

OPERATIONS BASED CONSTRUCTION PROCESS

THE HOLISTIC CONSTRUCTION PROCESS – REMEMBER OPERATIONS!

Many buildings look great when they are finished but unfortunately prove to be both expensive and difficult to operate. This may be due to a short-term focus, lack of reflection or excessive cost-consciousness, concentrating on how to get the most out of the construction budget while the operating budget is someone else's headache.

Whole-life costs, dialogue and end-to-end thinking are keywords for getting to grips with this. The challenge is to qualify the client, the project designers and the contractors to plan, design and execute a building project with well thought-through operational solutions.

On average, the ratio between the costs of construction and operation over 30 years of the life of a building is 1:4. By focusing on operational considerations and whole-life costs, and with a small investment in long-term sustainable solutions at the construction stage, one can quickly make significant savings against the subsequent operating budget. Similarly, well thought-out and user-friendly physical surroundings will promote well-being and productivity in both users and operations staff, and so contribute to the overall bottom line.

It is therefore important to think operations early in the construction process, when the crucial decisions are being taken. But regardless of when it happens in the process, there can be great financial and environmental benefits.

A structured approach means involving the right skills and asking the right questions at the right time. We provide a tool that helps all the actors in the project to create future-proof buildings with optimum operational solutions – benefitting the client, users and society.

Værdiskabende Byggeproces, 2013

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OPERATIONS-BASED CONSTRUCTION PROCESS

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APPENDICES AND CHECKLISTS CAN BE DOWNLOADED FROM WWW.VAERDIBYG.DK

RECOMMENDATIONS

THE CLIENT SHOULD...

- Lay down requirements for the use of whole-life costing and incorporation of operations into the construction project
- Involve users and operations staff as early as possible in the process to provide for controlled and prioritised coverage of needs.
- Describe the operational requirements and incorporate them into the tender specifications/design brief
- Attend to operational requirements throughout the project and incorporate requirements into the chosen solutions – e.g. by reviewing the detailed design together with the right representatives from the operations organisation
- Identify a permanent person from its own organisation or an operations or client consultant with the knowledge to look after operational concerns and transfer of experience throughout the construction process
- Take an active part when changes are made to the project – and insist on an assessment of the operational implications of the changes

THE CONSULTANTS SHOULD...

- Urge the client, users and operations organisation to think about requirements and wishes, and about changes to the project
- Invite the operations organisation to discuss the choice of solutions
- Use whole-life calculations in prioritising solutions and choices
- Include the operational implications of project changes in the choice of solutions

THE CONTRACTORS SHOULD...

- Draw attention to missing relationships in the operational requirements and enter into dialogue with the client and its consultants on solutions
- Offer suggestions for improvements – the best solutions from an operational standpoint are not always the most expensive
- Involve the client's operations staff as early as possible in relation to commissioning and training of operations staff
- Supply operations and maintenance documentation in a sensible format and well before handover

ABOUT THE GUIDE

This guide describes how incorporating operationally-friendly solutions into a building project can be prioritised and structured throughout the construction process. Holistic thinking, whole-life cost analyses and the right questions will help to maintain the focus on quality and well thought-out solutions.

The initial considerations will be directed mainly at the client and the building manager and will describe a number of strategic concerns related to whole-life costs, procurement, responsibilities and involvement of operations expertise, and more generally the tender requirements that can provide for a construction project oriented towards efficient operation.

The activities in the individual phases will be underpinned by a series of relevant questions to be asked in the course of the process. The guide also describes how to recover some of what has been missed if you only start to focus on subsequent operation when you are some way into the construction process.

The guide is aimed at:

- Clients and building managers looking for a more operationally-friendly building
- Project designers and contractors, who will find concrete tools and tips for incorporating operational concerns into the construction project
- Operations organisations and users, who can find inspiration on the interplay surrounding operationally-friendly construction

The appendices contain a number of tools to assist in the choice of operationally-friendly solutions.

ADDITIONAL GUIDANCE ON COMMISSIONING

In parallel with this guide, Værdibyg has produced a guide to the commissioning process. Commissioning is a proactive dialogue and quality assurance process which focuses on whole-life cost and interplay between the installations. The project is managed according to the technical requirements of the owner and the user – including requirements to minimise energy consumption, which make the process especially well-suited to energy renovation jobs.

The commissioning guide goes further than the present guide in systematising and defining operational requirements. It provides a general introduction to commissioning and a more detailed discussion of the commissioning process for the people who are to carry it out.

INITIAL CONSIDERATIONS ON THE OPERATIONS-BASED BUILDING PROCESS

Early in the building project, the client has to make a number of decisions which are crucial to the way in which operations are considered in the construction process – including the interplay with the operations organisation, energy and sustainability requirements¹, operating strategy, whole-life costs and type of contract.

There is traditionally no single party responsible for ensuring that operations are incorporated into a building project. The client is not always aware of the importance of considering operations in the building process and thinks this is something the consultants do “automatically”². However, it is the client and his consultants who have to take the necessary decisions to ensure that operational knowledge is called on in the construction process.

INVOLVING OPERATIONS EXPERTISE

There is much to be gained from involving operations staff in project design³ – ideally the same people who are to run the building at a later date.

There is a need for different input at different points in the construction process, and here it may be necessary to ‘invite operations to the party’. The relevant people should be present at the right meetings, and meetings or workshops should be organised very precisely so the dialogue addresses specific issues. Afterwards, as the project and the building evolve, the operations staff will be able to give more concrete and valuable input. Appendix 3 describes a method of handling operations and user comments.

Construction and operation can sometimes be perceived as two very different subjects. The operations organisation is not always experienced in the construction process, and it may be necessary to clarify the sequence of events. Appendix 4 contains suggested the

contents of an information folder for the operations organisation.

If the client does not have any operations staff, we recommend engaging an operations consultant or other third party with operational expertise.

WHOLE-LIFE COSTING

The whole-life costs of a given solution cover the costs of establishing and operating the solution.

Whole-life costing is a method of comparing one or more different solutions where the breakdown of acquisition costs and operating expenses may vary. Whole-life calculations help to qualify decisions in a building process when its operation has to be included. It is essential to limit the scope of the calculations to the areas where they make most sense – such as facades, technical solutions or energy supply issues.

A requirement to use whole-life costing should be incorporated into the tender documentation and actively used in connection with the overall plan, outline proposal and preliminary design, and in the event of changes.

Most building processes are completed in one to three years, while the buildings may then be used for 30 to 100 years. Of the total costs, approx. 80% are accounted for by the operation of a building. It therefore makes sense to choose solutions on the basis of a whole-life approach.

It may be OK to choose an operationally expensive solution, provided that the choice is made on an informed basis so this can be taken into account in the subsequent operations plan. Whole-life cost analyses should not only focus on operationally-friendly solutions but also on how to incorporate user-friendliness, to support the use of the building and the performance and productivity that the users deliver.

1 See e.g. ‘White Paper on Sustainability in the Construction sector’ (2013)

2 Torben Damgaard and Pia B. Erichsen, 2009: ‘Involvement of operations in construction’, University of Southern Denmark.

3 See also Værdibyg ‘Guide to user involvement’ (2012).

WHOLE-LIFE COSTING

There are a number of guides and tools for working with whole-life costing

EXECUTIVE ORDER 1179

Danish Building and Property Agency Order and associated guidelines on quality assurance, whole-life costs and OPP.

www.bygst.dk

LCC AND LCA TOOLS

In 2015, the Danish Transport Authority developed tools for whole-life calculations (life-cycle cost and life-cycle analysis)

www.trafikstyrelsen.dk

GUIDE TO WHOLE-LIFE COSTS IN TENDERING PROCEDURES

From Byggeri København/Københavns Ejendomme, now part of the guide to 'Sustainability in building' (2015)

www.byk.kk.dk

TOOL FOR WHOLE-LIFE ASSESSMENTS OF WINDOWS, FACADES AND ROOFS

Landsbyggefonden (2010)

<https://totaloekonomi.lbf.dk/>

BEST PRACTICE MANUAL ON WHOLE-LIFE COSTING

Danish Business Authority (2009)

www.bygningsstyrelsen.dk

THIRTEEN TIPS ON WHOLE-LIFE COSTING

Danish Business Authority/Danish Building Research Institute (2002)

www.sbi.dk

TENDERING

Requirements and requests for subsequent operation can advantageously be included in the tender documentation (often in the design brief).

When advertising for consultancy services, clear requirements should be set out for consultants to involve the right skills and incorporate operational considerations into the project design. The service descriptions do not focus heavily on this area, so it may be helpful for the client to lay down the following requirements:

- Use of total-cost calculations
- Consideration of operations, maintenance and cleaning of the structure, building installations and any production and research equipment or machinery which is part of the building project
- Consideration of user-friendliness for the future users of the building
- Also, precise requirements for the handover of operations and maintenance documentation, including digital deliveries

In procurement procedures, requirements and wishes should be incorporated into the tender specifications/design brief and into the project itself – depending on when the procedure takes place. In procurement procedures, the client may choose to advertise the project with 1-5 years of subsequent operation, providing for a greater focus on cost-effective operation on the part of the implementing parties.

Appendix 1 provides examples of how the client can set requirements to ensure that the project team includes operations in the project process.

OPERATIONS AND OPERATIONALLY-FRIENDLY CONSTRUCTION

Operation is used in this guide as a collective term for planning, managing and carrying out the activities which ensure that a building can be used as intended, i.e. that the building can maintain a defined level of quality and functionality with regard to

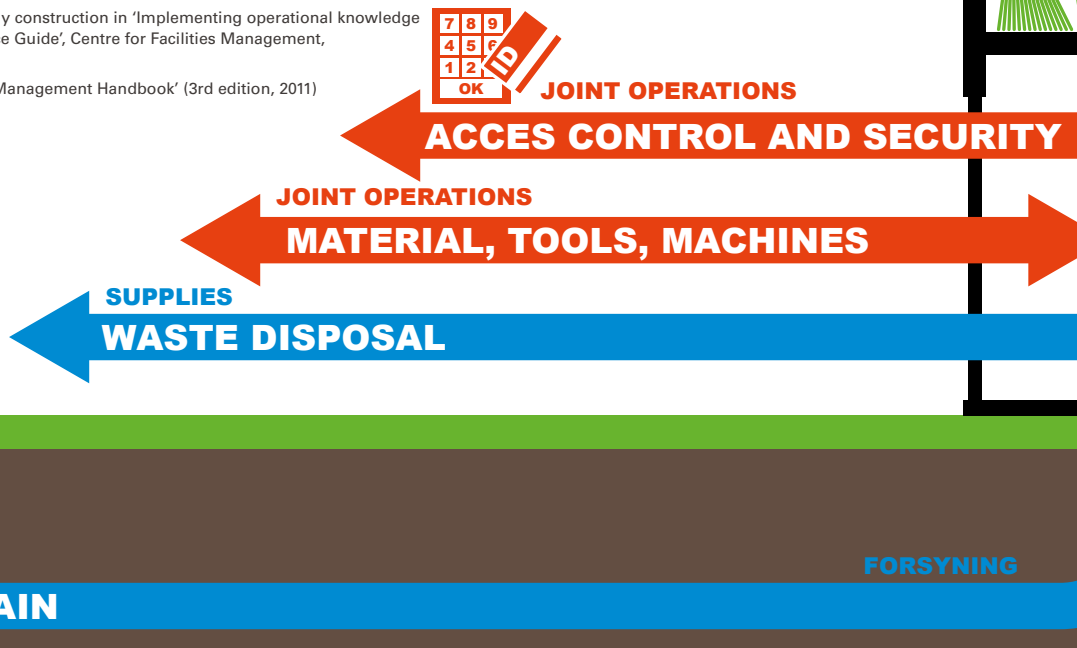
- Maintenance
- Cleaning
- Electricity supply
- Shared operation

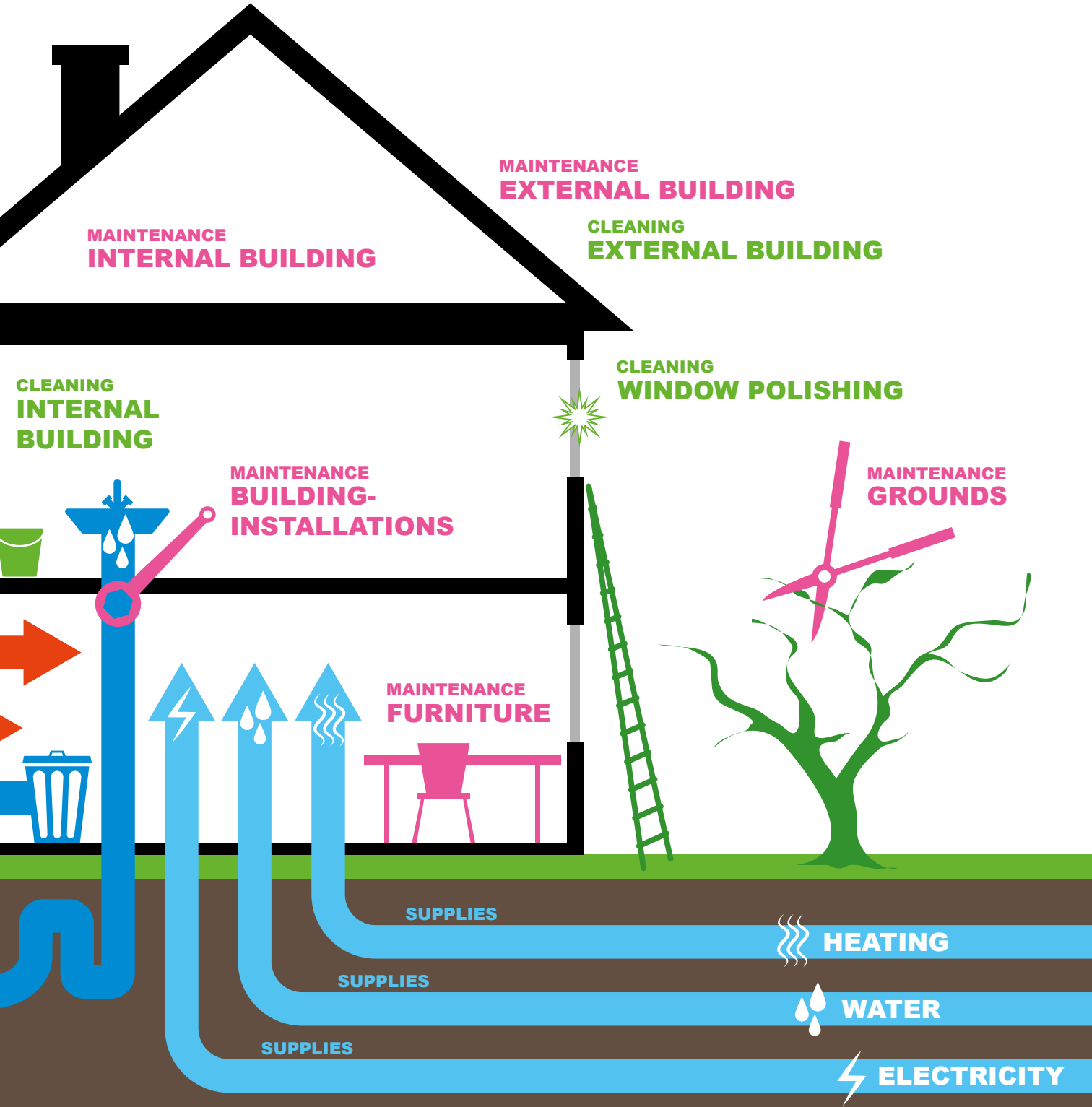
An **operationally-friendly project** should be understood both in relation to the operation of the building and in relation to the users' use of it – i.e. its user-friendliness. An operationally-friendly building project will focus e.g. on the following aspects: Service life, durability and energy consumption of the building elements, need for cleaning, maintenance and control, and environmental and health and safety concerns. It will also take account of how the building will work when in use – functionality, flexibility, fittings, space and accessibility for users, operations staff and technical equipment.⁴

These definitions are inspired by Facilities Management⁵, which covers all areas related to operation and maintenance and considers them together with the other activities that provide the best possible conditions for a company's core activities. Everything from strategic portfolio development to day-to-day canteen management. Facilities Management provides an overview of the relevant activities and offers a number of tools to handle them.

4 Read more about operationally-friendly construction in 'Implementing operational knowledge in the construction sector. Best Practice Guide', Centre for Facilities Management, Realdania Research, February 2011

5 See e.g. Per Anker Jensen: 'Facilities Management Handbook' (3rd edition, 2011)





THE RIGHT QUESTIONS IN THE CONSTRUCTION PROCESS

Considering operations in all phases of the construction process means asking the right questions at the right time. The key question that the client, the consultants or the contractors must keep asking themselves and each other is: **“What are the operational implications of the proposed solutions?”**, but questions and activities will change in the course of the construction process.

The construction process should therefore be organised so the essential questions can be resolved in the relevant phases – and in the relevant forums. The initial phases are often well-suited for workshops with large

groups of participants, and the further you progress in the project, the more relevant it will be to bring more specific operational expertise into project reviews.

In the following sections, you will find examples of the ‘right’ questions for the various phases. These can also be downloaded as checklists from www.vaerdibyg.dk

The figure shows activities through the construction process which should be carried out if you want to ensure that the building can be handed over for effective operation thereafter.



PROGRAMMING

- Questions can usefully be resolved at targeted workshops
- Organisation of participants, including agreement on responsibilities
- Set up of operational requirements in the design brief
- Whole-life cost calculations
- Operational review of outline proposal and preliminary design



PROJECT DESIGN

- Questions dealt with by the consultants with assistance from the relevant parties
- Incorporation of operational requirements into the project
- Updating total-cost calculations
- Evaluation of requirements raised
- Inclusion of requirements in procurement procedures
- Operational review of detailed design

BETTER LATE THAN NEVER

There will be projects where the operational considerations are only addressed a little later in the construction process, where many decisions have already been taken – including decisions that could have major operational implications. But it is never too late to start thinking about operational issues in a construction project.

Even later in the process, you can forward-looking requirements for the choices that have not yet been made, but you should also be aware of possible opera-

tional problems which need to be considered, such as a larger operating budget for the building.

Then there are the possibilities for enhancing operationally-friendly solutions through e.g. fixtures and fittings or changing user behaviour.

It may also be useful to allow for future optimisation of operations. This could take the form of preventive maintenance and planning a move to more operationally-friendly solutions for future replacement of building elements, operations staffing etc.



IMPLEMENTATION

- Project changes raised at client meetings and project optimisation workshops
- Collaboration between the operations organisation and technical supervision
- Evaluation of requirements raised
- Operations training
- Review of documentation / Operation and maintenance materials
- Draw up operations budget and plan

COMMISSIONING

- Defect remediation
- Handover
- Transfer to the users
- Does the building meet the agreed requirements? Various tests and e.g. energy labelling.
- Amendment of operations budget and plan ('as built')
- Follow-up on systems in use
- Evaluation workshop

PROGRAMMING

The planning phase lays the actual foundations for incorporating operations into the construction process. The client, possibly assisted by his client consultants, should organise the project and plan how the operational issues can best be addressed.

Appendix 1 gives a suggested definition of requirements for including operations in a tender/design specification

OPERATIONAL REVIEW

In order to incorporate operational considerations into a building project, the project team and people with operational expertise should review the project with regard to operations-related topics. Comments and questions that cannot be answered immediately should be taken forward to the right forums or later phases. Appendix 4 shows an example of a method for gathering and handling comments from operations staff and users in building projects.

Appendix 2 contains a checklist for operational reviews, identifying the key areas to be covered in most construction projects in the planning phase.

THE RIGHT QUESTIONS

- What skills should be involved in the construction process to achieve the desired operational quality of the building after commissioning?
- Does the operations organisation have any experience, standards or guidelines that need to be brought into the project at an early stage?
- Have the future operations manager and other staff been appointed, and can they get involved in the process? Or should an external operations consultant be engaged?
- How and when should the operations staff or the consultant be involved? (Take account of resource usage by the operations staff in the different phases)
- Have equipment rooms, cleaning rooms, stores etc. been included in the layout of areas?
- How is a focus on operational issues worked into the tender documentation?
- Has accessibility for cleaning and maintenance been considered?

Appendix 3 shows an example of a method for gathering and handling comments and questions.

PROJECT DESIGN

During project design, the client and consultants should focus on ensuring that the operational considerations from the design brief are actually planned for.

The design phase may include a number of cost-saving exercises if it turns out that parts of the project are more expensive than expected. If major changes are made to the project, the operations staff should be involved. Both structural and whole-life cost analyses or new proposed solutions may be needed.

The operational implications of the changes should be assessed and documented, and this should feed into the decision-making process. These may be altered choices of material, which call for changed cleaning and maintenance methods. Or they may be changes to technical installations which mean that all or parts of the system cannot be run, tested or maintained as expected.

Once the detailed design is in place, almost all changes will entail extra costs.

INTERFACES AND CLIENT DELIVERABLES

Coordination of operations-related client deliverables can be a challenge. It is the job of the client, no later than the design phase, to determine which client deliverables need to be incorporated into the project, and to handle any interfaces that crop up in this connection.

The designers need to incorporate client deliverables into the project. The client or client consultants will include the necessary coordination tasks in the tender documentation.

PROJECT OPTIMISATION

It may also be helpful to review those parts of the project that could have a particular bearing on subsequent operation. We recommend allowing the operations staff to track the design of a complicated facade solution, for example, if subsequent maintenance, cleaning, servicing and replacement are dependent on the detailed design of the facade.

The operational requirements can usefully be defined in detail in the project design and should be included in the tender specifications.

THE RIGHT QUESTIONS

GENERAL QUESTIONS

- Are we adhering to the operational and user requirements from the programming phase?
- How should the collaboration between the operations experts and the project design team be organised? – Are operations involved in the operations-related decisions?
- How can we meet the operational and user requirements in the tender documentation?

FOR THE INDIVIDUAL BUILDING ELEMENT OR COMPONENT, THE CONSULTANTS SHOULD CONSIDER:

- What is the whole-life cost of the solution (service life, energy consumption and operating costs in relation to price)?
- Does the solution raise specific requirements for accessibility, cleaning, replacement etc.?
- Does the solution affect the general accessibility, flexibility, future-proofing etc. of the building?

These questions can be adjusted and adapted to the individual building element or technical installation. Appendix 2 contains a checklist for operational reviews in the construction process.

Appendix 5 lists a number of questions that can be used as inspiration for relevant questions on selected technical solutions.

CONSTRUCTION

In the construction phase too, it is necessary to focus on subsequent operation.

PROJECT CHANGES

In the execution of a building project there will traditionally be many changes that raise issues with the operational requirements. These changes are typically decided on by the contractors and the client's supervisory function in collaboration with the client. Here too, the operational implications of the changes need to be thought through, so any decisions are taken on an informed basis.

SUPERVISION AND COLLABORATION

The operations staff should be present in forums where changes are discussed and decided upon. A good relationship with the technical supervisors on the building site is very valuable, because the supervisors have their fingers on the pulse of the project. Even apparently small changes in the construction process may have major operational implications.

The operations staff should work with the traditional supervisory function to conduct operational inspections in the course of the project to ensure that the agreed solutions are established and that no late changes are made that could compromise the operational friendliness of the building.

PREPARATION FOR COMMISSIONING

Commissioning and handover need to be carefully prepared in the construction phase. The necessary involvement, training and briefing of the operations organisation should take place well in advance of commissioning, so they are equipped both to monitor the commissioning and to take over the building.

"When they designed the project, the heating system was planned in such a way that we only had to shut off the supply to one department at a time when we wanted to service the installation. As it has been implemented, we now have to shut down the heating to the whole building, so we have the users on our backs!"

OPERATIONS AND MAINTENANCE MATERIALS

Operations and maintenance documentation, operations plans and budgets also need to be handed over to the client in good time. The contractors are often working on operations and maintenance materials long before handover, and there is no reason why the documentation cannot be handed over to the client either piece by piece or three months before handover, for example.

Documentation should only be attached for the building elements that are installed in the particular building. Whether the documents are in printed or electronic form, unnecessary documentation is a barrier to efficient operation of the building.

THE RIGHT QUESTIONS

- How should the operations organisation and the users be involved in the relevant activities?
- How do we take account of late changes to the project affecting operations and maintenance activities or the operations budget?
- How can we incorporate whole-life calculations for alternative solutions in response to project changes?
- How should different sub-components be coordinated when they are to work together in the final building?
- How can knowledge be transferred effectively from contractors and consultants to operations staff and users?
- How and when should operations staff and users be trained in the use of the building?
- How can we ensure that operations and maintenance documentation is handed over as agreed?

COMMISSIONING AND HANDOVER

The way in which the project is handed over may be crucial to ensuring that the building is used properly in the future – and at the operations organisation has the skills to run it. This period is often very intense, focusing on faults and defects, but a good commissioning process requires resources to be set aside for dialogue between the operations organisation and the contractors and for the users' needs to be satisfied.

COMMISSIONING

When the building is commissioned,⁶ the future operations organisation should be involved in the tests to be performed (e.g. calibrations or leakage checks), so they gain an insight into the strengths and weaknesses of the building.

HANDOVER AND DEFECT REMEDIATION

A thorough inspection of the building before handover (pre-delivery) can be a good time to restart the dialogue with the operations organisation⁷. The formal handover will follow AB92/ABT93 – including the final handover of the complete operations and maintenance documentation, including guidelines, operations plan and budget etc. Before handover to the client, the operations plan and budget should be amended to reflect the finished building ('as built').

The operations organisation – and in some cases selected users too – should be involved in defect remediation, so this also takes account of future operation and use.

TRANSFER TO THE USERS

When the users are introduced to the new building, the volume of information and training should be adapted to the individual user groups according to how they will be using the building.

We recommend training the users both in the use of the technical solutions and in the practical use of the building (sustainable behaviour) – e.g. how to ventilate it and how to adjust the underfloor heating. An office building will usually only require limited training,

which might cover the facilities for individual temperature adjustment, solar screening etc. Conversely, hospital staff will typically receive a more detailed introduction to the technical installations they will be using in their day-to-day work.

FOLLOW-UP

As a follow-up to the user training, we recommend an evaluation of use and operation around six months after commissioning, with the following focal areas:

- How does the equipment suit its purpose?
- Energy consumption and behaviour
- Are the systems adjusted correctly?
- Is there knowledge to be taken forward into other projects?

When the project has passed into operation, we recommend that the users should have one contact person who can handle enquiries relating to the building and its operation.

THE RIGHT QUESTIONS

- Do the operations and maintenance materials meet the requirements?
- What faults and defects will have a bearing on future operation, and how can any problems in this area be addressed?
- How can we correct any faults and defects in a proper way?
- How should the building be transferred to the users?
- Have the operations staff and the users gained the necessary insight into the future operation and use of the building?
- How should the follow-up be planned?

6 Værdibyg's guide to 'The commissioning process' elaborates on this part of the process.

7 See Værdibyg's 'Guide to the handover process' (2013)

APPENDIX

- 1 EXAMPLE REQUIREMENTS FOR INCLUDING OPERATIONS - THE CONSULTANT'S SERVICES AND OPERATIONS-RELATED REQUIREMENTS**
- 2 CHECKLIST FOR OPERATIONAL REVIEWS IN THE CONSTRUCTION PROCESS**
- 3 A METHOD FOR GATHERING AND HANDLING COMMENTS FROM OPERATIONS STAFF AND USERS IN BUILDING PROJECTS.**
- 4 SUGGESTED CONTENTS OF INFORMATION FOLDER FOR THE OPERATIONS ORGANISATION**
- 5 EXAMPLE REVIEW OF PROPOSED SOLUTION**

THIS BOOKLET FOCUSES ON THE VALUE CREATED BY INCLUDING OPERATIONS IN THE CONSTRUCTION PROCESS, AND PRESENTS CONCRETE METHODS FOR THE OPERATIONS BASED CONSTRUCTION PROCESS.

DIALOGUE, LIFE CYCLE COSTING (LCC) AND A HOLISTIC PERSPECTIVE IS CRUCIAL FOR CREATING FUTURE BUILDINGS WITH OPTIMAL OPERATION SOLUTIONS – BENEFITTING THE CLIENT, USERS AND COMMUNITY