The Building as a Place of Work for Maintenance and Service Personnel:

from Interviews to Guidelines

by Gudrun Linn

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The physical work environment for building maintenance and service personnel has been neglected. This article describes a project aimed at clarifying the problems, finding better technical solutions, and formulating generally applicable building design guidelines which address those problems. The purpose has been to reach clients, architects, and others who are responsible for the design of buildings and their surrounding environment. The project, spanning from interviews to a handbook for planners, is one stage in a process of change – the buildings of the future will determine the success of the venture.

Theme WORKSPACE DESIGN

WRITING A HANDBOOK is traditionally a matter of gathering familiar ideas – the author's and others' – and committing them to paper: established knowledge presented in a new package. The point in such a case is not to research or otherwise bring to light new findings, but rather to accumulate and above all to distribute "existing knowledge".

Producing a handbook aimed at dealing with problems which have never before been thoroughly studied is, on the other hand, a completely different kind of task. The problems must first be identified and analyzed, the project's aim established and its perspective defined, and an approach decided upon. Only then can the study be conducted and its resulting material revised to a predetermined level, such as to form the knowledge basis for a handbook. The step from such a basis to the text of a handbook is a huge one, requiring round after round of penetrating evaluation and critical review. In some cases, full scale experiments are necessary. A handbook is one stage in the process from problem definition and analysis to the practical application of solutions (as in design work). The development of a handbook for building is a heavy responsibility since its recommendations *must be reliable.* Misinformation can have substantial economic and functional consequences.

This article presents a Swedish project which has spanned from interviews to the development of a handbook for planners. It addresses the

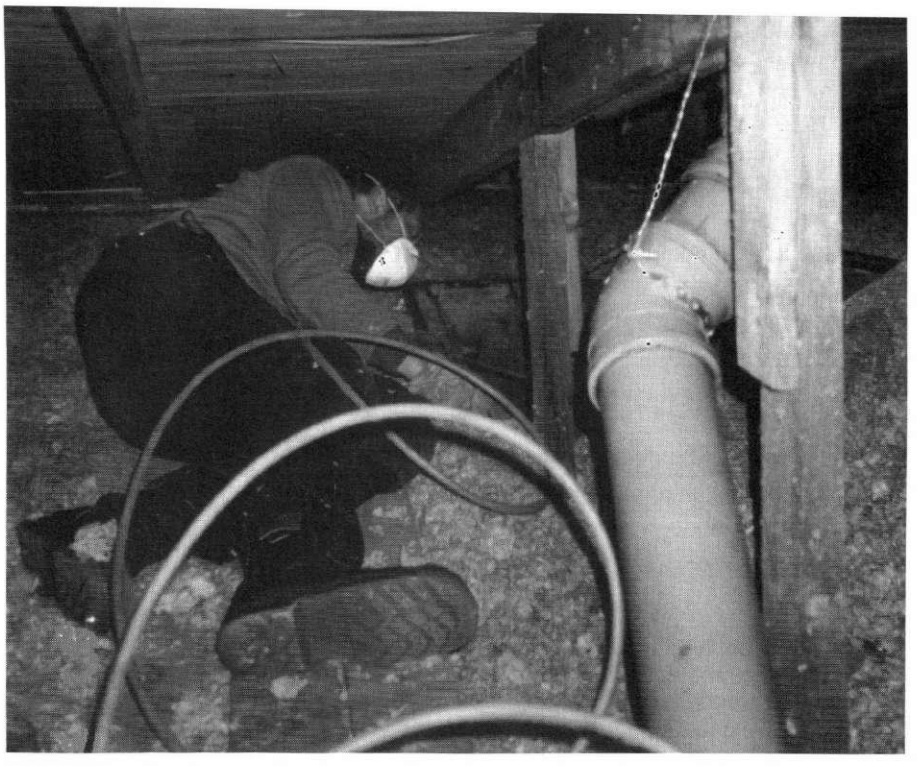

Figure 1. Work environment from the '60s–'70s. A chimney sweep cleaning exhaust ducts at the edge of a roof. A face mask is required.

poor working environment of building maintenance and service personnel; the aim of the project is to clarify this situation and to develop a handbook for professional use based on that situation. This is not a routine assignment, and it has no given method. My article therefore concentrates on certain issues of methodology specific to this project.

A Project at Chalmers

In the Department of Industrial Planning and Building at Chalmers University of Technology, I conducted a project called "The Building as a Place of Work for Maintenance and Service Personnel, So-Called Secondary Users: a Review of Problems and the Knowledge Basis for a Handbook". The project was commissioned by the multi-partisan Fastighetsbranschens Utvecklings- och Arbetsmiljökommitté (FUA), a committee on development and the work environment in the real estate sector. The committee comprises thirteen Swedish employer and labor organizations, lending a great deal of authority to the project. The project's financial sponsor was the Swedish Council for Work Life Research[1] and its predecessor. An information grant from the then Swedish Work Life Fund[2] has made it possible to revise the research results into a handbook, the publication of which is being discussed as this is written (Linn, manuscript 1996). A video and exhibition display have also been produced.

Those parts of the project not included in the handbook are presented in a research report (Linn, report forthcoming 1996).

In connection to the project, also commissioned by FUA and sponsored by the then Swedish Work Life Fund, an evaluative model for the analysis of the economic consequences of improvements to the work environment has been developed (Mattsson, manuscript 1995).

I have had assistance with matters of design from four experienced professionals: a structural engineer, an architect, a landscape architect, and a mechanical services engineer. The project has been supervised by a directing group of three representatives of the FUA and Professor Joen Sachs of the department. They have participated in the planning and diligently reviewed the extensive material. For the critical exami-

nation and discussion of issues of fundamental importance, the project has relied upon a reference group comprising sixteen representatives of various organizations, authorities, companies, and academic institutions which met five times to scrutinize and criticize the material. To insure greater reliability, a preliminary version of the handbook manuscript was broadly circulated for comments from all the trade unions and professional associations effected, as well as a number of other organizations and authorities.

The *background* for the project was the notoriously poor physical work environment for property maintenance personnel (noticed among others by Granath, 1982). A major problem is that the mistakes made by participants in the building process are so long-lasting: buildings stand for fifty years or more and are extremely costly to remodel. The building itself is difficult to adapt in comparison to other factors influencing the work environment. Unsuitable designs can cause daily difficulties and strains for people who work there.

Contributing to the problems is the fact that property maintenance personnel work in areas which in the past were not considered workplaces and which therefore have not previously been subjected to the laws governing the work environment in connection with the application for a building permit. The Swedish legislation has now been thoroughly revised, including the placement of responsibility for the work environment on the client who orders the building.

In cases where maintenance is contracted out, the personnel work for clients at various locations, making it especially difficult for them to influence the work environment.

A special background factor of the project was a new paragraph in the Swedish Work Environment Act (Arbetsmiljölagen 3:14, ratified in 1991), which stipulates:

> The person who commissions the construction of a building or other facility shall during the planning process be responsible for satisfying the requirements of the work environment relating to both the construction and the future use of the building or facility, and for coordinating the various aspects of the project.
> (...)
> Architects, building contractors, and other participants in the project shall be responsible for satisfying the requirements of the work environment within the realm of their individual assignments.

At the time the law was ratified, there were no specification of the problems and no guidelines for better design. Today there are regulations and provisions, mostly functional requirements, in the form of two documents appended to paragraphs in the Swedish Work Environment Act and the Swedish planning and building legislation (see Boverket 1995a, appendix 5), respectively. Both these documents (Arbetarskyddsstyrelsens författningssamling 1995:3 and Boverket 1995b) were referred to this project for approval.

The purpose of the project has been to clarify a problematic situation, to put the problems in relation to relevant laws and regulations, to find better technical solutions to those problems, to develop the knowledge basis for a handbook aimed at improving the work environment, and finally to write the manuscript for that handbook.

Of course maintenance and service personnel understand their own workplace, but their knowledge is seldom verbalized in a way that would lend it sufficient weight to be considered in a planning situation or to be applied more generally. These people are rarely consulted during planning – the personnel is usually not even hired until the building is completed. But even in cases where the users are known and available for consultation, the maintenance personnel needs a general collection of its knowledge that exceeds the experience of each individual. Such a collection of knowledge and experience could also be used for educational

purposes. It would combine the experience of many individuals and could be related to other building requirements.

Producing a handbook has been judged an effective way of addressing the problems, since it is likely that the lack of collected knowledge and experiences has strongly contributed to the present situation. A handbook shows the nature and extent of problems, the causes of which a more thorough future study might reveal.

Building types and personnel groups. This study covers common building types: apartment buildings (including group living for the elderly or handicapped), commercial buildings (offices, light industry, shopping centers), schools, and buildings for higher education.

Maintenance and service personnel is defined in this project as

- those who manage the operation, maintenance, and service of buildings and their surrounding exterior environments, such as custodians (caretakers), technicians (including the mechanical services installers, smiths and sheet metal workers, carpenters, painters, electricians, and gardeners involved in building maintenance), the cleaning staff, the window washers and glaziers, elevator repair technicians, chimney cleaners, garbage collectors, and those who take care of the indoor plants;
- others who provide services for occupants and businesses, including transportation service drivers, goods delivery drivers, security personnel, postal and newspaper delivery people, movers, ambulance crews, and, to a lesser degree, fire fighters.

The term *secondary users* describes the user groups covered in this project and distinguishes them from the primary users for whom buildings are planned.

Target groups. The handbook is intended to serve

- those who commission buildings,
- designers and planners,
- others involved in the building process,
- the education of architects and other planners, and
- the workers effected, both in their own education and as a tool to help them influence the planning of the building.

Research Perspective

Before embarking upon an assignment of this nature it seemed fitting that I clarify for myself and for others the approach I planned to take. Work environment problems can be tackled from various directions, using various methods and criteria. One could, for example, take a labor organizational or a psycho-social approach, or one could focus on issues of power and influence. Concurrently with the project presented here, the FUA commissioned a study of labor organization in the field of property management (Fendell, 1993). The then Work Life Fund took a psycho-social perspective[3], which was reflected in the programs for work environment improvements drawn up by the business sectors. The real estate sector's program, however, touched on the physical environment as well (FAK 1991). A power and influence perspective is exemplified by the dissertation *Att projektera med hänsyn till underhåll och arbetsmiljö* ("Designing for Maintenance and the Work Environment"; Rönn, 1989). There is a justification for each of these perspectives, but I chose another one.

As a researching architect who concentrates on how buildings function for users, I work from what I call a *building function perspective.* By this I mean *the function of a building in relation to its users*: its design and dimensions should be tested against the functional requirements of various users to insure that the building works well for its purpose, even from the point of view of those who are entrusted with its maintenance. Designing a building that works well or establishing guidelines for how to build requires knowledge of and insight into the conditions for use, but also demands the ability to weigh and transform the users' various

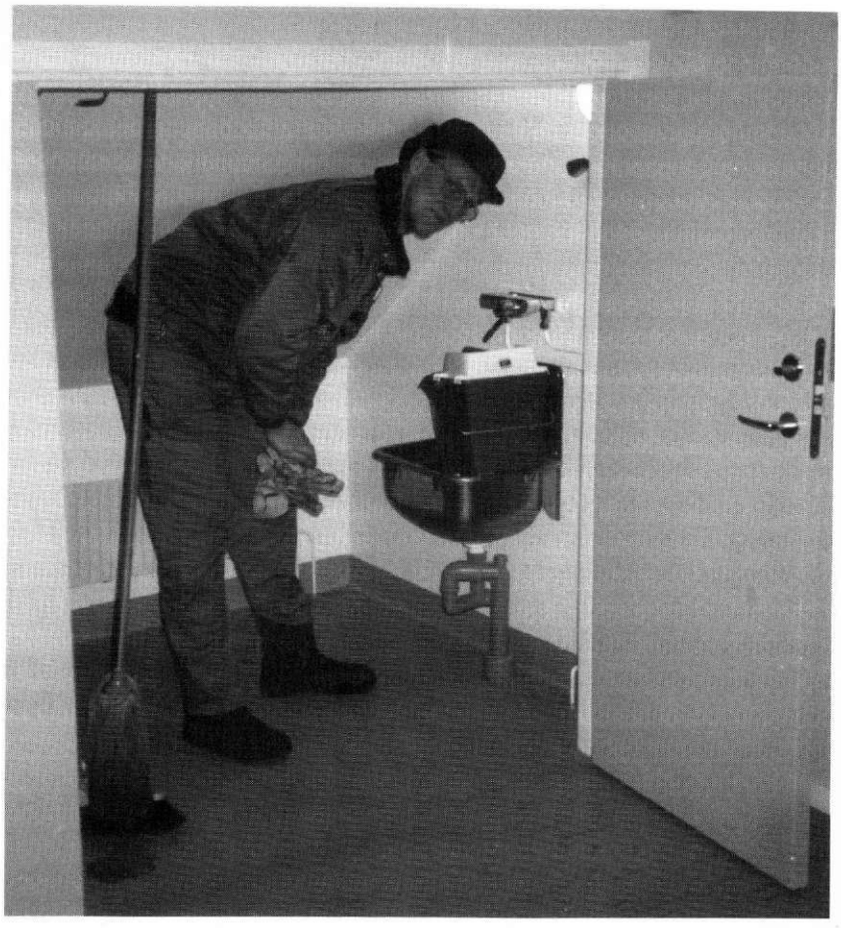

Figure 2. A cleaning room too low to stand straight in. The building is new. It just turned out that way.

needs into unambiguous product specifications. This perspective has direct implications for architects' and other planning professionals' competence and responsibility. It is also closely related to the Work Environment Act's paragraph 3:14, quoted above.

A building's performance for secondary users such as custodians and cleaners depends on whether the planners, client, buyers, builders, and others have been aware of the maintenance staffs' work environment requirements, if they have recognized the importance of those requirements, and if they have succeeded in finding design solutions which satisfy them. Researchers attack these problems with general analyses and recommendations *prior to* the planning stage, thus without connection to a specific building project. Several other research projects have taken this perspective (though it may not have been defined as such), but few of those projects dealt with the maintenance and service work considered in this study. The exceptions include *Entréer och trappor i bostadshus – utformning från städsynpunkt* (a study of how to design entrances and stairs in apartment buildings to facilitate cleaning; Linn, G. 1981), *Att angöra en brygga* (a handbook for the design of loading bays and loading areas; Granath et al, 1984), and the conference paper "Building Design from the Cleaning Perspective" (Linn, G. 1995).

Post-occupancy analyses of buildings are rarely if ever undertaken by design teams unless the client is a large organization which both builds and maintains its own stock and therefore has an economic interest in following up on the project. With the latter exception, we lack feedback from experience. In addition, the

time allotted for planning is short. It is against this background that the project presented here has its significance: to convey a body of knowledge which exceeds the individual's experience. The project – with its building function perspective – is intended to provide general empirical feedback.

The Project's Basis in New Construction

Why does this project not aim at producing a rebuilding handbook when rebuilding will in all probability dominate the construction industry in the future? This question has been asked and deserves a good answer, since it has a strong bearing on the method used in developing general design criteria.

The purpose of this project has been to establish general guidelines which can be applied to both new construction and, to a reasonable extent, to rebuilding. Each rebuilding project, however, presents unique conditions and conflicts which often result in compromises between various demands of function or economics. General guidelines which specify fundamental design requirements for a previously untouched area cannot be founded on compromises and exceptions, but must be based on an ideal situation. Basing the rules on compromises, though they may be abundant in reality, would mean built-in sources of error. The primary aim of this handbook has therefore been new construction.

Field Studies

In order to be able to define and chart the problems I have undertaken case studies in the form of visits to various sites and discussions with the affected personnel. I visited some 50 sites and interviewed about 120 people, usually in connection with those visits. The visits varied in duration from one or two hours to a day and a half, and in scope from one building to several residential neighborhoods. Representatives of different professions took me along on rounds of their typical responsibilities to show me various problems with the work environment. I took notes, as well as black-and-white and color photos.

The field studies were conducted for each profession separate from the others. I asked each group the same questions in order to provide a more objective background for evaluating their comments. The demands of the project have also influenced my working method.

The result was long lists of problems organized by profession into groups comprising various kinds of properties. At this point I did not evaluate or discard any of the ideas: all were initially assumed to be feasible. My thought was that an open attitude would encourage creativity and that all new ideas are backed by positive intentions and therefore worthy of recognition in this initial phase.

The Importance of Seeing with One's Own Eyes

The reason I chose not to use a questionnaire was my belief that it would be necessary for me to see the environments with my own eyes since I was not only to document the problems but also to conduct a discussion on better design.

One problem that turned out to be quite common was the difficulty of getting to various workstations. I had not addressed this problem in the initial interview questions, which were otherwise well chosen for the problems that emerged. The decision to follow along to each problematic place turned out to be extremely valuable in helping me understand these environments. I'm not sure I would have discovered as much about them if I had not been there in person. In projects like this, it is important for researchers to *see with their own eyes.* No questionnaire could replace my climbing up ladders and visiting fan rooms and dark crawl spaces. I had direct contact with the problems: they were not selected or filtered or restated by someone else, they were *first hand information.*

In certain situations I could not for safety reasons follow the person being interviewed all the way to the work site, which is an indication of the quality of the work environment.

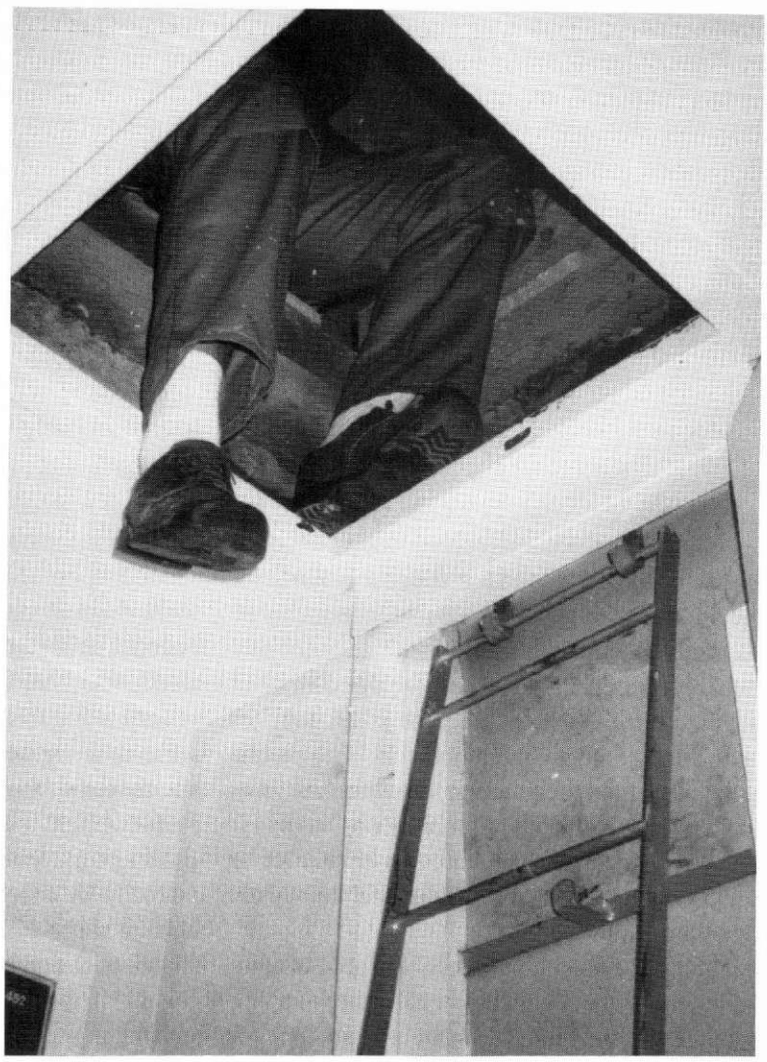

Figure 3. Where is the ladder? Equipment is to be carried up and down here. Distances of as much as 91 cm from the upper edge of the opening in the attic floor to the top of the ladder have been recorded. The floor below is of stone.

Examples were long outdoor ladders bridging between buildings and dangerous vertical distances from stairwell ladder to attic trap door. Another example of workplaces I did not reach completely was the fans in the cramped eaves of the attics of mass-produced houses of the '60s–'70s, to which a custodian must crawl in the dark through fiberglass insulation. The fibers of such insulation are a scourge for service personnel with responsibilities in tight spaces. They necessitate the use of a face mask, which makes the work even more arduous. Chimney sweeps also work in such an environment when they clean exhaust ducts.

All Affected Professions

As previously mentioned, all trades relevant to the subject have participated in the study. The work environments of fire fighters and ambulance crews are in part regulated in the building regulations, but I undertook a few interviews in that area anyway. The purpose of allowing all professions to take part was to create the kind of comprehensive picture which had previously been lacking.

Gathering all these professions in the same study is in fact an important matter of principle. Why not use the results of my field studies, already organized into groups according to

profession, to create a separate handbook for each individual group? The answer is that all of these people's various insights into a particular building area must first be coordinated with one another and with the requirements of other users, such as the building residents. Only after thus being addressed in the context of all user demands should information specific to each profession be extracted. For example, several different trade groups may have conflicting ideas about entrances. Therefore all ideas about entrances must first be coordinated and evaluated *together* if one is to formulate recommendations which are suitable and acceptable to everyone. It would not work, for example, to make one recommendation that suits cleaning staff and another for ambulance personnel: how would the planner then choose between them or compromise? The point of a project like this is to coordinate demands and ideas to achieve a result that is as good as possible for as many as possible. The results need not be problematic for any category. Thus it is that a recommendation may not be completely recognizable as the outcome of a particular interview, or may not seem optimal for a given profession.

The ideas of several professional groups coincided on certain points, increasing the weight of each and resulting in stronger demands for change. Never before had these groups' ideas been brought together; each had spoken only for its own interests. This had produced the familiar result that "Nobody listens to us." Conflicts of interest between the groups were never revealed.

I want to assert that *the requirements of maintenance and service personnel coincide with the requirements for the handicapped* in relevant areas, thus strengthening the demands of both groups.

Not all the trades involved in the study belong to organizations which are part of the FUA. The representatives of the FUA in the directing group have nonetheless realized the value of a comprehensive approach and accepted it. Since the FUA is a multi-partisan organization, it was important that the project maintain a balance between union and employer viewpoints. I had worked this way in the past because I found that my results were more influential when they could not be disclaimed as representing a particular interest group. At one point, when the balance of the project appeared to have shifted to the union side, we arranged a seminar with management representatives. There was, nonetheless, great agreement in the way the different sides viewed the physical environment.

Restructuring and Evaluation

In order to make the handbook easy for planners to use, it needed to be organized according to the various parts of a building rather than according to the various trade groups who work there. A convenient model was the Swedish BSAB System agreed upon by the various trades involved in the building process. This system has gained international attention. A structural engineer coded my study results and the material was structured according to the system, but as it became apparent that material dealing with rooms and spaces could not satisfactorily be adapted to the system, the BSAB coding was replaced by common numbering; however, the general disposition still adheres to the BSAB system. (The forthcoming new generation of the BSAB-system will probably be more suitable for aims like this.) The handbook text was also coded according to profession and has been indexed with search words to allow a multiplicity of uses by computer. In addition the handbook includes a chapter on the building process, written for the affected trade groups, and chapters on legislation and general problems in the area.

I filtered and evaluated the material for relevance and realism, then thoroughly revised it to make it useful in a handbook. The work has consistently been a matter of *judgment.* In cases for which it was impossible to propose a technical solution, functional demands have been formulated instead. The work process has generally been that, based on my discussions

with the users, I have proposed a conceivable technical solution to each problem. But this solution could not only satisfy the specific needs of these users, it had to be acceptable from the point of view of all the other demands made on that building – and here my judgments were based on my knowledge and experience as an architect. The proposals for technical solutions were then reviewed and judged by the group of planners previously mentioned, their collective knowledge providing the basis for evaluation. *In principle the approach was the same as in the building design process.* This was followed by critical review from the other participating groups – the directing group, reference group, and so forth.

For every new problem, for each of the hundreds of details examined during the project, the initial procedure was repeated, the idea of a conceivable technical solution and the judging of its feasibility with regard to other user requirements and other design aspects being reviewed in a complete cycle. This was not a formal procedure, but rather my own way of dealing with the assignment based on my experiences. This cycle of review for each building part and detail may be compared with Stuart Pugh's definitions of *total design* and *partial design* in his book *Total Design* (1991). "Partial design" deals with a product's form as seen from a particular perspective. If a product is to be successful, however, it must be shaped by "total design" – by consideration for all the demands that might be placed on it from a variety of perspectives.

Still, there are limits to the parallels to be drawn with the field of product design. As I mentioned, the revision of the proposals was based on experience, in contrast to that field's development of product design specifications (PDS) as described by Pugh:

> The PDS is essential in all fields of design activity from architecture to shipbuilding, electronics to mechanical engineering. A PDS must be comprehensive and unambiguous. If an experienced designer is asked to design something with a less than comprehensive PDS, he will almost, without thinking, fill in the gaps based on his experience and feelings; if these happen to be at variance with the true user needs, he will be designing to the wrong base.

I based my judgments on my experiences because in building it is neither reasonable nor possible to work with comprehensive need specifications. The planning process is full of design decisions about everything from the building's placement on the site to its exterior form, floor plan, and details, which are by custom based primarily on the planner's judgment. Therein lies the professional skill of the practicing architect. As Björn Linn asserts in a forthcoming book, the problems met in the planning of architecture are complex.

> This is because the functions of parts and of wholes can never be uniformly defined, since in architecture we design for comprehensive real-life situations, not – as is often the case with purely technical devices – merely for certain specified uses over a limited time span.

The Results of the Study

The study confirmed what was to some extent already known and what motivated the project: that the work environment for property maintenance and service personnel has been neglected compared to the working conditions of other groups. In general it may be said that the most common work environment problems in the field of property maintenance are:

- cramped spaces,
- difficulty of access,
- airborne dust and fibers in attic spaces, and
- the need for the strenuous manual transportation of objects.

It is extremely uncommon that the affected trade groups are enabled to participate in building projects. As mentioned previously, this is in all probability a major contributing factor to problems in the work environment.

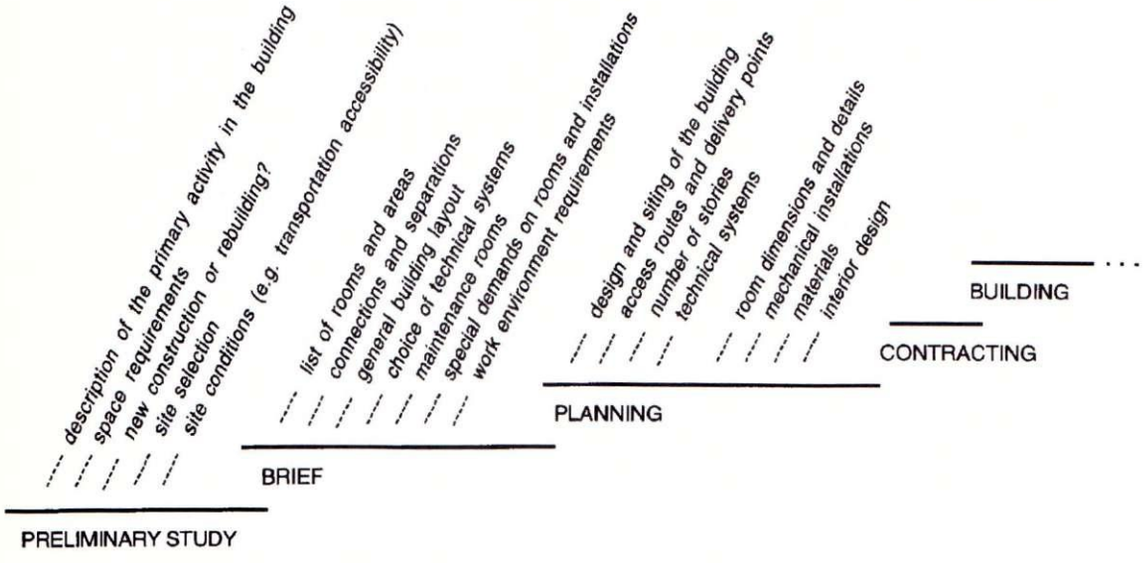

Figure 4. Schematic diagram of the issues addressed in the initial stages of the building process. To the traditional issues have been added "maintenance rooms" and "work environment requirements"; it is important that these be given attention early in the process. The diagram has been much simplified for laymen. It is primarily intended to present the issues and show their basic position. The various stages of the building process have been distinguished by symbolic lines; their relative proportions are not intended to be realistic.

My interviews revealed a problematic situation for the employees of the property maintenance and service contractors that compete for limited time commissions. The contractor does not want to diminish his competitive chances by complaining about the working conditions at the client's property: the client can always give the commission to someone else the next time. The contractors' dependence upon securing commissions makes it more difficult for them to formulate work environment requirements. Contracting out property maintenance has become increasingly common.

This situation has added to the motivation for developing a handbook. As a complement to the handbook, planners can retain the advice of the unions or trade organizations representing the maintenance and service personnel affected by a given project.

In some cases, such as window cleaning, the contractor must provide special equipment for his job. This might be ground support for a skylift or it might be scaffolding. This extra equipment increases the cost to the client. *"Anything can be done, but it's going to cost you,"* say the contractors. We may conclude that buildings designed with adequate knowledge and advice from their future secondary users or their representatives should have lower maintenance costs.

Certain planning and design issues have inspired more criticism than others. The most commonly cited problem is *the accessibility of and maintenance space for mechanical installations.* "But it's so seldom that anyone is up there in the attic. Why then do we need to worry about the design details?" The question is often asked by, among others, architecture students.

The answer is that maintenance personnel go from building to building, constantly meeting the same problems. These places are their everyday work environment, not some place they go four times a year. The young and strong

can handle most of these situations, but youth is not everlasting. These people should be allowed to work up to retirement. The problems are of course worse in older buildings, built according to the standards and conditions of an earlier age, but problems can be found in new buildings as well.

I was surprised at the great importance placed on *access routes, entrances, and surrounded courtyards* by many involved in the study. These included garbage collectors, transportation service drivers for the elderly and handicapped, movers, ambulance crews, maintenance contractors, and of course building residents.

Planning good entrance conditions in a residential neighborhood is difficult. The principle source of difficulty is the inherent conflict between child safety and vehicle access – an old problem arising again. In the past, personal car traffic has been with varying success banished from surrounded courtyards, while service vehicles have been allowed access. Courtyards planned for use by children often pose problems for the drivers of these vehicles.

Vehicular access to entrances is now generally argued in the interest of the elderly and handicapped. Transportation service drivers are responsible for the strenuous task of assisting or even carrying people great distances outdoors, especially difficult in conditions of snow and ice. Not all handicapped people use wheelchairs (see *Bygg ikapp handikapp!* 1995). Movers and ambulances should also be able to come close to entrances. The conflict between child safety and the needs of the elderly and handicapped was heightened in the 1980s by Swedish legislation stipulating that people in need of help and support should be able to live in normal residential areas. *Planning theory has not, as far as I can tell, addressed the conflicting demands of users on entrances.*

One scheme that solves the entrance problem is the traditional entryway spanning the full width of the building from street to courtyard. This arrangement consumes ground floor area but provides for both child safety and vehicular access. Trash rooms can be located at the edge of the courtyard, where garbage trucks can reach them without threatening children.

Even commercial properties experience problems when their entrances are not accessible to cars and trucks. The design of goods entrances is important for delivery drivers, as described in the above mentioned handbook on the design of loading bays and loading areas (Granath et al, 1984). In addition, the transportation paths for cash-in-transits (e. g. cash deliveries between businesses and banks) are overlooked during the planning process, and the inability of the drivers to pull up next to entrances exposes them unnecessarily to the risks of assault and robbery.

Cleaning is an arduous job, though conditions have improved a great deal in the past fifteen years, as evidenced by a comparison with a study of the difficulties of cleaning stairwells and entrances in apartment buildings I conducted at that time (G. Linn, 1981). Based on all I've seen of cleaning problems, I can say briefly that three simple, interrelated principles make for an easily cleaned building:

- dirt should be prevented from entering the building,
- polluting activities should be effectively separated from other activities, and
- it should be possible to remove dirt in a simple way.

Sufficient and properly designed cleaning-rooms should be provided, but this is not always the case. I have heard, for example, that Alvar Aalto's famous Finlandia Building in Helsinki originally lacked cleaning rooms, and that these were added afterwards where possible, such as under a staircase.

Stating the Obvious

Many of the handbook's stipulations go without saying. Unfortunately, the obvious must be stated anyway, since in practice buildings are not constructed as they "obviously" should.

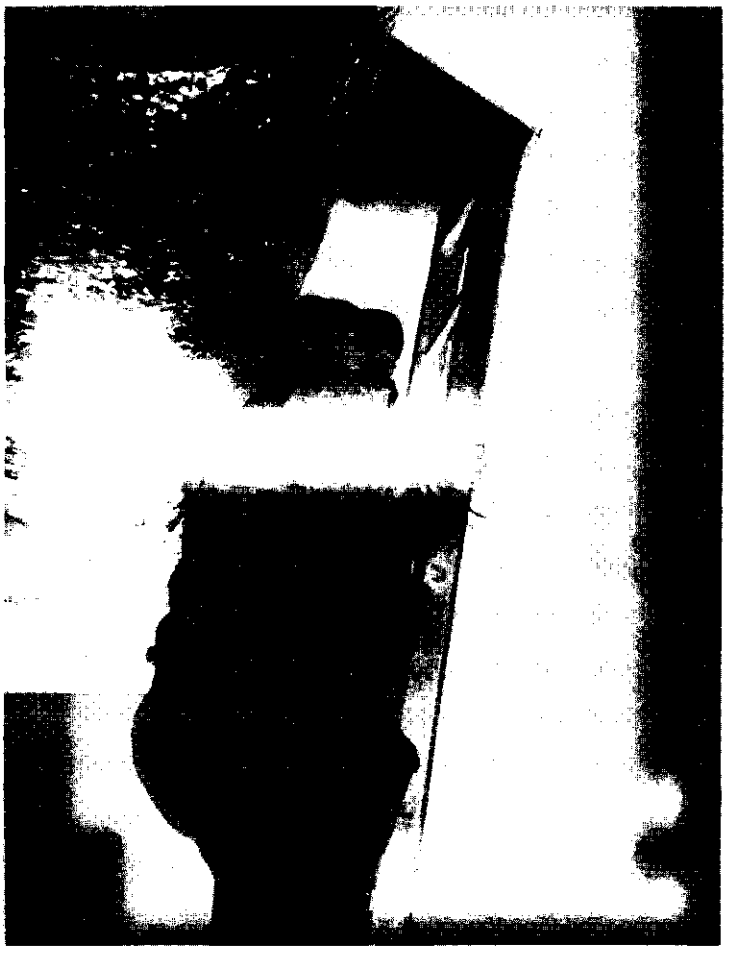

Figure 5. Collision between new duct work and the access to the roof of an older building. It just turned out that way.

This is the underlying problem, and it can be revealed by showing practical examples from existing buildings.

- How could someone lay a ventilation duct in an attic so that it blocks the access trap door?
- How could someone locate a roof fan so that the door to its access box can't be opened because it conflicts with the raised apron of the skylight right next to it?
- How could anyone in the '90s build a cleaning room with such a low ceiling that one can't stand up straight, and with a door one must bend over double to get through, when standards for cleaning rooms have existed for decades?

No one chooses to build this way – *it just happens.* All three examples are taken from reality – a reality that persists, year after year, for the personnel who must live with it.

Buildings can generally be rented out or sold (at least until now) despite the kind of functional shortcomings cited here. They could be remodeled, but this is of course expensive. Maintenance and service personnel adapt to deficient environments, managing as best they can. The argument for improving the situation can be driven far, and usually leads to issues of legislation and education.

What may have caused these shortcomings has been discussed both in the interviews and in the reference group, and in a few cases specific causes have been named. Faulty planning of mechanical installations has been attributed to the shortage of time allotted to plan-

ning and construction phases, to poor project management and coordination (different actors unaware of the others' actions), and to the number of different subcontractors involved simultaneously. Haste often results in makeshift solutions on the building site.

One reason for the problems with mechanical installations may be that they are installed according to a construction process rationale that fails to account for subsequent maintenance requirements. A handbook for mechanical systems installations which addresses both construction and maintenance considerations has been developed (VVS-branschens Arbetsmiljökommitté, 1993).

Tackling the problems covered by this study would require, according to the reference group, more thorough construction documents and total works documents, which in turn requires a reasonable time schedule for planning and smooth coordination between consultants, as well as good construction management – planning ahead and coordinating the various subcontractors. Record drawings, showing details as they were actually built, are important and should be kept current. Investment costs, too, exert a strong influence on the outcome of a building project. In summary, then, the general impression is that achieving a good work environment for the maintenance phase of a building's life demands

- knowledgeable planners,
- a competent client,
- utilization of available knowledge on the subject, and
- a dialog between planners and maintenance representatives.

Concluding Reflections

The point of this project has been in part to expand our knowledge of work environment problems, and in part to make that knowledge more useful – to make it operational. The study contributes to our awareness of the existence of these problems and to our understanding of their character, as well as developing good general technical solutions to the problems. Making the ideas operational means getting the new knowledge out to those who are responsible for and who influence the shaping of the physical work environment. To rejoin this article's introduction, the first stage is a research endeavor, while the second stage is about information.

A peculiar aspect of the building industry is that it does not always "need" new information – it manages anyway. We could keep building the way we always have. As products, buildings are not exposed to the kind of market pressures exerted on consumer goods. Influencing building practices may require legislation or special economic incentives.

In this project, the problems and needs of users have been transformed into technical design solutions with the same kind of thinking used in the planning of buildings. The project differs from an actual planning situation in that, whereas the planner focuses on a specific case, the researcher looks for generally applicable solutions.

The primary aim of the project is not to uncover the kind of "interesting results" so frequently sought out in the world of research. It is instead but one stage in a process of change. Problems in the physical environment, large and small, have through perseverance been identified, charted, and given concrete form, making them much easier to address. The results of the project – and the answer to the question of whether or not the endeavor has been a success – may be found in the buildings of the future.

Notes

1. Rådet för arbetslivsforskning
2. Arbetslivsfonden
3. This can be attributed to the language of the underlying Government Bill, *Anmälan till propositionen om insatser för aktiv rehabilitering och arbetslivsfondens verksamhet, m. m.* Arbetsmarknadsdepartementet (Ministry of Labour), Prop. 1989/62, Bilaga 2.

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