Open Building in Health Care Architecture: The Case of the INO Project in Bern, Switzerland

Stefan GEISER, Architect, Canton Bern Building Department
Hochbauamt (HBA) Reiterstrasse 11
CH - 3011 Bern, Switzerland
stefan.geiser@bve.be.ch

Abstract:

The west surgery wing of the University Hospital "Insel" in Bern, which was completed in 1971, no longer meets operational requirements. A decision was made in 1995 that it must be completely renovated. The INO renovation project embraces in particular the Intensive care, Emergency and Surgery Centre. The Building Department of the Canton of Bern, which is responsible for overseeing construction work on the Insel hospital, is pursuing an open building method for the INO project to ensure that the "serviced structure" of the building (with main utility infrastructure) will continue to be highly adaptable, and that the components of the building are interchangeable and reusable. Building sections with differing service lives and designated purposes are therefore kept consistently separate in the planning and execution phases. The use of separate (discrete) systems anticipates the long-term life cycle of the building, and thus safeguards its value in terms of future use. Work is divided into discrete system levels: the primary system (building shell) is designed for a service life of 50 to 100 years, the secondary system (fit-out) for 15 to 50 years and the tertiary system (hospital equipment) for 5 to 15 years.

The project is currently in the execution phase and is being developed in three stages. The 1st stage, the primary system, was completed at the end of 2002, the other stages have not yet been implemented. The 1st stage of the INO project is to go into operation by 2006 and the 2nd stage by 2009.

Key words: medical architecture, open building, distributed responsibility, sustainability

1. The Problem

Let us start with a question: Would you buy a car if the tires were moulded to the wheel rims, and the wheel rims welded to the chassis? I expect that your answer will be no. The first time your car needs a tire change, you would have to destroy the entire vehicle - although it still drives perfectly well - in order to make it fit for the road.
But this very procedure has always been followed, and is still being applied, in the construction sector. For example, cables are sometimes buried into concrete load-bearing ceilings (Figure 1). When you need to replace them after 20 years, you have to destroy the intact building fabric. This leads to considerable follow-up costs which are difficult to

estimate. But perhaps you would suggest that the cables could be simply disconnected. But where would you find the necessary space for the replacement installations?

Figure 1: "Spaghetti junction"

2. The Underlying Ideas

The problems outlined above and the Building Department's many years of experience prompted the following considerations:

1. The entire life cycle of a building must be taken into account. The service life and the resulting costs of a building do not end when the building is completed. All of life, including the environment, is in a state of flux and subject to constant changes. Even a building is never quite finished. It changes over time, depending on its condition and on needs.
2. The different service lives of the individual components of a building must be taken into account (Figure 2). This applies especially where different components are interconnected and interdependent in the construction work. An assembly of elements can only reach the age of its shortest-living component.

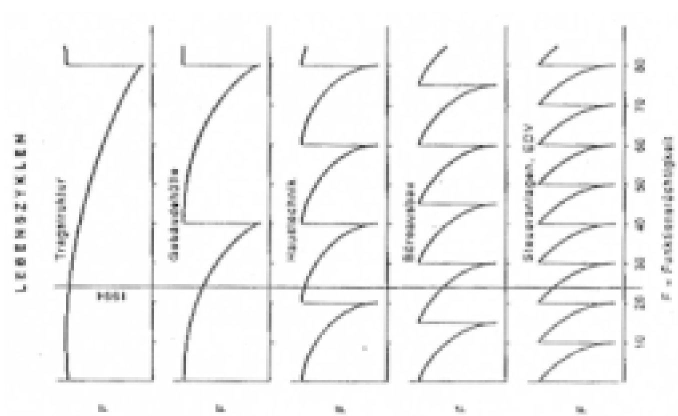

Figure 2: Life cycles

The follow-up costs are often underestimated in construction projects. Follow-up costs for building maintenance and renovation can be minimised if the best possible use is made of the service life of the components of the building. They can be reduced if individual components are assembled in such a way - during construction - that they can be replaced and reused when they reach the end of their service life without losing components that are still functional. This is only possible if they are not physically connected in a way that causes destruction when one part or the other is removed or replaced. This notion of separation or "disentanglement" contradicts the usual conventions of the planning and construction process and must therefore be pushed strongly by the client and management team.

3. The Method

These considerations led, logically, to a method of using discrete (autonomous) systems, although this is not readily accepted by advocates of the procedures followed to date. Urs Hettich and Giorgio Macchi (the former and the present head of the Canton Bern Building Department) developed an innovative, forward-looking planning method for the hospital construction work which aims to increase the service life of the building and reduce the follow-up costs. Operating and structural elements with different service lives and designated purposes are kept consistently distinct but coordinated in the planning and execution phases, thereby anticipating the later life cycle of the building.

Three discrete system levels are distinguished - the *primary, secondary and tertiary system* (Figure 3):

The *primary system* - with a service life of approx. 50 to 100 years - is a long-term investment and unchangeable (Figure 4). The primary system must be as open as possible for the different (and unforeseeable) activities in the secondary system, so the scope for adaptation must be as wide as possible. It must be assumed that the primary system will accommodate various secondary systems in different cycles during its service life. The primary system mainly comprises the following elements:

- External site conditions (site access, public utilities)
- Load-bearing structures (vertical and horizontal support structures)
- Outer building structure (facade, roofs)
- Building services structure (installation structure: concept of the technical access and location of the central control rooms)

The *secondary system* - with a service life of approx. 15 to 50 years - is a medium-term investment and adaptable (Figure 5). Subsequent install-ability, disassembly and reassembly are the key focal points for this system level. The secondary system mainly comprises the following elements:

- Finishing work (interior walls, finish floors, ceilings)
- Building services installations (central control rooms and technical access)
- Internal personnel, patient and materials movement (vertical and horizontal access, transport systems)

The *tertiary system* - with a service life of approx. 5 to 15 years - is a short-term investment that can be changed without any major structural work (Figure 6). It is subject to rapid change and is least predictable. The tertiary system mainly comprises the following elements:

- Medical equipment
- Fittings, furniture
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Figure 3: Crate with bottles (system levels)

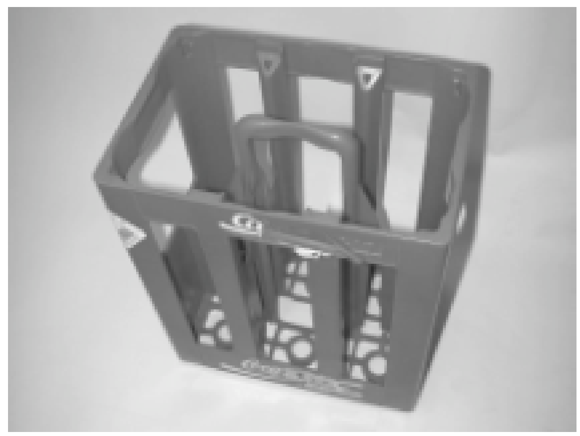

Figure 4: Empty crate (primary system)

Figure 5: Bottles (secondary system)

Figure 6: Liquid (tertiary system)

4. IMPLEMENTATION

4.1 The University Hospital of the Canton of Bern

The Insel hospital - which is referred to locally as the "Insel" (island) – was founded in 1354. In the founding papers, Anna Seiler demanded that her hospital must "always and for ever" be kept open for thirteen sick persons - who should be cared for by three "honourable people". Today the University Hospital of the Canton of Bern, with its 1,000 beds and some 5,000 employees, is one of the largest and most efficient hospitals in Switzerland. The Insel has several buildings, restaurants, a post office, a bank and chapels - in fact, it could be called a "city within the city" (Figure 7). The hospital's physical facilities are managed by the Canton Bern Building Department.

Figure 7: Insel Hospital, Bern

4.2 The INO project

The west surgery wing (Figure 8), which was completed in 1971, no longer meets modern standards of building services and safety. To overcome the technical and operational deficiencies and meet the requirements for a university hospital, the existing surgery wing must be completely renovated. The estimated investment amounts to some USD 200 million or EUR 170 million. The construction loan was approved in 1995 without a specific project. The basis for the decision was not a finished project, but was rather general project outline with a cost ceiling and approximate figures on the usable floor space.

The following key hospital areas are affected: intensive care and emergency ward, surgery center, diagnostic radiology, nuclear medicine, laboratory medicine-, central sterilisation facilities.

The existing west surgery wing was not planned for variable use. It was tailor-made for the use concept envisaged at the time of its construction. It has highly differing installation and load-bearing structures, and it is neither suitable for use nor adaptable.

On the one hand, the sanitary supply lines were buried in the concrete load-bearing structure (Figure 9). Today these supply lines are at the end of their service life and some are already defective, whereas the load-bearing structure is still in good condition. It goes without saying that dripping ceilings are intolerable for a surgery wing, and that leakages in water pipes are almost impossible to locate.

On the other hand, the dividing walls between the operating theatres were designed as load-bearing walls, so it is impossible to adapt them to changing needs. For these reasons, the thirty-year old building, which is still structurally intact, must now be demolished.

Figure 8: West surgery wing

Figure 9: Pipes set in concrete

To refurbish the west surgery wing without interrupting operations, present functions must be relocated. Implementation will take place in three stages (Figure 10). The first stage will be the construction of a new building to provide the necessary space, into which the functions currently occupying the surgery west wing will be moved. The second stage will be the demolition of the west surgery wing and the extension of the new building in its place. The final stage, following demolition of the 19th century buildings, will be to build the hospital garden that was originally planned in the 1960s when the in-patient tower building was constructed.

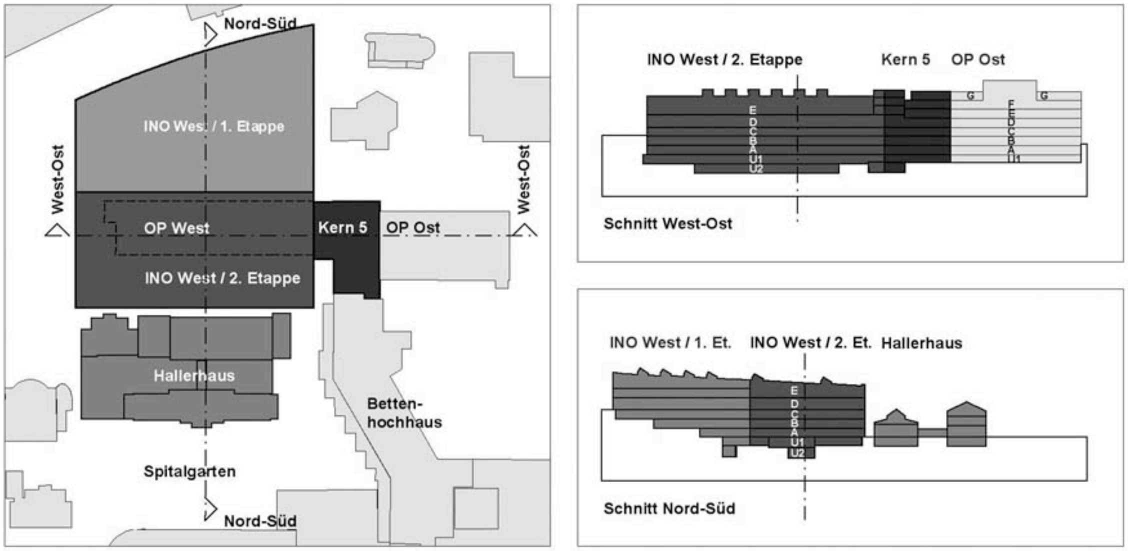

Figure 10: The stages of the project

4.3 The planning competitions

In 1997, the Building Department held an international and anonymous *competition for the primary system*. Nine teams - made up of architects, civil engineers and building services planners - took part in the competition after a preselection process. A deliberate decision was made not to invite teams with previous medical design experience. This competition was won by the team "4D Plus Generalplaner" from Zug, Switzerland (Figure 11). The project convinced the jury with regard to the following evaluation criteria: operational procedures (inner structure, function, execution process and feasibility), technical facilities (execution, interfaces and costs), architecture, urban design and ecology.

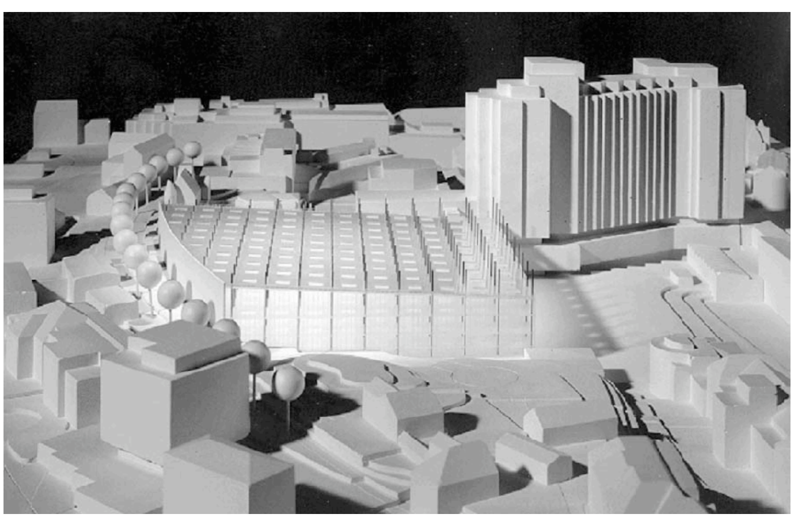

Figure 11: Model primary system

It was the only proposal to integrate the west surgery wing into the project, and this led to the final decision to demolish that structure. The resulting new structure offers large continuous spaces on each storey (approx. 8,000 m2 each, roughly corresponding to the area of a normal football field), which leaves great scope for the organisation of the future secondary system (Figure 12).

The floor structure has a structural grid of 8.4 x 8.4 m2 with openings of 3.6 x 3.6 m2 in the center of each structural bay. These holes in the "Swiss cheese" can be opened later for vertical access, cables, pipes, lift shafts or light shafts, depending on the changing needs in the secondary system.

The facade consists of a double layer (Figure 13). The inner wooden facade is protected from the weather by the outer facade of sheets of glass “scales”. The primary system is, in effect, a low-tech building for a high-tech content.

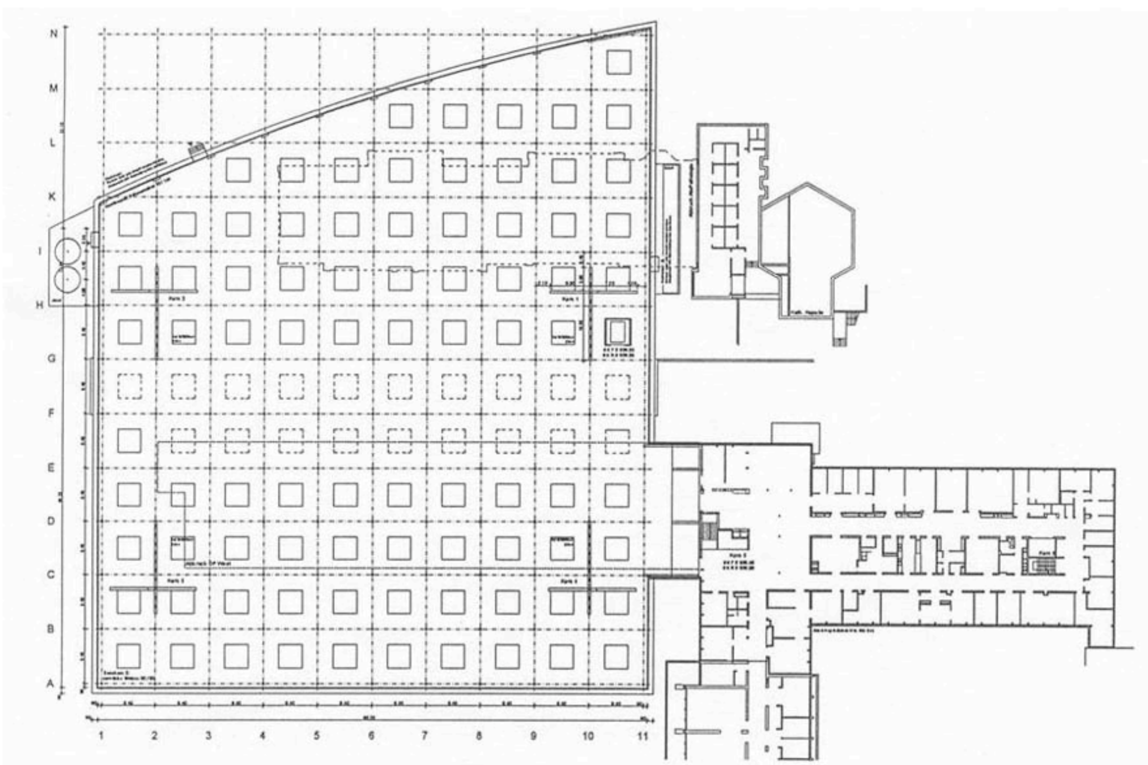

Figure 12: Floor plan of the primary system

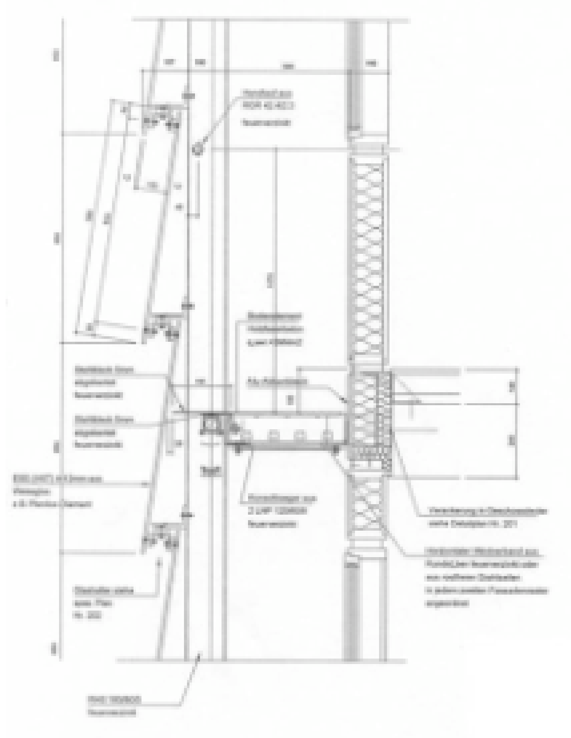

Figure 13: Facade cross-section, primary system

The *competition for the secondary system*, likewise international and anonymous, was decided in 1998. Ten teams took part, consisting of architects, medical facility and building services planners. The winning proposal by "Itten+Brechbühl Generalplaner AG" from Bern, Switzerland, is distinguished by an independent and logical concept which offers good processes and free space for the operation of the complex and clear spatial organisation with the interior movement routes (Figure 14).

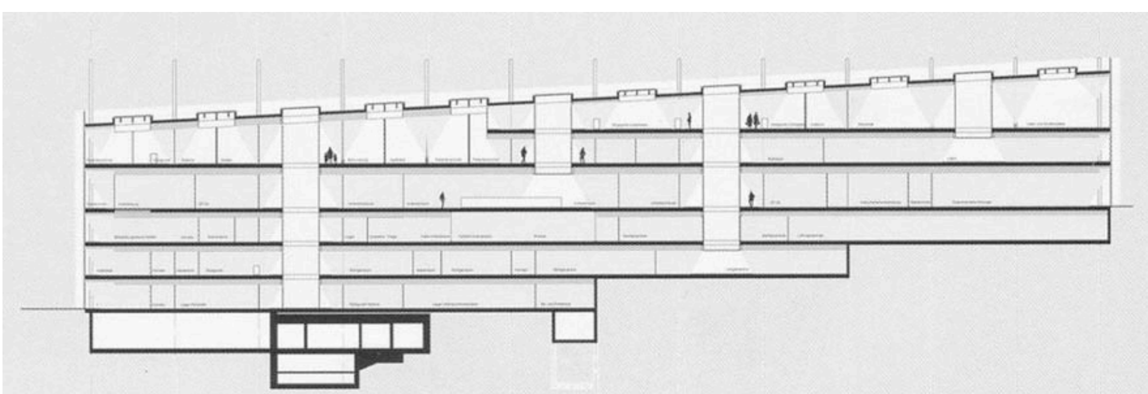

Figure 14: Cross-section, secondary system

After an international *preselection process for the tertiary system* in 2000, the "HWP Planungsgesellschaft" from Stuttgart, Germany, was commissioned with the planning and acquisition of the tertiary system.

4.4 The state of planning and execution

Planning of all stages of the primary and secondary systems is complete. As regards the tertiary system, planning of the 1st stage is complete, but only the concept has been finalised for the remaining stages.

As mentioned above, the INO project is to be carried out using a principle of "discrete systems". Each system level will be constructed by a different implementation team. The first stage - the primary system - was completed at the end of 2002 by a general contractor. The other stages have not yet been implemented (Figures 15, 16, 17, 18). The invitation for tender for the work on the secondary system will begin this year, after a delay of about two years.

The first stage of the INO project is to go into operation by 2006 and the 2nd stage by 2009.

Figure 15: Looking down on the roof

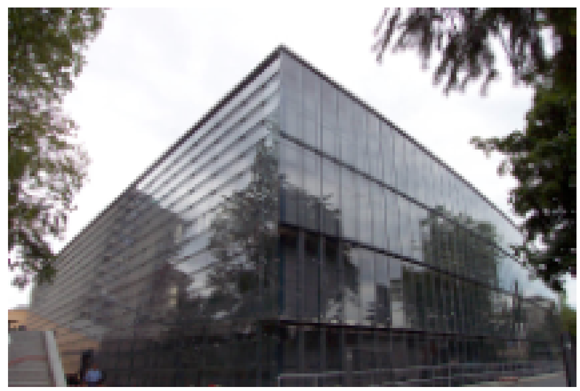

Figure 16: External view (north facade)

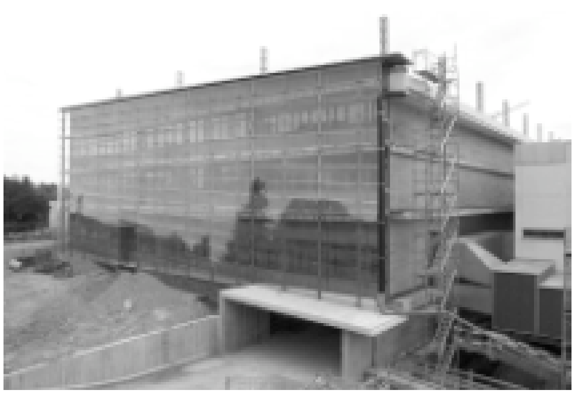

Figure 17: External view (west facade)

Figure 18: Interior view (central laboratory)

5. EXPERIENCES

5.1 Disadvantages of using discrete systems

The main problems in the INO project – primarily the delay in the construction schedule - largely arose because of the size and complexity of the project. It is one of the largest single medical facility projects in Switzerland. The problems can hardly be linked with applying the principle of discrete systems. Thus, delays resulted mainly from the revision of the plans to comply with the cost limits, delays in the execution planning (caused by the team planning the secondary system), objections to the high contract award amounts, a renewed round of invitations for tender, and political decisions (time-consuming processes). However, the following disadvantages of the use of discrete systems are especially worth noting:

5.1.1 Interfaces

The use of discrete systems means that the interfaces between the system levels cannot be ignored. Each team planning a system level has to take the needs of the subsequent system level into account without actually being involved in the planning of the next system. This requires extra work during the planning phase, a factor that has to be included in the calculation of the fees. In addition, the interfaces between the system levels must be defined and coordinated by an additional team. This mandated coordination team is also responsible for overall project management.

Using discrete systems also leads to extra work in the execution phase due to the additional coordination of the work at the individual system levels (e.g. coordination between several general contractors, site installations, guarantee and liability issues).

5.1.2 Number of project participants

Using discrete systems also means that there are more project participants, and that more contracts need to be concluded concerning scope of work at each level, and so on. This leads to extra administrative tasks and requires a greater exchange of information between the planning teams.

5.1.3 Changes in the project

Changes in the project hardly cause any planning problems if their scope is limited to the system level being planned. But if they have an unforeseen impact on the previous system level, this can lead to extensive follow-up costs in planning and execution - especially if parts of the building have already been built.

5.2 Advantages of using discrete systems

The main advantage of using discrete systems is the *adaptability* and *long-term suitability for use* of the building. Given that we are responsible for overseeing building work, this is an economic and ecological necessity for us. Other advantages include:

5.2.1 Specialisation of the planning teams

Each system level can be planned with a team of planners especially suited to the task. In the competition for the secondary system all participants had the same volume to work with (the base building or system level one already under construction), so the jury could focus mainly on internal organisation and functionality and did not need to balance these factors against the criteria of the primary system competition, e.g. urban design factors, etc. It was far easier to evaluate the different hospital projects against the same "backdrop".

5.2.2 Changes in the project

The question of whether the use of discrete systems was suitable in practice was answered in the planning phase. After construction work had already begun on the primary system, the doctors questioned the existing - and approved - execution planning for the secondary system. Instead of the new "cluster" concept, they wanted the surgery facilities to be arranged on the basis of the previous "linear" concept (Figures 19, 20). This required a complete change of the floor plan for the whole of storey D. Thus, the adaptability of the primary system was proven for the first time. In a conventional building process it would hardly have been possible to make such a fundamental change to the floor plan during the execution phase.

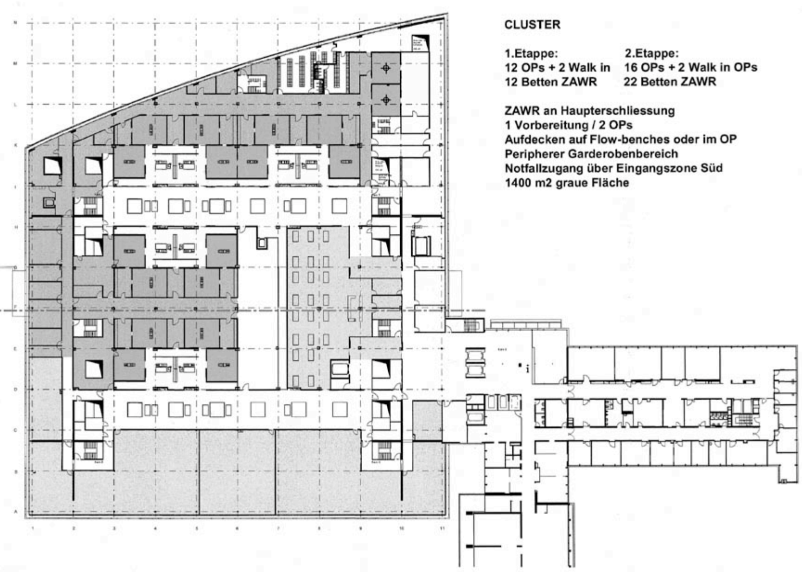

Figure 19: Surgery "Cluster" concept

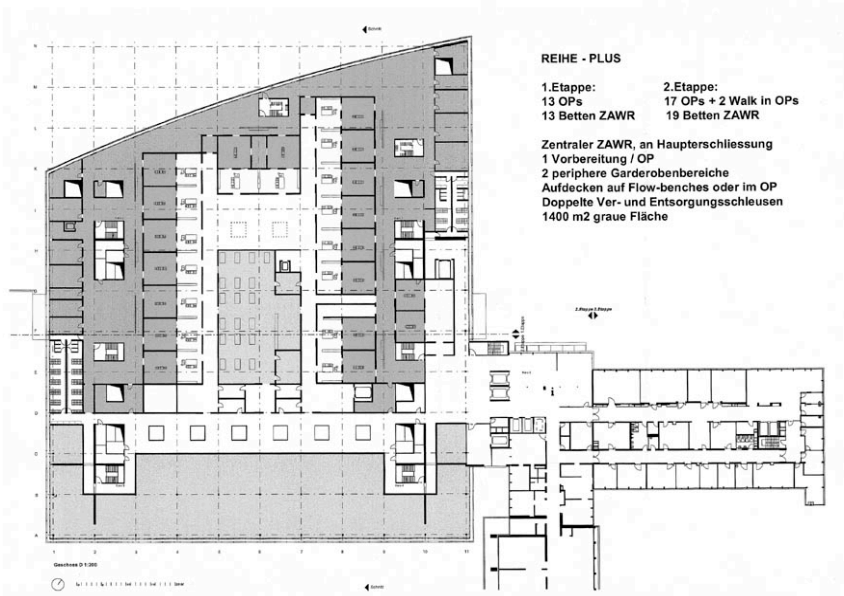

Figure 20: Surgery "linear" concept

5.2.3 Cost management

Each system level is treated as a separate project. The total cost framework is thus broken down into four budgets (primary, secondary, tertiary and general). This makes cost management easier.

5.2.4 Deadlines

The time schedule of the INO project is broken down into the three system levels and the three stages, making it highly complex. It is characteristic of the method used that planning starts with the larger dimension, then moves down to the smaller dimension. The primary system is planned first. During the execution of the primary system the secondary system is still being planned. When the secondary system is being executed, the tertiary system is still being planned. This has the following advantages:

On the one hand, decisions for the secondary system, and especially the tertiary system, can be made at the latest possible time. This is a decisive advantage in view of the rapid changes in medicine, hospital "politics", new regulations, and so on.

On the other hand, time can be saved in that construction of the building can begin even though the planning phase is still in progress.

6. Summary

In summary, the application of the principle of discrete systems

- Accommodates changes in condition and needs during the life cycle of a building and ensures high useful value in the long term.
- Simplifies replacements and adaptations during normal operation, and enables the replaced elements of the building to be reused.
- Increases the economic efficiency of structural measures for renewal and change of use.
- Enables operational decisions to be made in keeping with the current state of knowledge.
- Creates a rational and clear delineation of responsibility for operation and maintenance.
- Is a defining factor in the extension of the service life of a building.

The use of discrete systems as applied by the Building Department of the Canton of Bern may lead to extra work and expense in planning and execution, but so far this has not been easy to quantify. In view of the reduction in follow-up costs and the greater "accommodation capacity" for the future, the Building Department concludes that the long-term benefit outweigh any additional investment cost. For this reason, the Building Department now uses discrete systems to an appropriate degree in the planning and execution of all construction projects.

> "What is has been caused by what was,
> and what will be has its cause in what now exists"
> Rémy de Gourmont

7. BIBLIOGRAPHY

Hettich, Urs, and Macchi, Giorgio. 1998. Nachdenken und umdenken, Über das dreiteilige Modell des Wettbewerbs INO Inselspital Bern. In *Schweizer Ingenieur und Architekt (SI+A)*, No.13/1998. Zürich, Switzerland: Verlags-AG der akademischen technischen Vereine.