

# **CONSTRUCTING HEALTH – THE PURSUIT OF ENGINEERING A “HEALTH-PROMOTING INTERIOR CLIMATE” DURING THE 1830S AND 1840S**

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## **Keywords**

History of services (heating & ventilation), development of standards and codes

## **Abstract**

Taking a close look at the planning process of a major hospital built during the 1830s and 1840s opens up a new perspective into the process of selecting, implementing, and improving heating and ventilation systems during a period of ever-expanding technological options. Based on original planning documents and committee reports, as well as on contemporary treatises and articles, this paper seeks to shed light on the process of defining minimum standards and specific requirements. Furthermore, it will explore the reasons why, out of a wide range of systems proposed in technical magazines, only a few were practically implemented and further developed.

By 1830, public health had become a major economic impact factor. Spending a substantial sum of public money to improve the general health care situation appeared to be a worthwhile investment. Hence, the Zurich cantonal government decided, in 1835, to build a specialized hospital dedicated to curable patients only. “The elderly, infirm, miserable, and terminally ill” were explicitly excluded from this new kind of institution.

In those years, prominent hygiene enthusiasts proclaimed that, through a ‘health-promoting interior climate’, almost any disease could be cured. Despite the fact that, by 1830, it was far from clear which parameters exactly constituted such a climate, the Zurich authorities decided to engineer just that. Planning and installing an actual heating and ventilation system turned out to be a process that lasted over 6 years. First of all, an expert committee had to be formed that could agree on the particular requirements. A specific system had to be chosen out of numerous technological options, quotes had to be compared, and expert advice obtained. Subsequently, systems were partially installed, tested, and amended. Compliance with technical parameters turned out to be just one important criterion. Issues like investment costs and durability were considered; and even more crucial questions concerning warranties, repairability, and locally available technical competencies were discussed.

By 1830, the procurement of services led to the development of a set of complex specification criteria. Hence, understanding the history of services also requires a study of these criteria that facilitated the establishment of standards and codes during the following decades.

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## INTRODUCTION

The early 19<sup>th</sup> Century witnessed a boom of new hospital constructions throughout Europe, which led to the layout and implementation of adequate ventilation and heating plants becoming a rigorously discussed topic. Planning documents, as well as committee meetings, technical treatises, and journal articles emphasized the utmost importance in providing a hygienic and ‘health-promoting interior climate’. Although, by 1830, it is far from clearly defined which parameters exactly constituted such a climate, only after a period of several decades were specification parameters of acceptable temperatures and relative humidity ranges, air exchange rates, as well as maximum CO<sub>2</sub>-levels agreed upon.

As early as the second half of the 18<sup>th</sup> Century, the design of efficient heating and ventilation systems was an acknowledged key-aspect of a successful new hospital. Besides temperature, stakeholders were convinced of the importance of purified air, since “foul air” was believed to be the primary origin of most common diseases. The English physician Thomas Percival noted in 1771: “Air, diet and medicine, are the three great agents to be employed, in preventing and correcting putrefaction and contagion in hospitals. A gallon of air is consumed every minute by a man in health, a sick person requires a larger supply, because he more quickly contaminates it” (Aikin 1771).

A similar view was expressed by the German physician Franz Häberl in 1813: “The breathing of a healthy person already vitiates the air, even more so in case of a sick person. [...] As diverse as the alloys might be that contaminate the air, greatest attention should be directed towards the transition of matter that may transmit a disease to other patients” (Häberl 1813). The only effective remedy, Häberl added, was to ensure an efficient air exchange during both day and night. Similar to Thomas Percival, who recommended the use of ventilators, sash windows, and extraction ducts for the construction of hospital wards, Franz Häberl occupied himself with the design and improvement of heating and ventilation systems for hospitals, and reported on his supervision of extensive alterations to the Munich St. Maximilian Hospital, undertaken between 1794 and 1802, to ensure an “atmospheric salubrity”. Häberl further noted that he could greatly benefit from these experiences, and applied them during the design process of the new General Hospital in Munich which opened in 1813 (Häberl 1813).

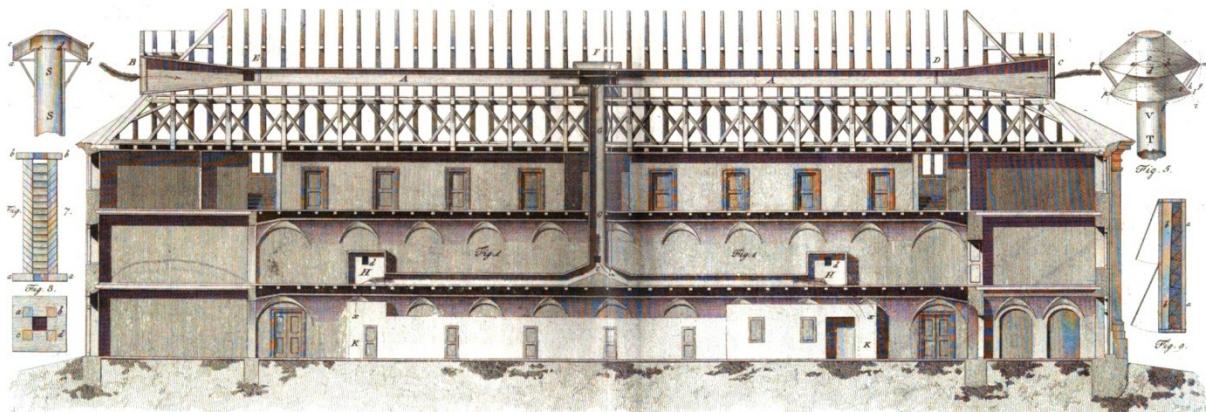


Figure 1: Cross section of the General Hospital Munich: Häberl, Franz: «Abhandlung über öffentliche Armen- und Krankenpflege...» 1813 , Bd.: 2, Tafel VI

When the Zurich cantonal government decided in 1835, to allocate a large sum of public money towards the construction of a new hospital, its primary concern was to ensure that the money would be spent on a building that facilitated the speedy recovery of patients by means of adequate ventilation and heating.

## DESIGN & SPECIFICATION PROCESS

### Competition

By the beginning of the 1830s it became evident that the existing Cantonal Hospital – where over 530 people were cared for – had become too small. As well as 140 “curable patients”, the hospital also accommodated orphans, paupers, the mentally ill, and pregnant women. (StAZH. S 231.5; 16). The cantonal government, therefore decided to build a new hospital that would “comply with the requirements and demands of our times”, while the old hospital would continue to serve the “old, feeble, miserable and incurable [...] the new hospital would be dedicated to patients only” (StAZH. S 231.1; 108 § 2).

In 1836, all 13 entries for the subsequent architectural competition were dismissed due to their display of an “utter ignorance of science and laws of health” (StAZH. H I 476. 28 March 1836). The responsible expert committee therefore decided to commission the architect of the second placed scheme [Figure 3] and another participant [Figure 2] to submit plans for the new hospital, following a rigid brief drafted by the committee.

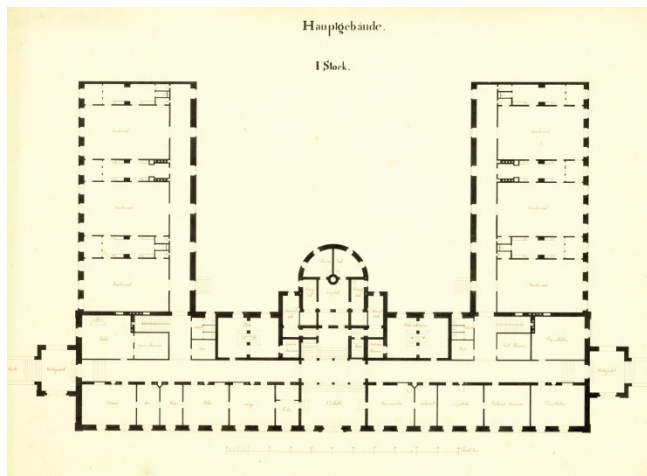


Figure 3: Design proposal for the new Cantonal Hospital by Albert Wegmann, First Floor, Baugeschichtliches Archiv Zürich, Zeugheer Nachlass, Zeu 6Ab

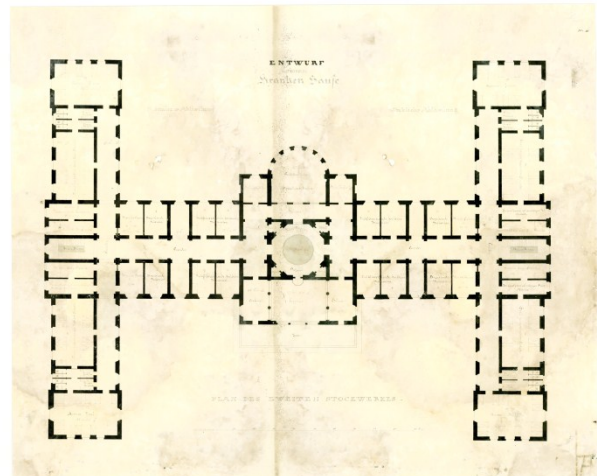


Figure 2: Design proposal for the new Cantonal Hospital by Leonhard Zeugheer, First Floor, Baugeschichtliches Archiv Zürich, Zeugheer Nachlass, Zeu 6d

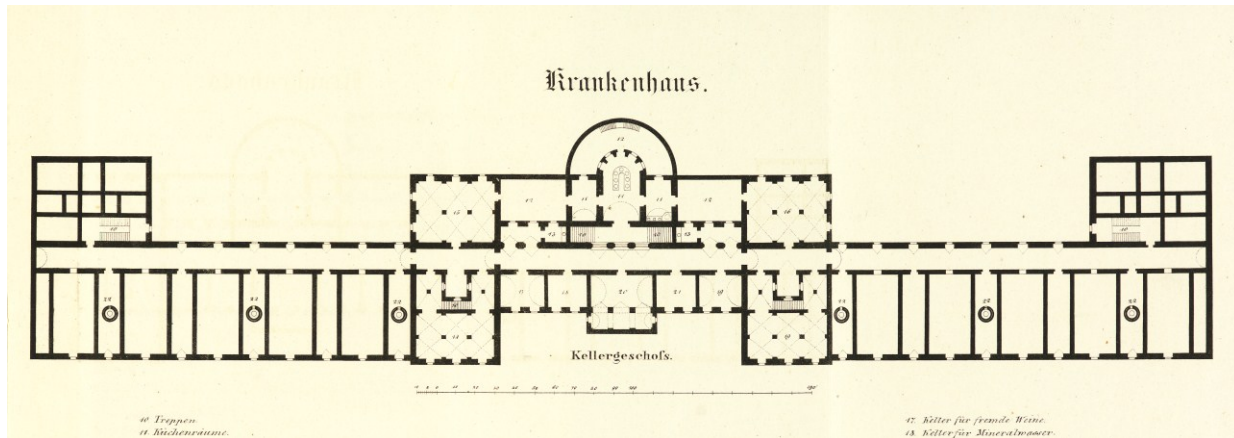


Figure 4: Joint Design by A. Wegmann & L. Zeugheer, Basement Plan, StAZH S 231.5; 16

### Implementation of a heating and ventilation system

The basement plan [Figure 4] of the joint design scheme submitted by Leonhard Zeugheer and Albert Wegmann in 1836 shows provisions for an air-heating system very similar to the one proposed for the *Berliner Bauakademie*, and whose plans were published in several editions of the architectural magazine *Allgemeine Bauzeitung* during the same year [Figure 5]. The costs for this bespoke air-heating system were estimated at Fr. 8,000. However, it was actually only implemented in the adjoining anatomy building.

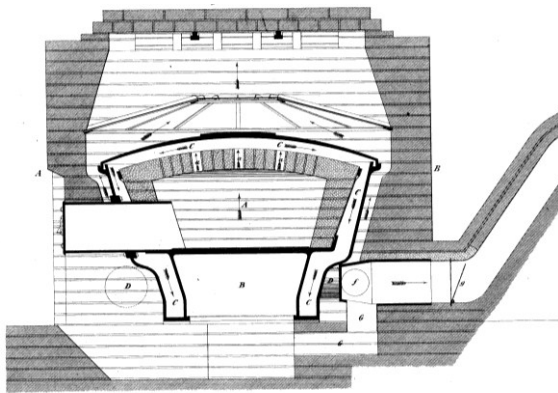


Figure 5: Detail drawing of air heating system of the Berlin Bauakademie published in *Allgemeine Bauzeitung*, 1836, Nr. 29, Table LII, Fig. 3

Only three years after the approval of the joint design scheme, both architects had changed their opinions on the air-heating system, and were less convinced of its feasibility. In the minutes of the responsible building committee meeting, the following entry can be found on 12 March 1839: “In regards to the salubrity many observations have shown that an extended stay in an air-heated room [...] causes headaches, anxiety and arduous breathing, despite the fact that fresh air is constantly drawn from the outside and heated, and indeed a constant air-exchange is guaranteed, we can see that through the heating process most gaseous

forms of water particles are destroyed, which causes a certain dryness considered to be disadvantageous for the respiratory process.” (StAHZ, H I 479)

The building committee, therefore, decided to authorize the two architects to search for suitable alternatives to the originally proposed system. After ruling out conventional stove heating, the architects proposed to adopt *Price’s Patent Warming and Ventilation Apparatus*, which was introduced in both the *Mechanic’s Magazine* in March 1838 and, subsequently, in *Dingler’s Polytechnisches Journal* [Figure 6] during the same year. Unlike the air-heating system proposed for the *Berliner Bauakademie*, the Price-heating system heated air through a secondary hot-water system, where “water [is] being raised to the boiling point (212°), a continual and rapid circulation is kept up between the boiler and series of iron cases, imparting to



their extensive surfaces the power of effectually warming the thin equal stream of fresh air, which are admitted beneath them from the external atmosphere” (Mechanics' Magazine, 1838). Albert Wegmann himself – one of the two commissioned architects – published an article in the Swiss magazine *Zeitschrift über das gesamte Bauwesen* in 1839, where he praised the merits of the Price heating and ventilation system as perfecting the ordinary air-heating systems by preventing an “overheating of inlet air [...] and thereby retaining its degree of humidity” (*Zeitschrift über das gesamte Bauwesen* 1839).

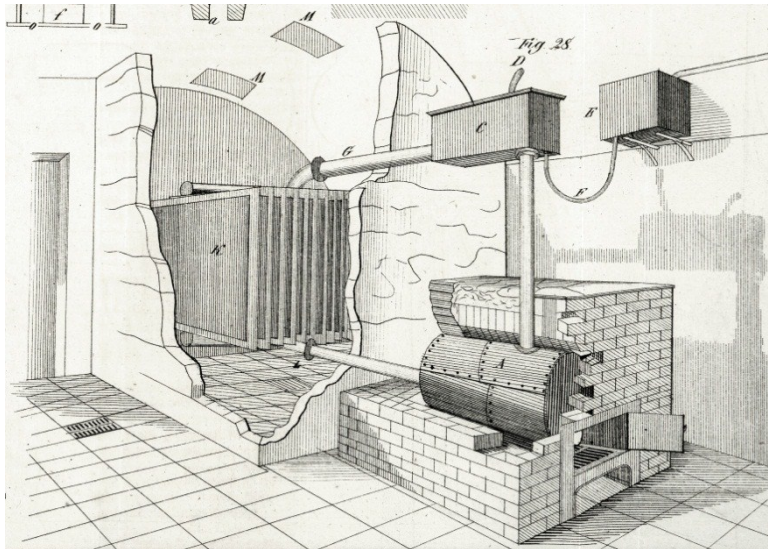


Figure 6: Price's Patent Warming and Ventilation Apparatus: Dingler's Polytechnisches Journal 1838 Band 70, Nr. VI, Taf. 1, Fig. 28

The building committee sympathized with the architect's proposal, but had to reject the Price heating and ventilation system upon receiving a quote for over Fr. 35,000, which was over four times the original budget. Further concerns were raised in regards to the ability of local companies to maintain and repair the system if needed (StAHZ HI 479, 12th March 1839).

Subsequently, the building committee instructed the architects to assess the option of installing an alternative hot-water heating system (StAHZ HI 479, 28th June 1839), to which the

architects responded some two years later by submitting a report in which they stated that several buildings in Zurich had already been successfully equipped with hot-water heating systems and that, despite the higher investment costs, the significantly reduced fuel consumption made these systems more economical in the long term (StAHZ HI 479, 11 March 1841).

Two months later, H. Escher Wyss & Comp, a company specially advocated by the architects as being the most experienced and suitable to undertake the work, submitted a quote for a bespoke project of Fr. 13,799. The proposed system was based on a Perkins hot-water heating system, with several boilers placed on the ground floor level, serving each four wards by forming hot-water spirals in the center of each ward, through which external cold air is passed by means of an under-floor duct.

Prior to 1841, Perkins hot-water heating systems were discussed in various German-language technical magazines. One of the earliest articles was published in Dingler's Polytechnisches Journal in 1832. This article stated that the high operating temperatures of the system would allow for small heating surfaces. By installing heating pipes of only 3.5 cm in diameter along the walls of larger rooms, considerable volumes could sufficiently be heated (Dingler's Polytechnisches Journal, 1832). During the 1830s, several German language magazines reported that the Zurich-based company H. Escher Wyss & Comp successfully installed Perkins hot-water heating systems in larger buildings. An article published in 1835 stated that, due to concerns being raised in regards to potential accidents that could be caused by the bursting of hot water pipes, the heating system was tested at the factory site of H. Escher Wyss & Comp by increasing the flow temperature – normally ranging between 175-200°C – to over 320°C, causing no disruption or explosion (Bernoulli 1835).

Following the quote submitted in May 1841, the building committee decided on 17<sup>th</sup> June 1841 to test the system prior to signing a final contract with H. Escher Wyss & Comp by partially installing the system in two hospital wards (StAZH HI 479). During its subsequent testing phase, major deficiencies were noted in providing equal temperatures in the two wards. These complaints led to a range of amendments upon which H. Escher Wyss & Comp is commissioned to install the system throughout the entire hospital under the constraint that the performance of the system would be monitored during the winter months of 1842 and 1843, and that the company would be liable to remedy all detected defects gratuitously. The contract further states the H. Escher Wyss & Comp guaranteed that the wards and bathrooms could be heated up to 14 - 15°Ré [ 17.5 – 18.75°C] at an external temperature of -12°Ré [- 15°C].

During the following months, several complaints were voiced out by the building committee in regards to temperature differences, maintenance efforts, and insufficient air exchange rates. Despite minimum interior temperatures being reached as stated in the contract, significant temperature differences were measured on the ground and first floor levels. Measured temperatures on the first floor level were so high that the medical personnel were, in fact, concerned that it might be harmful to the patients’ health, and hinder their speedy recovery. Furthermore, the installed ventilation system was found to be deficient in providing ample fresh air to the hospital wards.

It became evident that the conditions enclosed in the contract with H. Escher Wyss & Comp fell short of the actual complex requirements to ensure a ‘health promoting climate’ in the hospital wards. Except for maximum interior temperatures, no threshold levels were defined for air-exchange rates or maximum CO<sub>2</sub> levels that needed to be met by the manufacturer.

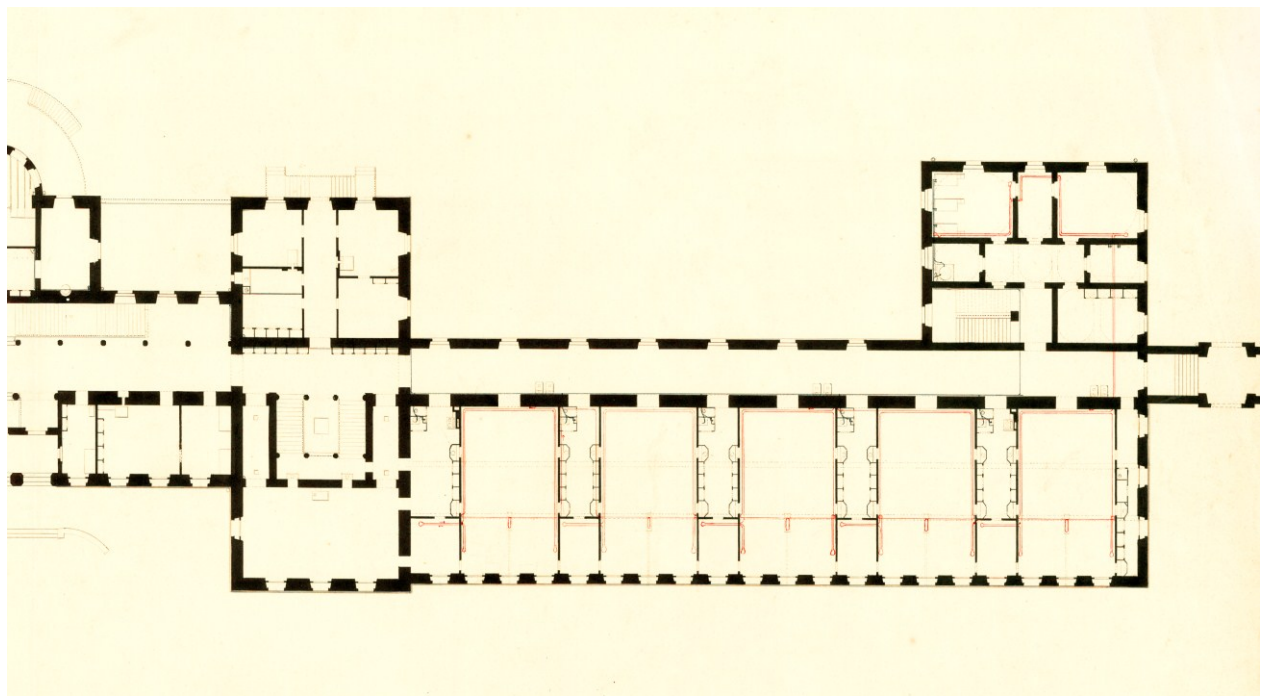


Figure 7: Ground floor plan with heating system: StAZH Planarchiv: Plan 6A1

## CONCLUSION

The erection of the Zurich cantonal hospital demonstrates a fundamental shift in the installation of plant systems during the first half of the 19<sup>th</sup> Century. Prior to that, a recognized expert in the field would have been consulted and instructed to install whatever he deemed necessary to ensure that the salubrity standards would be met. But, by 1830, things had gradually changed, and, out of ever-expanding technological options, a particular system had to be chosen. Simply tendering a heating and ventilation system that would provide “sufficient interior climates conditions” fell short of the actual demands. Only by defining exact threshold values could a procurement process be initiated that could facilitate a comparison of various different systems. This study demonstrates that, by 1840, it had become clear to all stakeholders that a sufficient monitoring system had to be established to ensure the long-term functional ability of the installed plants.

Furthermore, a crucial and still valid dilemma became apparent: the desire to specify an innovative system that met present and possibly higher, future demands, while at the same time specifying that the system was tested, thereby minimizing the risk of failure and the need for costly alterations. Moreover, the functional requirements and threshold values, warranties and liabilities had to be negotiated with the manufacturers and contractors.

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Constructing health – The pursuit of engineering a “health-promoting interior climate”

StAZH S 231.1: Staatsarchiv Kanton Zürich, Verzeichnisse Grundrisse/Pläne für Neubau.  
Kostenberechnung, Programme

StAZH S 231.5: Staatsarchiv Kanton Zürich, Programm betreffend die Erbauung eines neuen  
Krankenhauses 1835