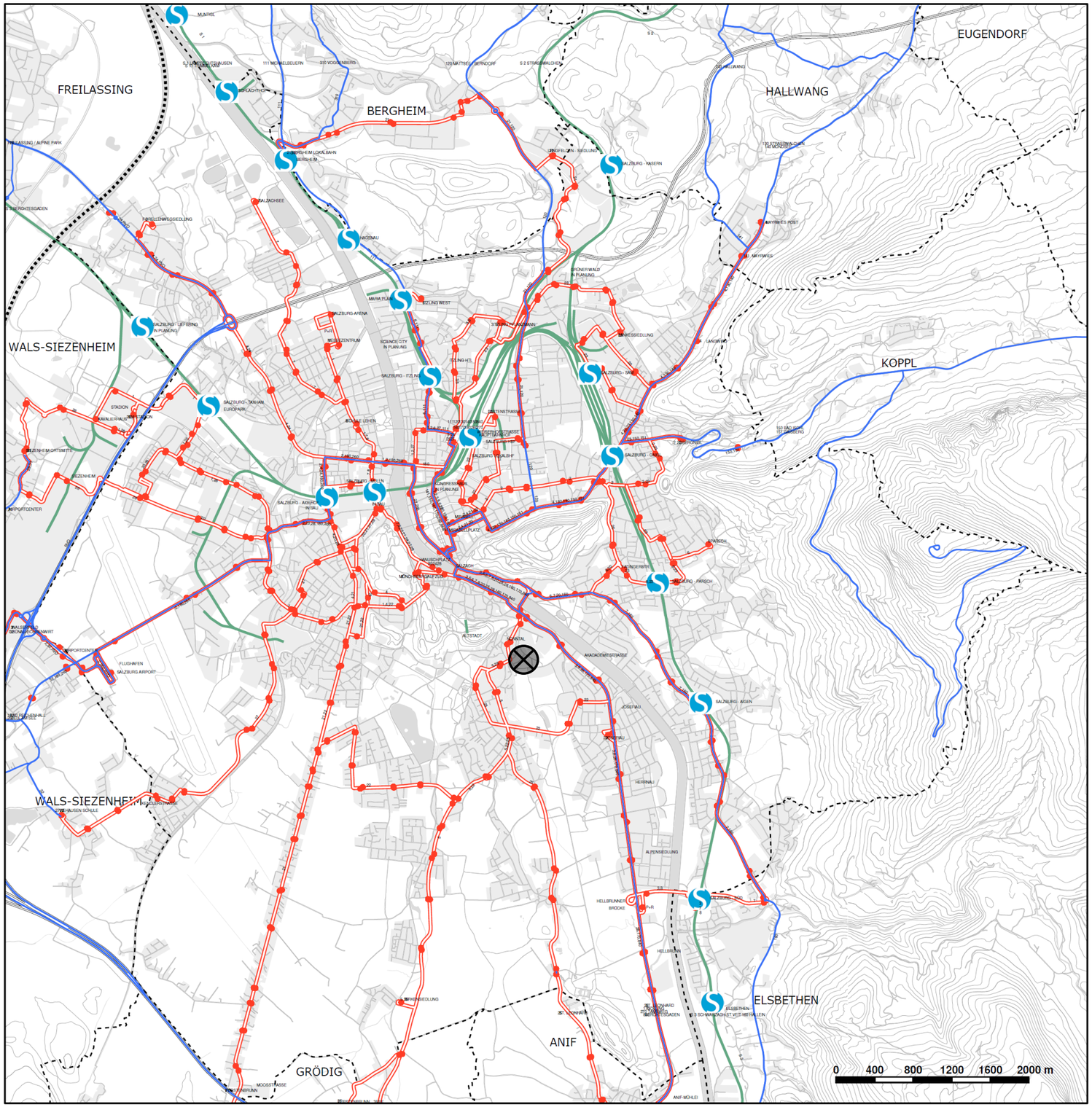
Freiraumkonzept

Legende:

- Grünkorridor
- Grünzug
- Grünverbindung
- Grauer Weg
- Grünland (FWP97 inkl. 46 TAÄ)
- Größere Gewässer (FWP97 inkl. 46 TAÄ)

Plangrundlage: Digitaler Stadtplan
Datenquelle: Amt für Stadtplanung und Verkehr

Datenstand: 25.08.2008
Erstellt am: 03.12.2008



STADT : SALZBURG Magistrat
Stadtplanung
und Verkehr

Räumliches Entwicklungskonzept 2007
Gemeinderatsbeschluss vom 17.12.2008

Plannummer: 4.05

ÖPNV - Liniennetzplan

Verkehrskonzept

Legende:

Schienenverkehr

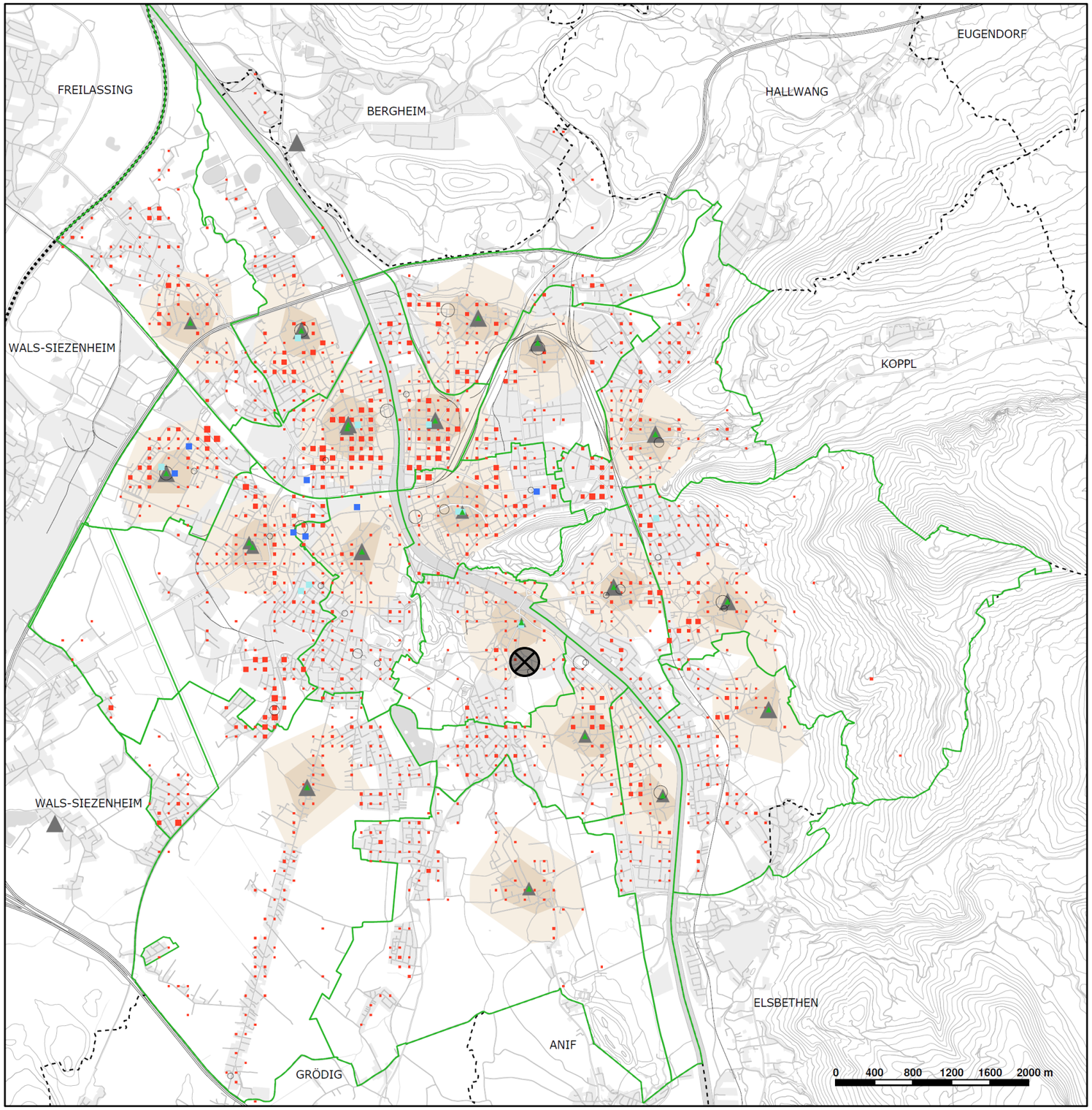
- Schienennetz
- S-Bahn Haltestellen

Bus - Obusverkehr

- Busnetz Salzburg (SalzburgAG, Albus, Hogger)
- Regionalbusse (ÖBB, Post, RVO)
- Haltestellen Bus/Obus

Plangrundlage: Digitaler Stadtplan
Datenquelle: Amt für Stadtplanung und Verkehr

Datenstand: Juni.2006
Erstellt am: 09.12.2008



STADT : SALZBURG Magistrat
Stadtplanung
und Verkehr

Räumliches Entwicklungskonzept 2007

Gemeinderatsbeschluss vom 17.12.2008

Plannummer: 5.05

Volksschulen
und Kinderbetreuung für 6 - 15 jährige

Infrastrukturkonzept

Legende:

Volksschulen - Standorte und Anzahl der SchülerInnen

- bis 100
- 101 bis 200
- über 200
- Schulbereiche

Erreichbarkeit von Volksschulen

- gut erreichbar (300 m)
- erreichbar (700 m)

Wohnbevölkerung im Alter zwischen 6 und 10 Jahren je ha

- bis 2
- 3 bis 5
- 6 bis 10
- 11 bis 20
- über 20

Schulen mit ganztägiger Kinderbetreuung

- Volksschule
- Hauptschule
- Sonderschule

Standortbezogene Kinderbetreuungsplätze in Horten

- bis 10
- 11 bis 50
- über 50

Plangrundlage: Digitaler Stadtplan
Datenquelle: Amt für Stadtplanung und Verkehr
Schulamt und iSPACE-RSA

Datenstand: 2003
Erstellt am: 21.07.2008

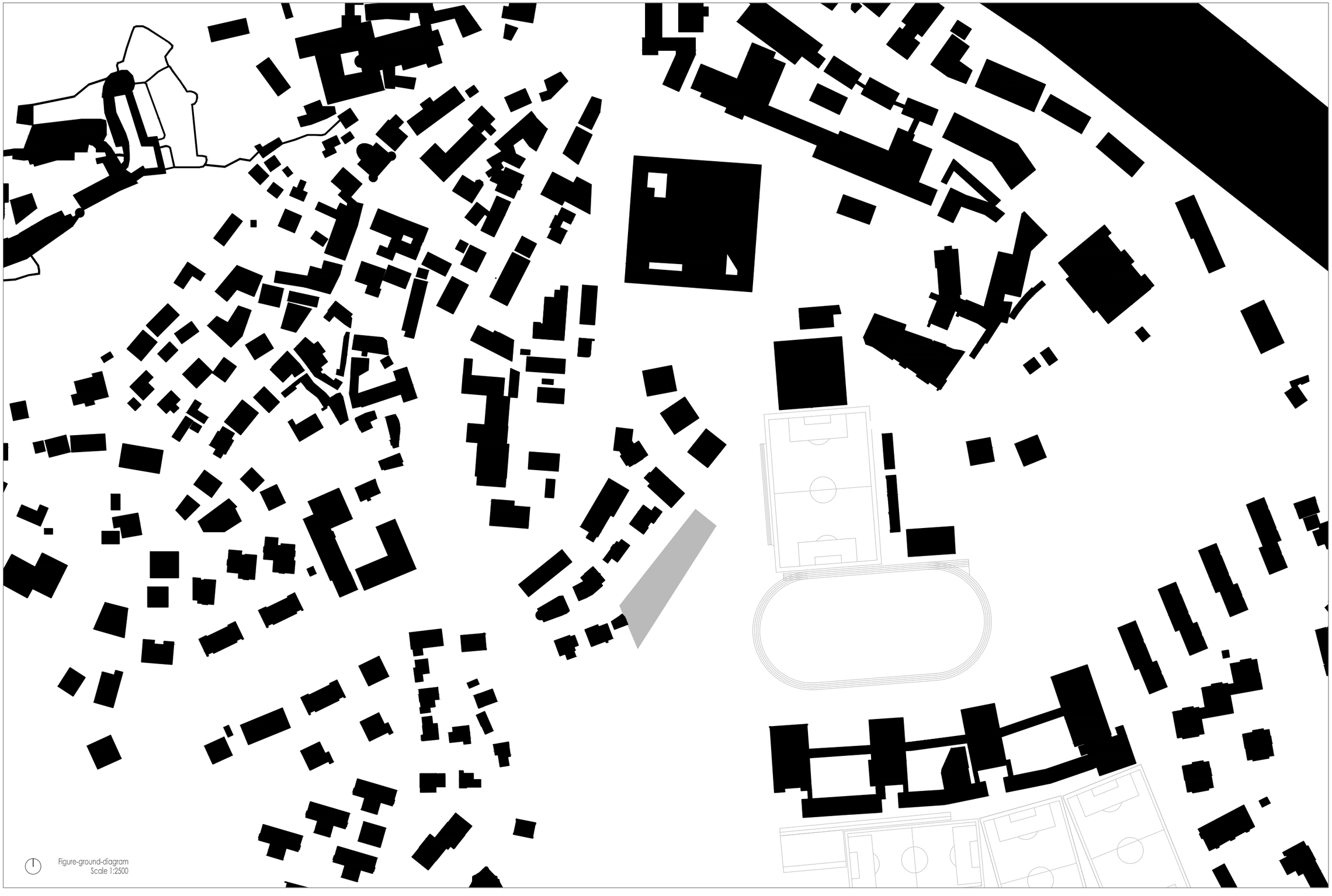
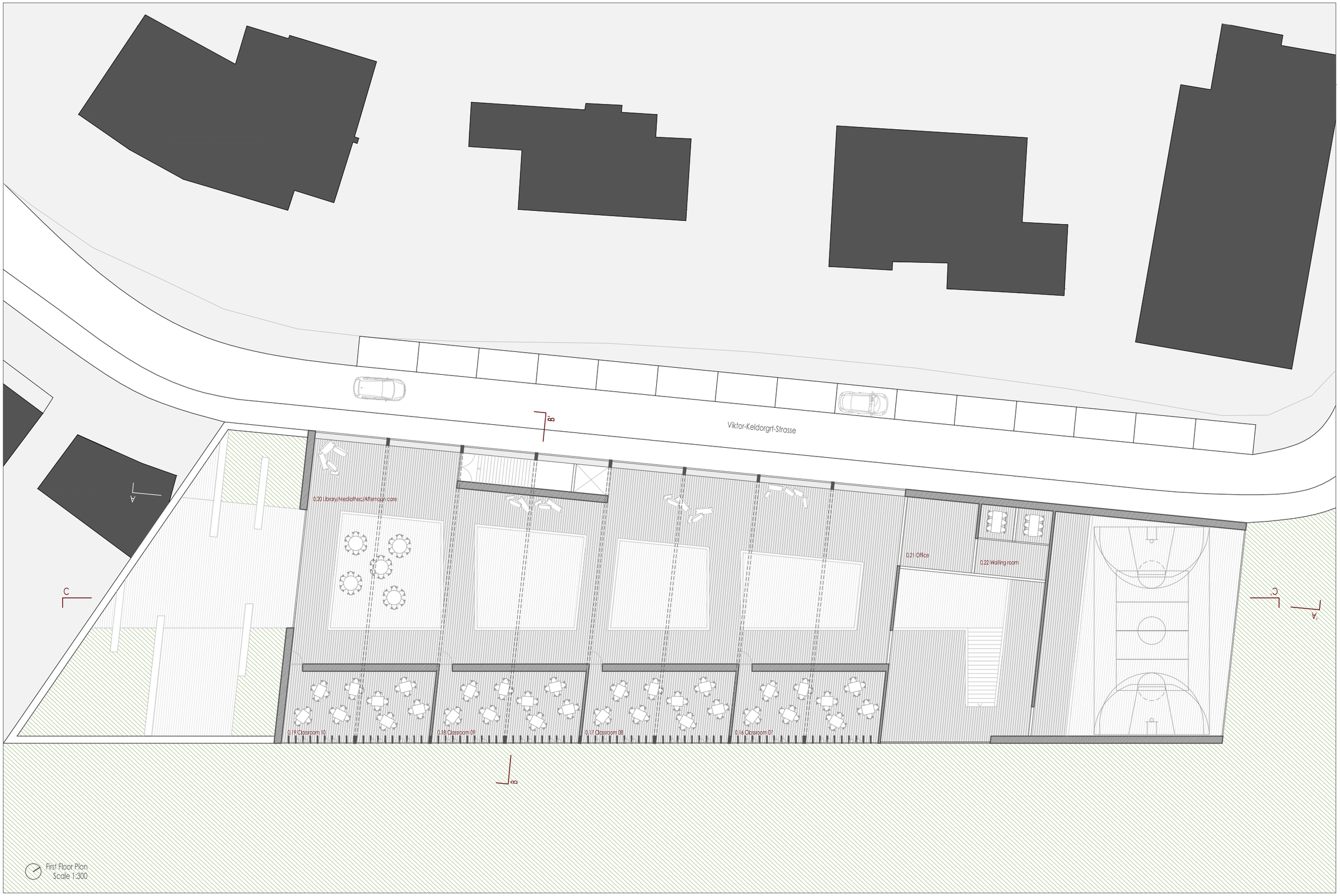
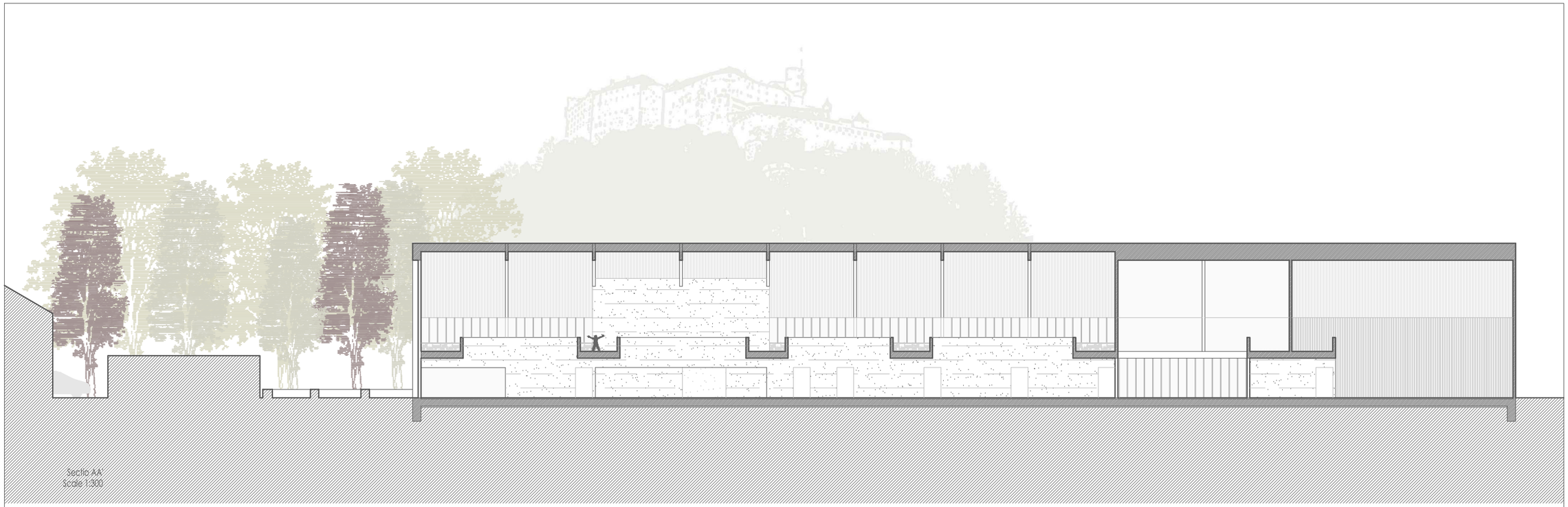


Figure-ground-diagram
Scale 1:2500

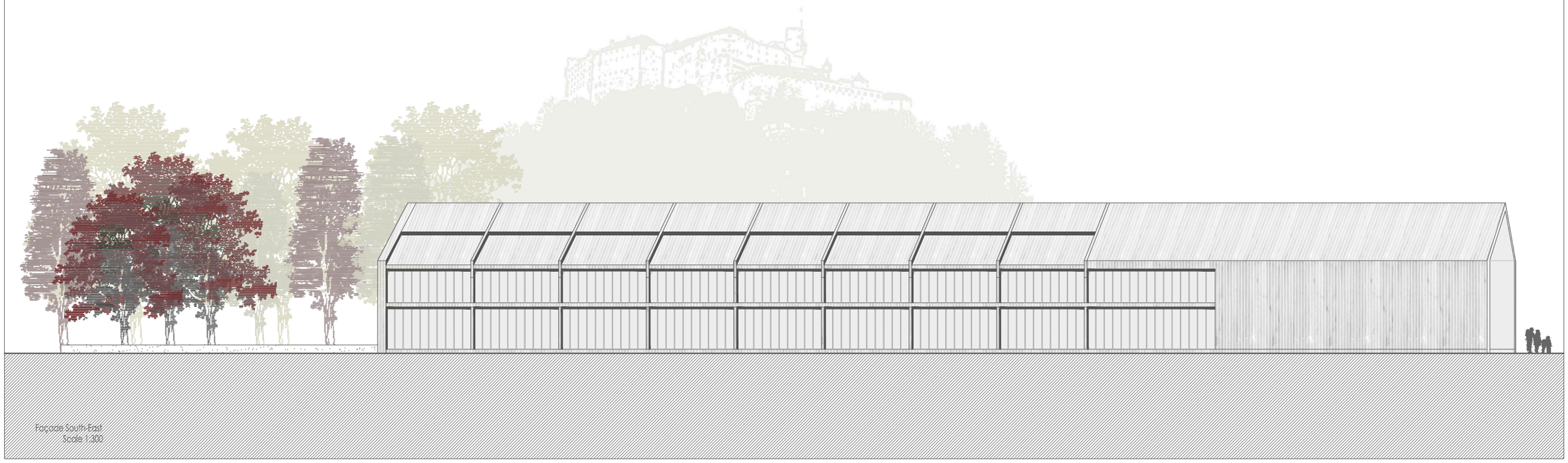

Viktor-Keldorgrt-Strasse
A
B
C
Roof Plan
Scale 1:300


Viktor-Keldorgrt-Strasse
0.12 Kitchen
0.13 Storage
0.14 Storage
0.15 Integration Area
0.1 Entrance
0.11 Multifunctional room
0.10 Classroom 06
0.9 Classroom 05
0.8 Classroom 04
0.7 Classroom 03
0.6 Classroom 02
0.5 Classroom 01
0.4 Music room
0.2 Cloakroom
0.3 Storage
A
B
C
Ground Floor
Scale 1:300

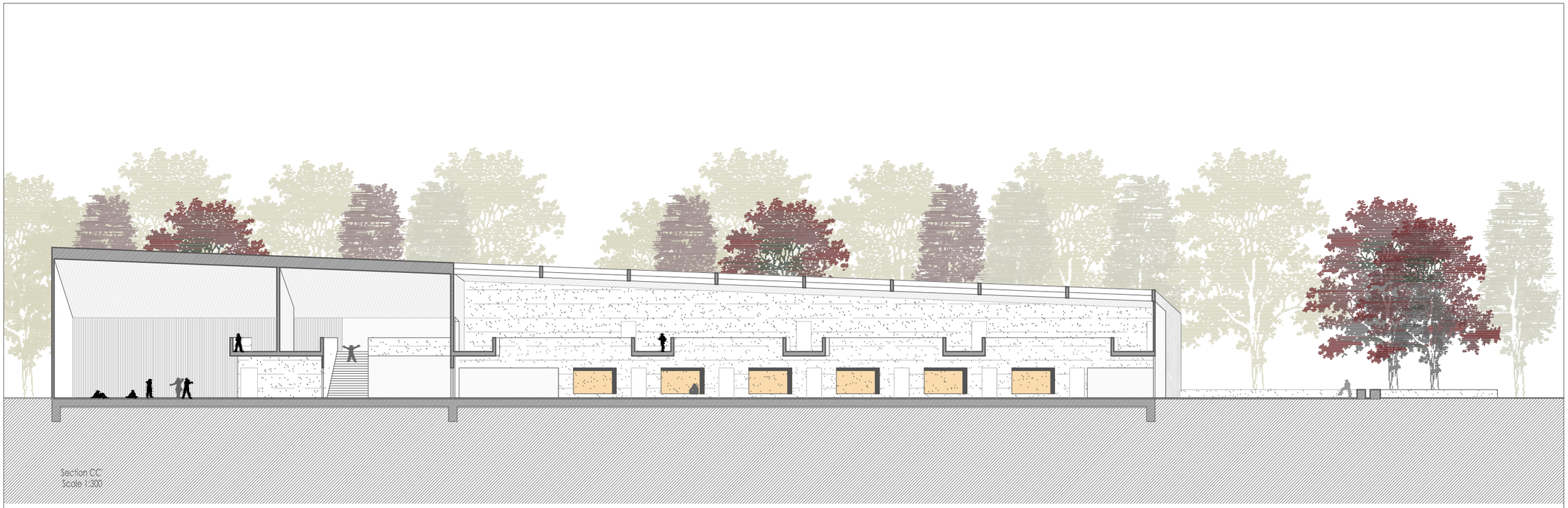

Viktor-Keldorgrt-Strasse
0.20 Library/Mediathec/Afternoon care
0.19 Classroom 10
0.18 Classroom 09
0.17 Classroom 08
0.16 Classroom 07
0.21 Office
0.22 Waiting room
A
B
C
First Floor Plan
Scale 1:300



Sectio AA'
Scale 1:300

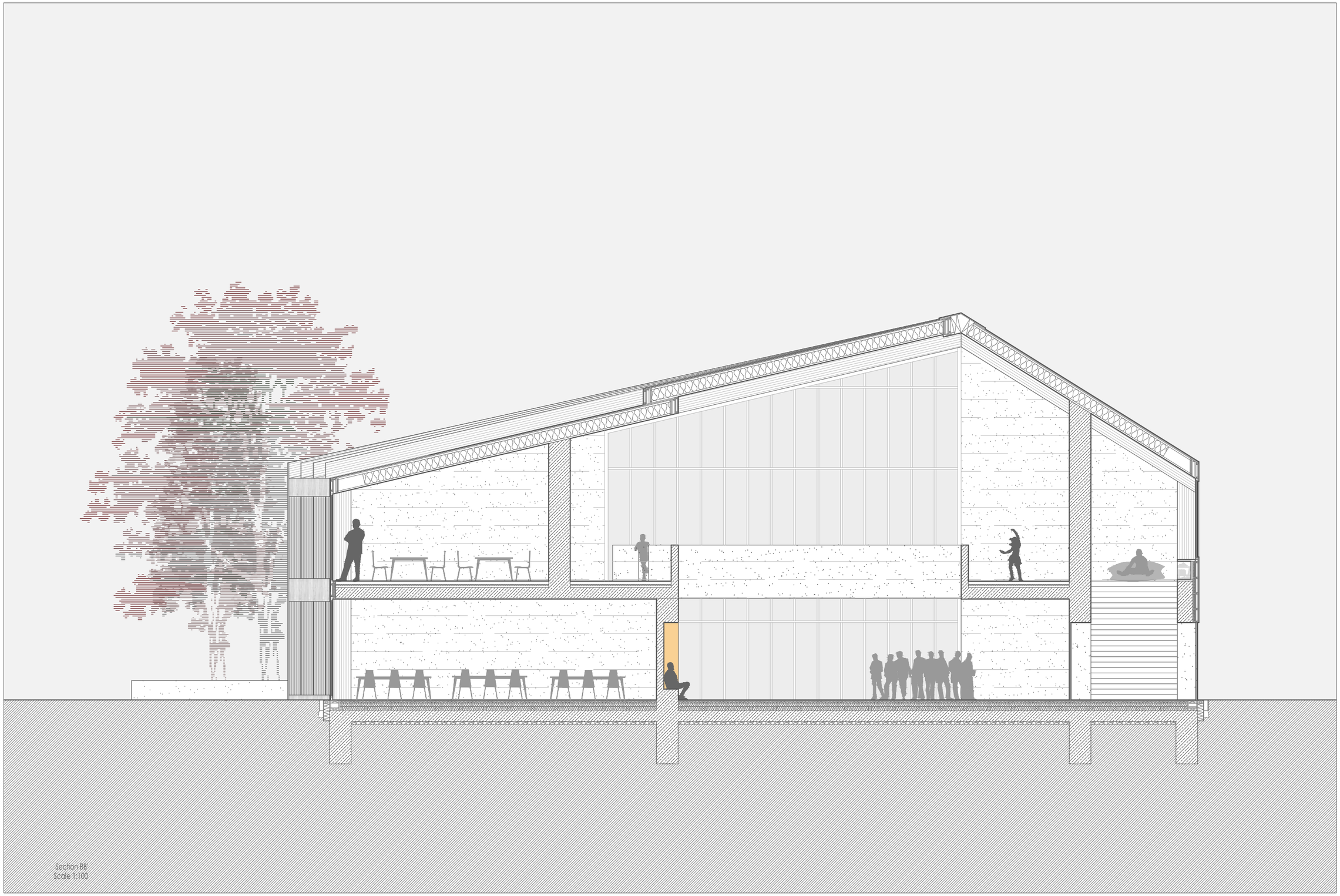


Façade South-East
Scale 1:300



Section CC'
Scale 1:300

Façade North-West
Scale 1:300



Section BB'
Scale 1:100