Fréjus Nature Centre

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Bounded by the main railway connecting Turin and Grenoble, and the motorway leading to the Fréjus Road Tunnel, the Fréjus Nature Centre perches on the slopes of the Cottian Alps above Modane, France. This nature centre exists within a number of frameworks, each with their own cultural references and building typologies. The project refers to the heritage of mountain lodges and refuge stations that grew out of enlightenment alpinism, the hot springs and thermal baths that dot the Alps, the design of wood long-span bridges, as well as the visitor interpretation centres found in national parks and conservation areas. In addition to its connection to these more conventional models, the nature centre forms a part of a large underground neutrino observatory. The relationship of the nature centre to the observatory plays a decisive role the design of the centre, influencing its location, form, and design approach. A survey of the history of observatory design illustrates a number of important underlying conditions of this project, and sets it in a specific light. This nature centre is, on one hand, an example of the support building typology that separated from observing spaces during the evolution of observatories. On the other hand, it is a projection and synthesis of the divergent design tendencies reflected in historical approaches to instrument and support buildings.

The history of astronomical observatories reaches back to the Neolithic Era, and includes proto-observatories like Stonehenge in England and the Mayan temple El Caracol; naked eye observatories such as Uraniborg (fig. 1), Stjerneborg, and Jantar Mantar (fig. 2 & 3); and a series of telescope-based observatories beginning in the 17th century and continuing up to the present day. In proto-observatories and naked eye observatories, space and architecture were used to directly tune the observation of the cosmos. In many ways the buildings were the instruments (fig. 2 & 3).[1] As specialized instruments were introduced to aid observation, only generic architectural space was needed to perform measurement of the stars. However, with a desire for greater

[1] Maharaja Jai Singh II's Jantar Mantar observatories in Jaipur and Delhi, India are series of buildings that act as instruments for measuring the sun and stars.

precision, instruments grew in size and once again became physically integrated with architecture (fig. 4),[2] influencing the orientation, structure and spatial qualities of specialized buildings that often housed both observing, studying, and living spaces.

The advent of telescopes marked a shift in the design of observatories, and the beginning of a trajectory from the early observatory as a complete work of architecture, to the eventual physical, conceptual, and aesthetic separation of instrument and ancillary spaces. This trend can be readily seen in parallel with the development of astronomy, the improvement of lens technology, and the introduction of large refractor and reflector telescopes, but also perhaps as a response to larger cultural changes, such as the specialization and segregation of scientific disciplines, and their overall separation from public life.

Early observatories counted among the significant buildings of their time, owing to the cultural, military, and mercantile importance of astronomy in the late renaissance and baroque, and also to royal patronage. As such, observatory buildings were designed to communicate their value physically and aesthetically, and were designed by notable architects, built of similar materials, and included the same formal, stylistic, and ornamental qualities as other noteworthy buildings of their time. Early observatories were conceived as a single coherent work of architecture. While they contained purpose-built spaces for astronomical instruments, they also contained libraries, kitchens, offices, laboratories, and lodging for astronomers, students, and

Figure 1: Tycho Brahe's 16th century naked-eye observatory Uraniborg

Figure 2: Maharaja Jai Singh II’s 18th century Jantar Mantar, Jaipur, India

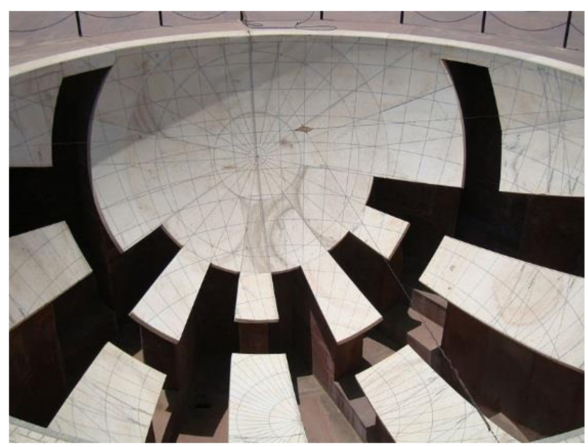

Figure 3: Maharaja Jai Singh II’s 18th century Jantar Mantar, Jaipur, India

[2] For example, the mural quadrant at Tycho Brahe’s Uraniborg.

visiting scholars,[3] accommodating all aspects of the astronomer's life and work. From this status as coherent and comprehensive multi-use buildings, splits emerged whereby instruments were removed into separated individual buildings. At first, these specialized buildings were located on a campus in close proximity to the other observatory building. Later, the instrument buildings were located remotely. At the same time, the instrument buildings became increasingly specialized, responding to the technical requirements of the telescopes they housed, in many cases becoming dominated by utilitarian concerns and reduced to basic engineered sheds. Case studies of the Royal Greenwich Observatory, the Pulkovo, Strassborg and Nice Observatories, the Lick Observatory, and the David Dunlap Observatory explore this typlogical and architectural transition in greater detail, while Erich Mendelsohn's Eistein Tower offers a counterpoint.

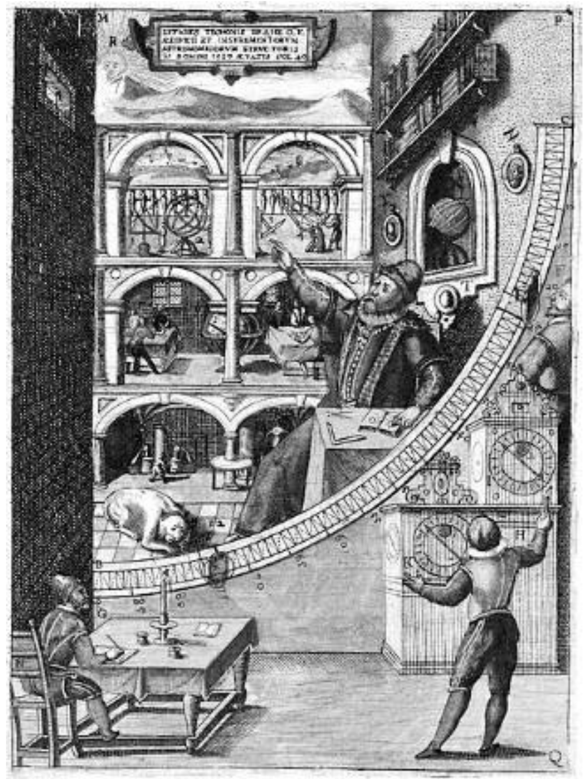

Figure 4: The large mural quadrant and small wall slit used to record star positions at Uraniborg

At the request of King Charles II, architect and mathematician Christopher Wren was commissioned to design the Royal Greenwich Observatory. He responded with a scheme for a symmetrical red brick building with stone quoins. The central volume is abutted with two short stair towers and large scroll buttresses, and set along a wall flanked by two symmetrically placed small summer houses. "The north façade thus presented to the riverfront a rich and ordered composition, enlivened by the varying position of the telescopes when set up for use"[4] (fig. 5). Indeed, Wren included to dummy windows to maintain the harmony and order of the north façade. The observatory's basement

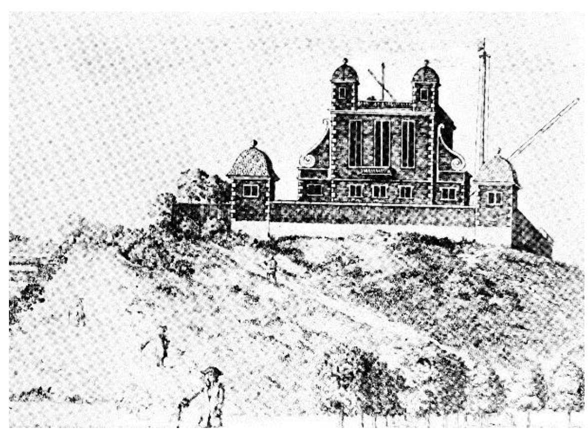

Figure 5: North elevation of the Royal Greenwich Observatory

[3] "Uraniborg - Observatory, Laboratory and Castle," TychoBrahe.com, A Universal Website, accessed July 15, 2014, http://www.tychobrahe.com/UK/uraniborg.html.
[4] Marian Card Donnelly, *A Short History of Observatories* (Eugene, Oregon: University of Oregon Books, 1973), 21-22.

contained a kitchen, unheated parlour, and store rooms.[5] On the ground floor there are four rooms that contained a bedroom and study for the first Astronomer Royal, John Flamsteed, and rooms for his assistant (fig. 6). On the second storey, there is one large octagonal room that housed instruments including a large mural arc sextant, quadrants, and small telescopes. Two tall pendulum clocks are built into the walls. The observatory was expanded incrementally to the south with small and large additions for both instruments and living accommodations, all without ever challenging the architectural prominence of the iconic north façade.

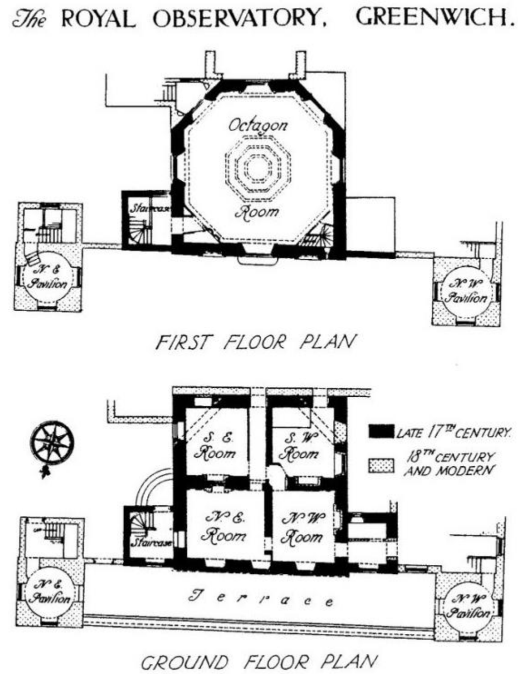

Figure 6: Floor plans of the Royal Greenwich Observatory

Built between 1835 and 1839, the Pulkovo[6] observatory was the first large institutional observatory,[7] and like the University Observatory at Gottingen before it consists of U-shaped plan with a central observatory block topped by a large central dome, with two side domes located at the junction of the two wings. However at Pulkovo, architect Alexander Brüllof designed a much larger central block, while the wings remained roughly the same size and still contained offices and living quarters (fig. 7). The building is entered through a temple-like portico, possibly inspired by the pantheon,[8] but was otherwise relatively spare. The large central block was fully occupied by observing rooms, signifying a shift in the proportional allocation of space towards larger instrument spaces.

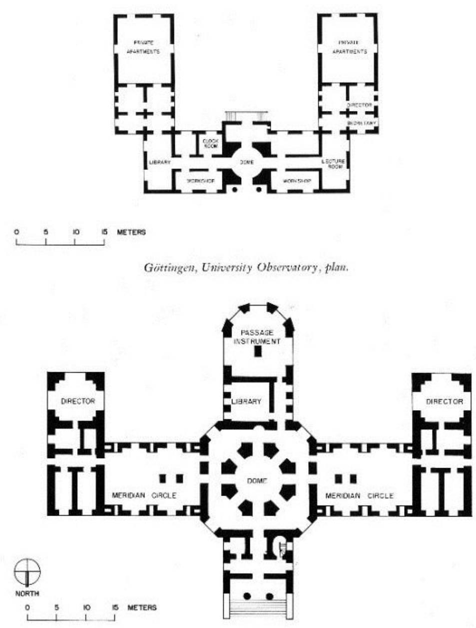

Figure 7: Comparison of the floor plans of the Gottingen (above) and Pulkovo (below) observatories.

The Strasbourg Observatory marks the beginning of the trend to physically separate instrument and habitable spaces. Here, the great dome and its large refraction telescope, a second

[5] Graham Dolan, “Flamsteed House and the Early Observatory,” The Royal Observatory Greenwich, accessed July 1, 2014, http://www.royalobservatorygreenwich.org/articles.php?article=916.
[6] Donnelly spells this Pulkowa, however I have opted to follow the transliteration favoured by the Russian Academy of Science: Pulkovo.
[7] Ibid, 72.
[8] Ibid. Donnelly notes that Brüllof had recently returned from Rome.

observation space with two small domes and a meridian room, and the living quarters were separated into three distinct buildings. Built between 1875 and 1880, the buildings were arranged on the university campus and connected by covered walkways to protect scholars and astronomers from bad weather (fig. 8).[9] The architect Hermann Eggert designed the three buildings individually (fig. 9), rather than as a complete whole,[10] focusing the attention and architectural expression on the great dome, and giving it a temple-like appearance.

This approach to design and construct separate buildings for observing instruments and support spaces was extended with the Bischoffsheim Observatory at Nice, France. Built between 1881 and 1887, it was the first European observatory built at altitude, and the buildings were located to suit the topography of Mont Gros (fig. 10).[11] Architect Charles Garnier (already famous for the Opéra de Paris) designed a number of individual buildings containing both instruments, public and support program including a laboratory, residence, library, and large telescope. Garnier's building for the large refraction telescope was a fairly elaborate Egyptian-inspired neo-classical design, which was topped with a large unornamented ribbed metal dome that he designed in collaboration with Gustave Eiffel (fig. 11).[12] Following the construction of the Nice Observatory, the desire to move observatories to higher altitudes to would become

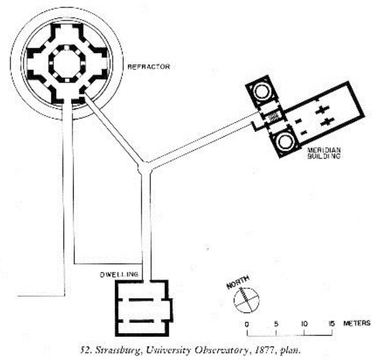

Figure 8: Floor plan of the Strasbourg Observatory showing the three distinct building and covered walkway.

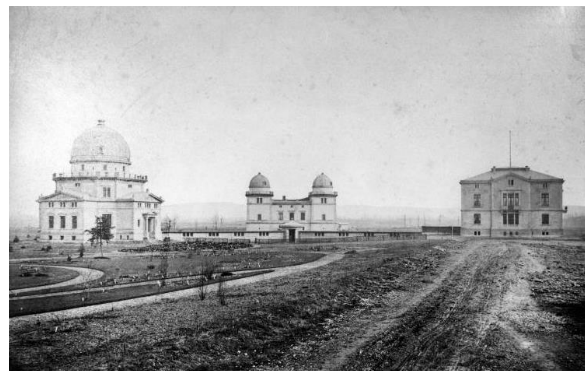

Figure 9: Photo of the Strasbourg Observatory. The great dome is on the left, and the residence is on the right.

Figure 10: The Nice Observatory distributed on the slopes of Mont Gros.

[9] André Heck, *A Multinational History of the Strasbourg Observatory* (Dordrecht: Springer, 2005).
[10] Donnelly, 111.
[11] Françoise Le Guet Tully, "La Patrimoine de l'OCA: Disposition des bâtiments sur le site," Observatoire de la Côte d'Azur, accessed June 17, 2014, http://patrimoine.oca.eu/spip.php?article50. The observatory was built at 375m above sea level
[12] Ibid.

prevalent, as would the tendency to have separate buildings for instruments and support program.

The Lick Observatory on Mount Hamilton, built 1885-1888 at an altitude of 1283m, and the Mount Wilson Observatory, built 1904-1908 at an altitude of 1738m, are both important examples of this trend of separation. At Mount Wilson, the separation between buildings, specifically between the instrument buildings and the support buildings was stretched much further – the offices were located over 40km away in Pasadena, California.[13] Furthermore, these observatories mark a significant change in the architect's role from planner to advisor,[14] where engineering concerns outweighed architectural design, and the expressed desire of observatory director was that "'the first object should be to prepare everything with reference to its use, and then to give the building such an architectural effect as seems best without interfering with its utility.'"[15]

The David Dunlap Observatory in Richmond Hill, in addition to illustrating the inclination to physically separate instrument and support spaces, also clearly shows the different aesthetic approaches that came to characterize the design of the two types of space. The Toronto firm of Mathers and Haldenby was hired in 1932 to design the administration building, producing a beaux arts classical limestone building complete with stone quoins, bas relief panels and detailing

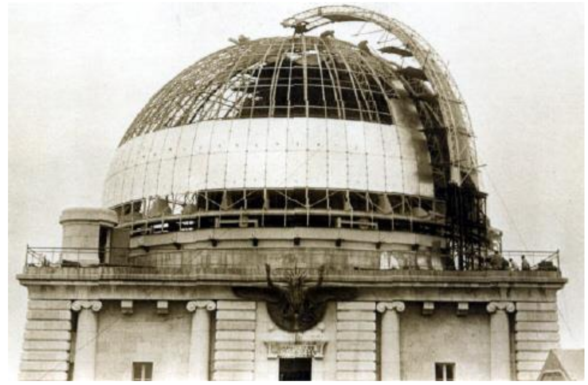

Figure 11: Photo of the telescope building at the Nice Observatory showing Garnier and Eiffel's floating dome under construction. Also note the winged Egyptian god above the entrance.

Figure 12: Mathers and Haldenby's administration building at the David Dunlap Observatory

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[13] "The Carnegie Observatories: History" Accessed July 18, 2014. http://obs.carnegiescience.edu/about/history. The Mount Wilson Observatory was funded by the Carnegie Institution. In 1969m, the Carnegie Observatories went on to establish the Las Campanas Observatory in La Serena, Chile, more than 8300 km from the main offices, library, archives and machine shops in California.

[14] Donnelly, 119.

[15] Edward S. Holden, "Notes on the Early History of Lick Observatory," *Publications of the Astronomical Society of the Pacific* 4, no. 24 (June 11, 1982): 139, quoted in Donnelly, 117.

(fig. 12).[16] Though such a grand and embellished building was understood by the architects and client to befit an observatory administration building, the great telescope dome was in stark contrast. It was an unornamented construction of steel ribs and sheet metal that "gave the building a somewhat mechanistic appearance."[17] Utility and economy determined its design, and likely sharing the same sentiment of the director of the Mount Wilson observatory, the telescope dome need only contain the telescope and cover it with a moveable dome capable of the required span (fig. 13). In fact, the dome's designer is not even mentioned. A contemporaneous account of the building project by the Dunlap observatory's director describes the dome and administration building in detail, noting Mathers and Haldenby's involvement only in the latter.[18] Though the dome at the David Dunlap Observatory was the focus and *raison d'être* of the observatory, and indeed at many observatories after it, it was fully removed from the realm of architecture, willfully 'un-designed', and conceived as an independent utilitarian enclosure.

Figure 13: The telescope dome at the David Dunlap Observatory

As observatories grew to incorporate larger telescopes, and were built at higher altitudes, the separation of the instrument spaces from other spaces, with general attitudes about their design, became entrenched. The telescope domes became the visible focus and singular identity of the observatories, while the support buildings disappeared entirely or played a much reduced role. Already removed from the realm of architecture, the design of the telescope buildings continued to be dominated by utilitarian ideas and aesthetic. Architect and critic George Baird, in broader terms, describes this concept of pure instrumentality. Baird, referring to Hannah Arendt, describes instrumentality as a condition "where the ends not only justify the means …

[16] "David Dunlap Observatory and Park," Heritage Canada the National Trust, accessed July 16, 2014, http://www.heritagecanada.org/en/issues-campaigns/top-ten-endangered/explore-past-listings/ontario/david-dunlap-observatory-and-park
[17] Donnelly, 137.
[18] Clarence A. Chant, "The David Dunlap Observatory," *Journal of the Royal Astronomical Society of Canada* 26 (1932): 289. Chant describes both buildings in great detail, but only attributes the administration building to Mathers and Haldenby, omitting any design attribution for the dome.

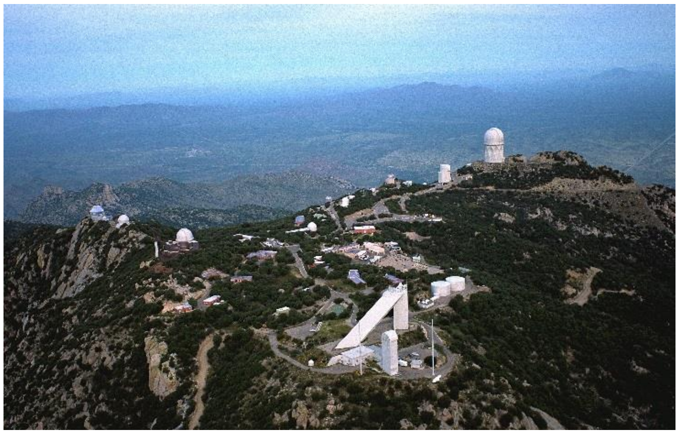

Figure 14: Kitt Peak Observatory, California.

Figure 15: Mauna Kea Observatory, Hawaii.

Figure 16: The MMT (multi mirror telescope) at Mt Hopkins Observatory, Arizona.

Figure 17: Paranal Observatory, Chile.

but produce and organise them,"[19] where architecture is characterized above all by its productivity and use value. Indeed, a narrow interpretation of rigorous functionalism and economy were, and still are, primary concerns in observatory design, and with time began to dictate the form and design of the buildings. The Kitt Peak National Observatory, California (1962); Mauna Kea Observatory, Hawaii (1967); MMT Observatory, Mount Hopkins Arizona (1987); and Paranal Observatory, Chile (1998) (figs. 14-17), clearly illustrate this functionalist and instrumental approach.

In the midst of this general movement from the early observatory as a monumental and complete work of architecture, to the contemporary observatory as a fragmented and instrumentalized cluster of telescope sheds, there are some notable exceptions. Indeed even within the examples I have listed so far there are outliers. For instance, the McMath-Pierce solar telescope at the Kitt Peak Observatory, designed by

[19] George Baird, *The Space of Appearance* (Cambridge, MA: MIT Press, 1995), 133.

Skidmore Owings & Merrill (fig. 18), gracefully incorporates functional requirements, challenging mechanics and cooling into an elegant and monumental form that evokes two balancing obelisks.

Erich Mendelsohn's Einstein Tower is another poignant exception. Designed between 1917 and 1920, and built between 1920 and 1922, the tower (fig. 19) is described by architectural historian Kathleen James as "a pivotal point between the prewar fascination many German architects had with monumental architecture and the postwar *neue Sachlichkeit* substitution of technology for pomp."[20] Designed to house instruments to test Einstein's theory of relativity by observing the sun's light spectra, the "Tower provides the first example of what became Mendelsohn's characteristic manipulation of dynamic form within functional bounds, as he attempted both to represent and serve Einstein's controversial new scientific theory."[21] Working closely with his friend, and client for the tower, astrophysicist Erwin Finlay Freundlich, Mendelsohn responded carefully to the technical requirements of the solar telescope and other programme spaces. Mendelsohn was also profoundly influenced by Einstein's theory of relativity, and the equivalence of matter and energy dictated by the theory shaped his idea of the relationship between mass, motion, and light. He conceived of matter as fluid and animate, and of the tower as an organism – a hybrid form of technology and a living body.[22] The sculpted curves of the overall massing, window openings, and even roof scuppers, evoke the dynamism of a body moving through space (fig. 20), articulating his understanding of the technology and character of its materials – the steel skeleton supporting a plastic reinforced concrete flesh[23] – and at

Figure 14: The McMath-Pierce solar telescope at Kitt Peak, designed by Skidmore Owings & Merrill.

Figure 15: Erich Mendelsohn's Einstein Tower, Potsdam, Germany.

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[20] Kathleen James, "Expressionism, Relativity, and the Einstein Tower." *Journal of the Society of Architectural Historians* 23, no. 4 (Dec. 1994): 405.
[21] Ibid, 392.
[22] Ibid, 407.
[23] James, 405. James notes that Mendelsohn's vision of plastic sculptural reinforced concrete may well have been naïve, and owing partly to the challenge of forming the curves, and to cost saving the tower is mostly constructed of brick and plaster stucco.

the same time, capturing the cultural spirit of its time, evoking the movement of Kandinsky's expressionist painting and dynamism of Boccioni's sculpture.[24] The Einstein Tower is often cited as an example of expressionist architecture, and was criticized by proponents of the *neue Sachlichkeit* as irrational, eccentric, individual, and monumental. However, by looking more closely at Mendelsohn's ideas and design process, the tower can also be seen as a rational attempt to genuinely express the theory of relativity in built form.


Figure 16: Detail of the Einstein Tower's window openings and scupper.

My design for a nature centre is a nuanced response to the legacy of observatory design and to Mendelsohn's particular design process. Rather than rejecting the narrowly functional and instrumental condition of observatory design, I propose an expanded approach to instrumentality, drawing in multiple and layered considerations of building technology, thermal movement and mechanical systems, structural forces, programme and function, vernacular building, and environmental stewardship, into the design process. This extends Mendelsohn's approach, in the sense that the design incorporates the technical and programmatic requirements, material characteristics, and expresses its function in architectural terms, but rather than seeking to *represent* its generative ideas formally, the nature centre explores the limits of this multifold instrumentality, and embodies them in a finely-tuned and integrated architecture.

In its relationship to the neutrino observatory, the nature centre and neutrino detector caverns are also analogous to the physically separated elements of an astronomical observatory. Where the neutrino observatory is a collection of spaces that house detectors and experiments, the nature centre contains a wide range of ancillary and supplementary programme that relate to its role as a support building, and its alpine context. However, my design for the nature centre rejects the aesthetic dichotomy between science spaces and public or support spaces, between instrumental and monumental architecture, instead pursuing a hybrid approach that through

[24] Ibid, 394-407.

multiplied, interwoven instrumentality expresses its cultural significance in the close attention paid to its physical, cultural, and environmental context.

Conceived as the outward expression of an underground observatory buried deep beneath the France-Italy border, the nature centre sits at the mouth of the observatory access tunnel and cantilevers over the excavation spoil heap, looking over the town of city below. The nature centres acts as a beacon and entrance point for the hidden observatory, pointing to its presence and indicating the scale of the hollow underground spaces by the enormous quantity of stock-piled excavation spoil. The excavation process, and the synthetic landscape that results, are central to the form and focus of the nature centre, which examines strategies for the ecological regeneration of the spoil heap. The form and structural system of the nature centre directly engage the spoil mound as an anchor and counterweight for the cable stays that support the cantilevered building. The nature centre is coupled thermo-dynamically to the observatory, and forms the end of a thermal loop. It removes the geothermal heat that accumulates within the mountain, using it to generate electricity and warm thermal baths that are buried within the spoil mound.

Reaching out in order to look back on the spoil, the nature centre manifests a speed and trajectory that suggest an energetic source deep within the rock. Like the Main Ring Lake at Fermilab outside of Batavia, Illinois, the form of the nature centre and the spoil mound itself trace, and refer to, subterranean space. However, unlike the Main Ring Lake, the references here are not direct transpositions of form, but isometric and scalar translations that reveal only partial information. The spoil mound volume indicates the aggregated scale of the underground caverns that make up the neutrino observatory, but gives no indication of their configuration. But even with this intuitive and physical reference to the magnitude of hollow underground space, precise estimation is challenged, since the only the surface dimensions are knowable and the depth of the spoil mound is unclear. One is left with a tangible feeling of something that one cannot objectively know.

The nature centre is coupled thermodynamically with the neutrino observatory, acting both as a radiator and absorber of the geothermal energy accumulated in the observatory. The ambient rock temperature in the heart of the Col du Fréjus is nearly

38°C. This unremitting heat surrounds the observatory spaces, necessitating constant cooling of the labs. The neutrino detectors themselves operate optimally at 12°C, setting up an even steeper temperature gradient. As heat is constantly pulled out of the observatory environment, it is transferred to a water loop that is piped to the nature centre where the geothermal 'waste' heat is used for heat and power (fig. 21). A thermal transfer station within the nature centre concentrates the heat and generates electricity with a micro-turbine. The hot water loop is used to heat the pools in the thermal bath, and the building's radiant heating system. Finally, the upper spoil mound functions as a natural draft cooling tower, and evaporatively cools water as it percolates through the loose rock before returning it to the observatory.[25]

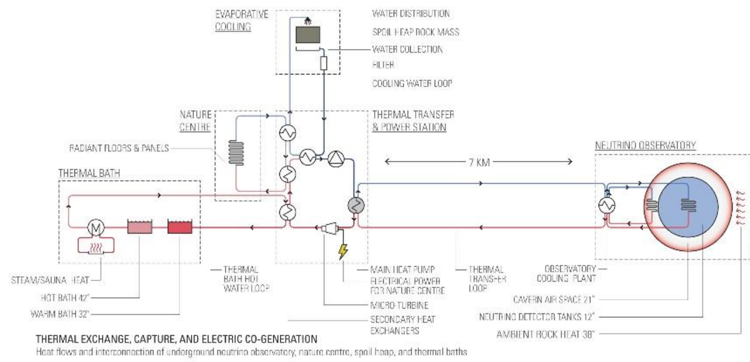

Figure 17: Diagram of thermal exchange loop linking the nature centre and neutrino observatory

The excavation of the observatory chambers and access tunnel causes a radical re-organization of the geological strata, disrupting the churned forms of metamorphic rock, and replacing it with a new indistinct fluidity. The sedimentary precursors of the calcareous schist that make up the Col du Fréjus were laid down layer by layer in horizontal strata at the bottom of an ancient ocean. Under immense pressure and temperature, these sediment were gradually transformed into foliated schists, which were again deformed as the tectonic plates collided in slow-motion, crumpling, twisting, and folding the layered rock. The resulting rock mass is at once ordered and convoluted, seemingly static in a human frame of reference, but behaving like an viscous fluid at the scale of geological time. The order and placement of the various rock types, veins of mineral inclusions, and rock strata are broken by the boring machine in the excavation process, and are transplanted from the centre of the mountain to its surface and deposited in a near homogenous arrangement. As the tunnel boring machine inches through the rock, each successive layer of the vertical rock face it encounters is

[25] More recent development of my nature centre design moves the evaporative cooling from the spoil to a mesh sheath that wraps the cantilevered building exoskeletal matrix, enveloping the centre in a misty veil. Strategically placed openings in the mesh direct updrafts which punctuate the fog and allow views out to the landscape.

pulverized and transported to surface where it is dumped down the face of the growing spoil mound. Since the excavation and disposal process is incremental, what was once finely layered solid becomes a dispersed rock 'foam' that is deposited in diagonal layers that homogenize and blur all detail, maintaining only macroscopic differences. The process of removal transfers the borders between geologically distinct nappes to the spoil heap, retaining basic information about broad changes in rock type, but muddling the boundary between them, and allowing the distinct types to overlap and bleed into each other.

The nature centre focuses on this synthetic landscape of excavation spoil, using it to examine the regeneration of sensitive ecosystems after the devastation of rockslides, the dispersal of mine tailings, or other scarred landscapes. From its extended position, the nature centre offers an opportunity to observe the process of unassisted re-naturalization, and monitor active strategies for regeneration including re-forestation, directed plantings, and low-intensity agriculture (fig. 22). These diverse strategies for regrowth can be seen by visitors and nature centre staff from the long observation deck promontory on top of the nature centre building, and can also be explored along walking trails that connect a number of large and small terraced areas and lookouts. This focus on the establishment of plant and animal life of the spoil mound anticipates a range of naturally occurring and manmade conditions, including the frequent rockslides that occur throughout the Alps, the corresponding need to stabilize loose material, the construction of the Lyon-Turin base tunnel and the resulting massive volume of spoil it will create, and the more general questions of mending the scarred landscapes of ore tailings, open pit mines, and the residues of tar sands extraction.

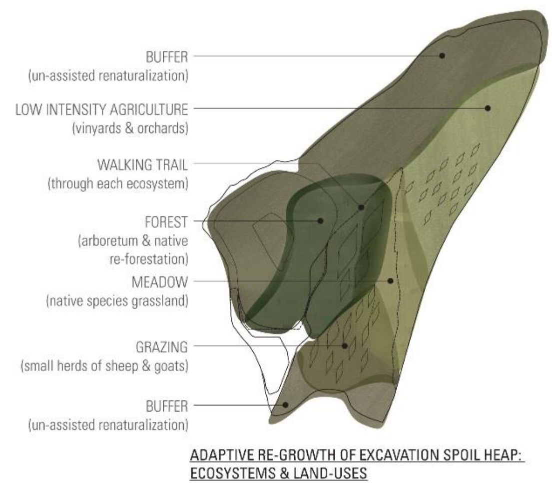

Figure 18: Plan diagram showing placement of re-growth strategies.

In addition to being the nature centre's focus of study, the spoil mound is also its physical foundation, providing the weight necessary to enable the nature centre's reaching lightness. A splayed array of cable support the cantilevered nature centre, connecting to nodes on the centre's exoskeletal structural matrix. The regular cable array distributes the nodes in such a way as to create an evolving irregular three dimensional truss matrix (fig. 23), the form of which evokes a sense of movement akin to the photographs of Etienne Jules Marey (fig. 24), and recalls Hans Grubenmann's remarkable layered alpine wood bridge designs (fig. 25).[26] As the cables extend back towards the spoil mound, they are gathered into two thick bundles at the moment they pass through the surface of the spoil mound. At this point of concentration, the cable bundles run over steel saddles sitting atop two massive concrete struts. The cables then disperse into the spoil heap, subdividing into smaller and smaller bundles in order to establish themselves in a three dimensional network of low-strength friction anchors. This strategy distributes the forces over a diffuse area, activating the aggregated weight and internal friction of a sizable portion of the loose spoil to anchor the cantilevered building. The floor diaphragms gather the compression forces needed to balance the pull of the cable stays. A series of ribs and gradual thickening of the slabs direct the forces into four asymmetric tubular struts. The hollow centres of the struts carry building services of serves as the connecting walkways between the underground and above ground spaces.

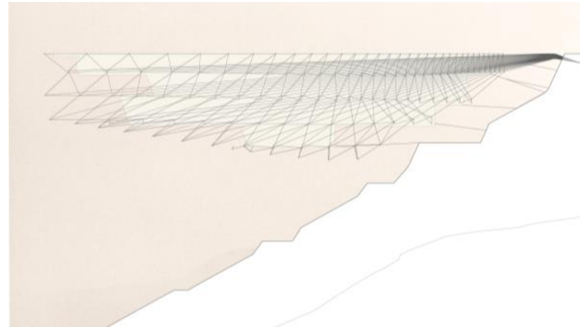

Figure 20: Elevation of the nature centre's external structural matrix.

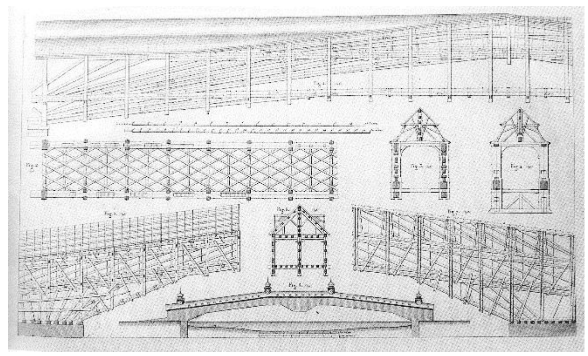

Figure 19: Grubenmann's design for the Schaffhausen Bridge.

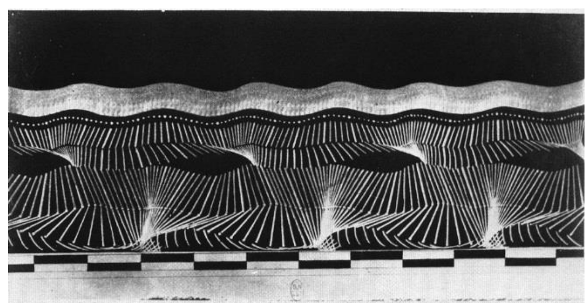

Figure 21: Étienne-Jules Marey, Walking Man, chronophotography, 1884.

Upon arrival to the nature centre, visitor pass through a series of large buried voids in the spoil mass, walking beneath the thermal transfer station and thermal baths. Climbing a staircase within one of the hollow structural struts, visitors pass through surface of the spoil, and arrive at an open reception area and information desk. Two large exhibition spaces house permanent displays, accommodate visiting exhibitions, and serve as large multi-purpose spaces. Two medium-sized tiered multimedia classrooms can be used individually for workshops and seminars related to the nature centre's or observatory's activities, or combined into

[26] Angelo Maggi, Nicola Navone, eds., *John Soane and the Wooden Bridges of Switzerland: Architecture and the Culture of Technology from Palladio to the Grubenmanns* (London: Sir John Soane's Museum; Mendrisio, Switz.: Archivio del Moderno, Accademia di architettura, Università della Svizzera Italiana: 2003).

one large hall for presentation and conference addresses. A café and restaurant are located at the tip of the nature centre has views out over the spoil mound, the alpine valley, and city below. In addition to these extroverted uses, nature centre building also includes a small hotel and thermal bath. Tourists and visiting scholars are accommodated in seven rooms that look out to the surroundings. A series of hot, cold, and tepid pools are buried within the spoil mass, reinterpreting the heritage of colonizing natural hot springs, and creating an abstracted equivalent that is displaced from its geothermal source in the heart of the Alps, and transposed from a usual home on a mountain side to voids within the newly foamed rock.

In a broader sense, the nature centre's program also compliments that of the neutrino observatory, operating at physical and timescales between the extremes explored in neutrino physics. Where the neutrino detectors study phenomena at incredibly small sub-atomic scales, and explore their relationship to incredibly large scale questions,[27] the nature centre operates in the intervening scales, centering on the scale of a human and extending down to the realm of plant biology and up to the scale of geology. By focusing on the particular and subtle characteristics of the many disciplines, systems, energy flows, and technology that overlap in the nature centre, an expansive and multi-layered instrumental design approach emerges. This manifold instrumentality offers an alternative to the narrow functionalism and segregation that has generally come to pervade the design of spaces for science, without rejecting it outright in favour of a return to monumentality. Instead, by engaging in a detailed way with multiple frames of reference, the result is an evocative and highly specific architecture.

[27] Neutrinos range in size from approximately $1x10^{-26}$m to $1x10^{-26}$m. Neutrinos may provide a way of understanding the matter and anti-matter asymmetry that was produced during the formation of elementary particles during the processes of baryogenesis and leptogenesis that occurred in the early stages of the universe in the big bang. Neutrinos may also offer a means to see beyond the cosmic microwave background radiation that defines the edge of the observable universe.

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