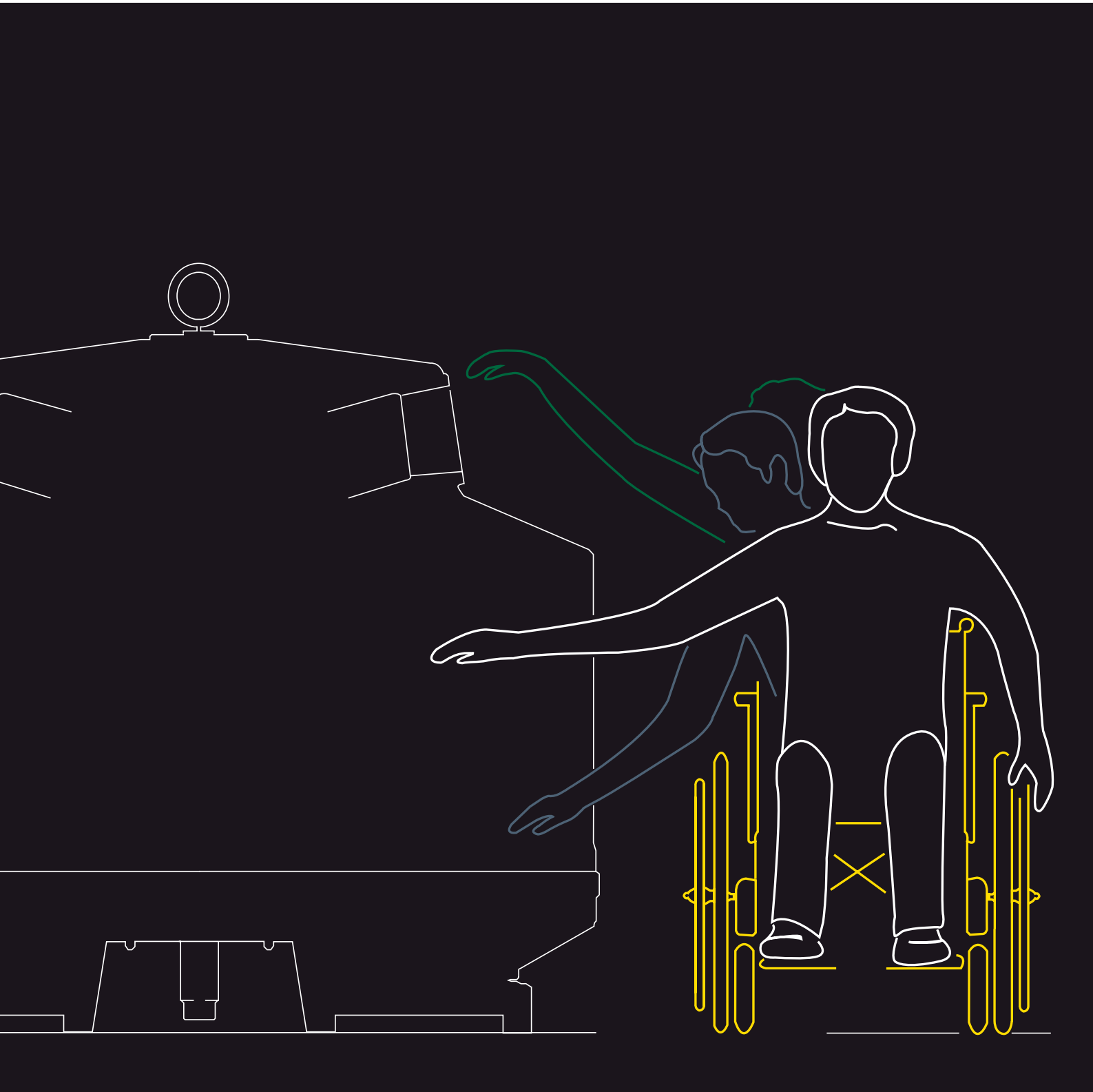
User-friendly waste disposal with emphasis on disability and accessibility

SBI REPORT 326 · DANISH BUILDING RESEARCH INSTITUTE · 2000



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ISBN 87-563-1076-5
ISSN 0573-9985.
Price: DKK 125,00 incl. 25 per cent VAT.
Word processing: Annette Frøhling.
Cover design: Sabine Skovfoged Østergaard.
Photos: Jan Carl Westphall, if no other reference.

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Preface

This report describes the results of the research project *User-friendly waste disposal with emphasis on disability and accessibility* and highlights the problems experienced by persons with disabilities and senior citizens in relation to waste separation and disposal.

User-friendly waste handling and waste disposal concerns not only accessible waste bins and containers but also addresses the design of access routes and layout of the collection points as well as the way in which information on separation and disposal of waste fractions is presented to the users. The aim is to give persons with reduced functional abilities equal opportunities in participating in waste separation and disposal activities.

The publication is intended for the actors in the waste management field: national and international manufacturers of waste bins and containers, municipal planners, and refuse collecting agents as well as housing associations and user organisations in the disability field.

The project was conducted by project leader Philip Jensen MSc, EBO Consult, and architect MAA Christian Woetmann Nielsen, Danish Building and Urban Research.

In the project period, December 1998 to May 2000, the authors have held meetings with a planning group at the 1898 Public Cleansing Company consisting of Michael Dencker, Gert Hansen, and Kjeld Mørch and a steering group consisting of Managing Director Erik Christiansen, PrivatBo, Head of Division Kjeld Mørch, the 1898 Public Cleansing Company, and Senior Researcher Ole Kirkegaard, Danish Building and Urban Research.

The project has received substantial assistance from Søren Ginnerup, Senior Consultant, Danish Centre for Accessibility, and green guide Bettina Fellov, Green Guide, The Housing Association & Administration 3B in relation to the questionnaire survey in the housing estate 'Hørgården'. Ivor Ambrose, Senior Researcher and Expert to the European Commission, Brussels, who commented on the report, is thanked for his time and assistance.

A number of Danish disability organisations have had the opportunity to review a draft version of this report.

The project was financed by the R98 Foundation and the Institute for Service Development.

EBO Consult, the 1898 Public Cleansing Company, and Danish Building and Urban Research wish to thank all parties involved for their valuable contributions to the project.

Danish Building and Urban Research
Housing and Urban Research Division.
March 2001
Hans Kristensen, Head of Division

Summary and conclusions

This research report is the first comprehensive account that focuses on the problems experienced by persons with disabilities and senior citizens in connection with waste disposal.

The first chapter deals with the implications of United Nations document *The Standard Rules on the Equalization of Opportunities for Persons with Disabilities* (1993), particularly in relation to accessibility.

The second chapter outlines the results of two previous Danish studies on the user-friendliness of current waste storage receptacles (BUR, 1991;Jensen, 1997). These studies conclude that the very design of waste bins and banks to a large extent preclude persons with disabilities from participating in day-to-day waste disposal activities on an equal level with others. Also, the information on how to separate at source proved to be inadequate. The studies document the need for developing receptacles which are accessible for a much wider range of users, including persons with mobility disabilities and visual impairments.

The chapter closes with background information on accessibility. The Danish design manual *Accessible Outdoor Environment* (1997) distinguishes five categories of disabilities in an attempt to define the specific accessibility requirements of disabled persons. Story et al. (1998) outlines the seven design principles behind the concept of universal design where the requirements of a very broad spectrum of abilities are taken into consideration.

The following chapter describes how current standard receptacles were modified to cater specifically for persons seated in wheelchairs and walking aid users. The modified receptacles were used in field tests in three housing estates in the municipalities of Copenhagen and Frederiksberg over a period of seven months. In the course of the field tests the tenants were asked to assess the modified receptacles' usability through questionnaires and interviews. Furthermore, the modified receptacles were tested by persons with visual impairments. The results of the field tests show that it is indeed possible to achieve a higher degree of user-friendliness for persons with mobility problems by modifying standard receptacles. It should also be noted that the modified receptacles were received positively by the able-bodied tenants. However, it is proposed that the future development should concentrate on designing new waste bins and banks that accommodate a broad range of individual preferences and abilities.

On the basis of the previous Danish studies, field tests and information retrieval this report draws up design guidelines for user-friendly waste disposal, including

- Information on waste separation and disposal
- Design of the access route from the dwelling to the primary source collection point
- Layout of the primary source collection point
- Design and dimensions of primary source storage point receptacles.

In general, the guidelines are aimed at the actors in the waste management field, housing associations, and responsible authorities.

More specifically, the guidelines on information on waste separation and disposal can be used by municipalities, collecting agents, and user organisations in the disability field.

The guidelines on the design of the access route as well as the layout of the collection point may serve as background information for preparing tender documents for new buildings and refurbishment projects and may also be used as a planning tool for architects and engineers. Moreover, the guidelines may be included in future building requirements in this field.

The guidelines on the design and dimensions of receptacles are prepared in such a way as to make them suitable for inclusion as requirements made by municipalities and service providers in their tender material for the manufacture and supply of waste disposal equipment. The guidelines may also be used directly by the manufacturers in the design of future receptacles.

In addition, it would be highly desirable if the requirements on user-friendliness were to be incorporated into Danish and European standards, the DS/EN standards governing waste management.

Standard Rules on the Equalization of Opportunities for Persons with Disabilities

Within the framework of disability policy, the overall objective is that persons with disabilities should in all respects have the same opportunities as able-bodied persons, and consequently the rights and obligations of disabled persons have been highlighted in recent years.

The United Nations' document *Standard Rules on the Equalization of Opportunities for Persons with Disabilities* was endorsed in December 1993 (Resolution 48/96) by the member states of the United Nations, including Denmark (UN, 1994). The adoption of the *Standard Rules* marks a turning point for policy-making and planning for disabled persons. For the first time ever, an agreement was reached on an international instrument that can be used to influence and guide actions leading to full participation of disabled persons on equal terms with able-bodied persons.

The purpose of the *Standard Rules* is to ensure that persons with disabilities may exercise the same rights and obligations as able-bodied persons. It is emphasized that the number af persons with disabilities in the world is large and growing, and that there are still obstacles that prevent disabled persons from exercising their rights which makes it difficult for them to participate fully in the activities of their societies.

Furthermore, the *Standard Rules* define the terms 'disability'and 'handicap'. The term 'disability' embraces a great number of different functional limitations occuring in any population, and people may be disabled by physical, intellectual or sensory impairment, medical conditions or mental illness. Such impairments, conditions or illnesses may be permanent or temporary in nature. The term 'handicap', on the other hand, means the loss or limitation of opportunities to take part in the life of the community on an equal level with others. It describes the encounter between the person with a disability and the environment. Thus, the purpose of the term 'handicap' is to emphasize the shortcomings in the environment and in many organized activities in the society which prevent people with disabilities from participating on equal terms.

In a historical overview of disability policy, the *Standard Rules* note that concepts of integration and normalization which reflect a growing awareness of the capabilities of disabled persons were introduced after the Second World War. Towards the end of the 1960s, however, organizations of persons with disabilities started to formulate a new concept of disability that established the close connection between the limitation experienced by individuals with disabilities, the design and structure of the environments, and the attitude of the general population.

The term 'equalization of opportunities' in the document's title refers to the process through which the various systems of society and the environment, such as services and information, are made available to all. The principle of equal rights implies that the needs of each and every individual are of equal importance, that those needs must be the basis of the planning of societies, and that all resources must be employed in such a way as to ensure that every individual has equal opportunity for participation.

Although not legally binding, the *Standard Rules* call for action and define eight target areas of decisive importance for the quality of life and for the achievement of full participation and equality, each with a set of specific aims. The target areas include 'Accessibility', 'Education', 'Employment', 'Income maintenance and social security', 'Family life and personal integrity', 'Culture', 'Recreation and sports', and 'Religion'.

The target area, 'Accessibility', refers to two fields of action:

> "*States should recognize the overall importance of accessibility in the process of the equalization of opportunities of all spheres of society. For persons with disabilities, States should (a) introduce programmes of action to make the physical environment accessible; and (b) undertake measures to provide access to information and communication.*"

The first of these, *Access to the physical environ-*

ment, has the following components:

- Development of standards, guidelines and possible legislation for access to housing, buildings, transport, streets and outdoor environments.
- Information to architects, designers, engineers, and other design professionals on access policy and suitable measures to ensure access.
- Incorporation of accessibility requirements in design and construction from the beginning of the design process.
- Consultation with disability organizations when developing norms and standards, and local involvement of these organizations in public construction projects.

The second, *Access to information and communication*, has the following components:

- Information on rights and available services and programmes presented in forms accessible to persons with disabilities.
- Development of strategies of making information services and documentation accessible for different groups of persons with disabilities.
- Provision of sign language interpretation services to facilitate communication between deaf persons and others.
- Incorporation of the needs of people with other communication disabilities.
- Incorporation of accessible computerized information and service systems offered to the general public.
- Consultation with disability organizations when developing measures to make information services accessible.

As the objective of the *Standard Rules* is to ensure that disabled persons may exercise the same rights and obligations as other groups of citizens, it is pointed out that when disabled people achieve equal rights in the above target areas, they should also have equal obligations. As the rights are being achieved, societies should therefore raise their expectations towards persons with disabilities and, as part of the process leading to equal opportunities, provision should be made to assist them to assume their full responsibility as members of their societies.

Today, disability is viewed as a consequence of a society which does not take into account the human variation and the characteristics and qualities of the individual person. This point of view leads to a development towards eliminating man-made obstacles in society. This line of thought is reflected in the revision of WHO's classification of "impairment", "disability" and "handicap" which was first published in 1980 by the World Health Organization. The second revised draft of the new classification *ICIDH-2: International Classification of Functioning and Disability* (WHO, 1999) which is expected to be endorsed at the WHO General Assembly in May 2001 systematically groups functional states associated with health conditions (*i.e.* diseases, disorders or trauma). The overall aim of the ICIDH-2 classification is to provide a unified and standard language and framework of human functioning and disability as an important component of health.

Given that the principles and objectives for integration of disability requirements in planning are clearly established in the international agreements outlined above, it is now highly relevant to identify targets for their implementation at national level. The case of user involvement in waste management is therefore addressed in this research report as a particular area for development of systems suitable for disabled persons.

Disposal of household waste fractions in relation to persons with disabilities and senior citizens

Access to housing, buildings, transport, streets and outdoor environments is a basic feature of the built environment that enables people to participate in a wide range of social, economic, and enviromental activities. For the majority of people, *i.e.* regular able-bodied persons, access is taken for granted, and this portion of the population uses the facilities in the built environment in an independent and equal way. However, for a sizeable portion of the population, the built environment is far from accessible and persons with disabilities, in particular, experience numerous obstacles when entering buildings or using the outdoor environments on a regular, day-to-day basis. Because of these obstacles many facilities cannot be used by disabled persons at all, or only with a high degree of inconvenience and difficulty. As a result of this, persons with disabilities are in many cases excluded from taking part in the various everyday activities of the societies of which they are naturally a part. Thus, in order to ensure equal opportunities of participation in social, economic, and environmental activities, everyone - with or without a disability - must be able to use any part of the built environment as independently and equally as possible.

Evidently, a society works better when people are not prevented from going where they want to, either to use a facility or to offer their services. A case in point is provided by activities pertaining to separation and disposal of household refuse and recyclable materials. As the generation of waste is inherent in the activities of our societies, it is of the greatest importance to make optimal use of the resources of the waste fractions. Therefore, the everyday recycling activities should offer householders a chance to do something practical for the environment by disposing of the different household waste fractions in an environmentally correct way. However, at the present moment, a noteworthy problem of waste management is that not all householders have equal opportunities of participating actively in waste sorting and handling activities.

Two Danish investigations (BUR, 1991; Jensen, 1997), described below in detail, have shown that persons with disabilities find disposal of refuse and other household waste fractions to be highly problematic as the general design of the waste bins and other storage point receptacles only addresses the general requirements of able-bodied people, thus failing to take into account the requirements of disabled persons. In a Swedish study, Nakajima Wahlström (1997) has documented that suppliers of waste disposal equipment have not considered the specific needs of persons with mobility problems and orientation difficulties as regards using the receptacles.

Consequently, the otherwise simple task of taking out the household refuse and other waste fractions becomes a major undertaking for a great many people.

Household waste management schemes in Denmark: a brief overview

Growing environmental concern and strict environmental regulations and requirements concerning recycling have led to new waste management schemes in Denmark.[1]

The Danish approach with respect to household waste management, as described by Moe (1995) in his *Environmental Administration in Denmark*, is based on the experience that waste streams should be kept separate if recycling is to be succesful, and the idea of separate waste streams now markedly influences the handling of household wastes.

The Danish municipalities are responsible for the collection of household waste and call for the source separation of household waste into different waste fractions which are collected and transported to treatment plants. The citizens are thus obliged to use the directions and

[1]Terms used in connection with source seperation, disposal, storage, collection of wastes, and waste management are in accordance with Skitt (1992).

instructions laid down by the municipalities in order to dispose of the household waste.

The majority of the municipalities have chosen a model whereby the municipalities themselves typically handle the administration, planning, purchase of receptacles, and everyday contact to the citizens while a contractor holds the concession to collect the household waste in accordance with the regulations stipulated by the municipality.

The 1898 Public Cleansing Company - in short R98 - is a consumer-led, non-profit waste collecting agent which is governed by a concession granted by the municipalities of Copenhagen and Frederiksberg to carry out the collection of household waste in the aforementioned municipalities. However, R98 not only manages the collection of waste fractions from the households but also takes care of administration, everyday contact to the users, development of new collection schemes, and purchase and development of receptacles. In this particular case, the municipalities of Copenhagen and Frederiksberg set the main policies and waste regulations for the household waste collection

According to R98 (1998), the service schemes covered by the refuse collection charges are:

- Separation and collection within the curtilage of the primary source premises, *e.g.* courtyards of housing estates.
- Separation and collection at predetermined points in the neighbourhood.
- Separation and collection in the district at recycling stations.

The waste fractions that are collected from the primary source premises, in the neighbourhood or in the district depend primarily on the bulk and the toxicity of the waste.

The majority of the waste that originates from households is collected by the refuse collectors at the primary source.

Table 1 shows the various waste fractions which are collected from multi-storey buildings and single-family houses, respectively.

Table 1. Overview of the different waste fractions collected from multi-storey buildings and single-family houses

Multi-storey buildings	Single-family houses
Household refuse	household refuse
Newspapers and magazines	-
Glass/bottles *	-
Organic waste **	organic waste **
Bulky waste	bulky waste
Garden waste	garden waste

* Glass/bottles are collected only in housing estates where tenants pay an assitional fee for this service
** Organic waste is collected only in selected areas in the municipality of Copenhagen

At pre-determined points in the neighbourhood, citizens may dispose of newspapers/ magazines and glass in communal storage containers, usually located at supermarket shopping centres.

At recycling stations in the district, citizens may dispose of a number of recyclable materials in communal storage containers as well as biohazardous household waste. Thus, the environmentally concerned citizens are in a position to reduce the amount of waste for incineration by using the recycling stations in a systematic way. In order to make the collection of biohazardous household waste easier for the citizens, there are other environmentally correct ways of disposing of the toxic waste. Thus, leftovers of medicine and mercury-containing thermometers may be delivered to all pharmacies in the two municipalities. Leftovers of paints, solvents and suchlike may be delivered at all chemists' shops; and used batteries may be handed over to selected retail shops and institutions. Furthermore, specially-adapted 'environment vehicles' receive all types of biohazardous household waste, and collection time tables issued by R98 as written information are from time to time sent to all households in the two municipalities.

Moe (1995) emphasizes the fact that the Danish municipalities depend upon the positive participation of the citizens in order for household waste schemes to function succesfully. Hence it follows that every household is expected to participate actively in source separation and disposal of household wastes. Thus, the household waste schemes are not only an opportunity for citizens to get rid of their waste; the citizens also have a responsibility to ensure that the waste fractions are disposed of in an orderly, environmentally correct way.

Household waste project in the housing estate 'Rådhusdammen'

A report published by the Danish Building Development Council (BUR, 1991) describes a household waste project in a housing estate 'Rådhusdammen', a series of two-storey apartment blocks located in the municipality of Albertslund, west of Copenhagen. The tenants of 'Rådhusdammen', who included wheelchair users and elderly people, found that the waste plan issued by the municipality did not take into consideration the specific needs of these groups in relation to source separation and waste disposal. Thus, the purpose of the project was to draw up and test, within the framework of the municipal waste plan and in an interplay with the tenants, practical solutions in the kitchen regarding source seperation as well as solutions regarding the design of the receptacles at the collection points within the curtilage of the housing estate so that they could be used by as many tenants as possible. Self-reliance and participation in everyday activities were key issues in the project.

The project was funded by the Danish Ministry of Housing and Urban Affairs and carried out by the engineering consultancy Nellemann A/S and Arkitekterne Bahn.

In the kitchen, the tenants should have the option of choosing between different kitchen cupboards, handles that are easy to grasp and fittings to suit individual needs.

In the sheds which served as collection points the following recommendations were made:

- Existing wooden doors should be replaced by automatic glass doors for security reasons.
- The illumination of the room should be improved as the tenants described the room as being too dark.
- The ventilation of the room should be improved because of unpleasant odours emanating from the waste.

The lids of the receptacles located at the collection points were heavy and awkward to handle, and thus the following improvements were proposed:

- Containers with a lid at the front.
- Containers with a smaller lid incoporated in the existing lid.
- Containers with a sliding door lid incorporated in the existing lid.

In order to make waste bins as well as receptacles for the disposal of recyclable materials readily distinguishable, it was proposed that the containers should be painted in different colours and supplemented by easy-to-understand symbols and Braille lettering.

However, although several useful solutions were drawn up and tested it was concluded that it was impossible to come up with one single solution which took into consideration the needs of all the tenants concerned. Subsequently, none of the proposals were put into effect in 'Rådhusdammen'.

Survey on the user-friendliness of receptacles in the municipality of Køge

Jensen (1997) conducted a survey on the user-friendliness of current waste bins, paper banks, bottle banks, and compost bins utilised by the municipality of Køge, located south of Copenhagen, based on interviews with selected people with disabilities, five persons with visual impairments and twelve persons with various motor disabilities, including wheelchair users. The interviewees resided either in single-family houses or in apartments. The study was carried out by the Department of Planning at the Technical University of Denmark in conjunction with the Roskilde county branch of The Danish Council of Organisations of Disabled People, a Danish umbrella organisation in the disability field.

The interviewees with visual impairments proposed that the information regarding the municipal waste plan should be issued as an audiotape in addition to the leaflet they had received, but not read. It was emphasized that the issuing of an audiotape in this particular case would not only benefit the visually impaired, but also slow readers and people with learning disabilities. Also, stickers with readily understood symbols or pictograms and Braille lettering should be affixed to the receptacles.

On the whole, wheelchair users and people with other motor disabilities, like the visually impaired, had established their own daily routines in the kitchen regarding the separation of materials at source for recycling purposes. However, some of the wheelchair users did not take part in either source separation or waste disposal because it was too burdensome for them, for which reason these persons required

help from others, *i.e.* spouses or home helps, to dispose of the household wastes. Those who did participate in waste sorting and handling activities pointed out that the access route from the dwelling to the collection point constituted a serious accessibility barrier, mainly because of differences in levels of paths and surface irregularities.

With regard to the design of the waste bins, banks, and compost bins in the municipality of Køge, the following improvements to the collection systems were proposed by the interviewees with motor disabilities:

- Waste bins and containers should be operable with one hand only as persons with reduced arm/hand functions and some wheelchair users found it difficult, or in some cases impossible, to open the lid and put in the refuse at the same time.
- Containers should be fitted with a smaller lid incorporated in the existing lid as many complained that the existing lids were too heavy to handle.
- Containers should be fitted with a sliding door lid incorporated in the existing lid.
- Paper banks and compost bins should be fitted with inlets/lids placed at a height so that a child would be able to put in the waste fractions.
- An overall collection point solution for separating out household refuse and recyclable materials should be established instead of separate waste bins and containers placed far apart.

The interviewees pointed out that some senior citizens with less strength to overcome physical barriers also found it difficult to dispose of the waste.

Preliminary conclusions

The two studies referred to above point out that the very design of current primary source storage point receptacles such as waste bins, paper and bottle banks, containers, and compost bins to a large extent precludes people with disabilities from participating actively in the disposal of household waste fractions on equal terms with able-bodied people.

In both cases, however, the disabled persons in question put forward proposals to make the current receptacles more disability-friendly. The studies show that there exists a need to develop accessible receptacles that can be readily used by persons with disabilities as well as senior citizens. Thus, accessible waste disposal equipment - developed in close collaboration with the two target groups - is seen as a prerequisite of involving people with disabilities in tasks pertaining to waste disposal on an equal basis with other groups of citizens.

Within the group of people with disabilities, however, the specific requirements with regard to source seperation and waste disposal of those with visual impairments are quite different from those of wheelchair users, walking aid users and people with reduced arm/hand functions. Thus, a broad range of different functional limitations must be taken into consideration when evaluating and/or designing accessible receptacles rather than only focussing on the needs of a specific group of disabled people.

Further, the studies also draw attention to the fact that the access routes from the households to the collection points as well as the design of the collection points themselves are far from adequate in relation to the accessibility requirements of persons with disabilities.

In a study on the user-friendliness of current receptacles offered by Swedish collecting agents four suppliers of waste disposal equipment were questioned whether they had taken into consideration the needs of persons with mobility problems and orientation difficulties in the design of the primary source receptacles (Nakajima Wahlström, 1997). It turned out that none of the companies had contemplated designing receptacles with the aim of accommodating persons with disabilities because disability-friendly receptacles were not in demand. Nevertheless, the Swedish study stressed that testing of the receptacles, in collaboration with persons with disabilities, would be advantageous in order to draw up specifications for the design of disability-friendly receptacles.

Definition of functional ability

In order to design disability-friendly products and environments it is important to have detailed knowledge of the concept of functional ability, the accessibility requirements of persons with disabilities, and the principles behind the concept of universal design.

Everybody may come up against an unsuitable environment full of obstacles. At any given time, a large group of people may be temporarily disabled such as people with sporting inju-

ries, people carrying heavy bags or luggage, and people pushing prams. Children and senior citizens may also experience impairments during periods of their lives. Thus, all of the above experience reduced functional abilities which restrict their normal range of action.

According to Bringa (1984), the functional ability which we all possess enables us to a large extent to overcome the majority of the functional requirements of the society. It is highly likely that the functional ability is normally distributed in the population in the same way as height, weight, sight, and hearing are distributed. Thus, the functional ability is a measurement of how well a given person is able to function and to overcome the overall requirements of the society (Fig. 1). The overall requirements are also known as the society's functional requirements. If a given person's functional ability is below the society's minimum functional requirements then this person is disabled. The difference between the society's minimum functional requirements and the functional ability which the disabled person possesses is designated the functional deficit.

Evidently, the functional deficit is to be eliminated if persons with disabilities are to function as independently and equally as able-bodied persons. In many cases, however, it is an unrealistic proposition to eliminate the functional deficit completely. However, by reducing the functional deficit, or in other words moving the society's minimal functional requirements to the functional ability to the left of the curve, *i.e.* towards greater self-reliance, many persons with disabilities and senior citizens would be able to function in society on equal terms with able-bodied persons.

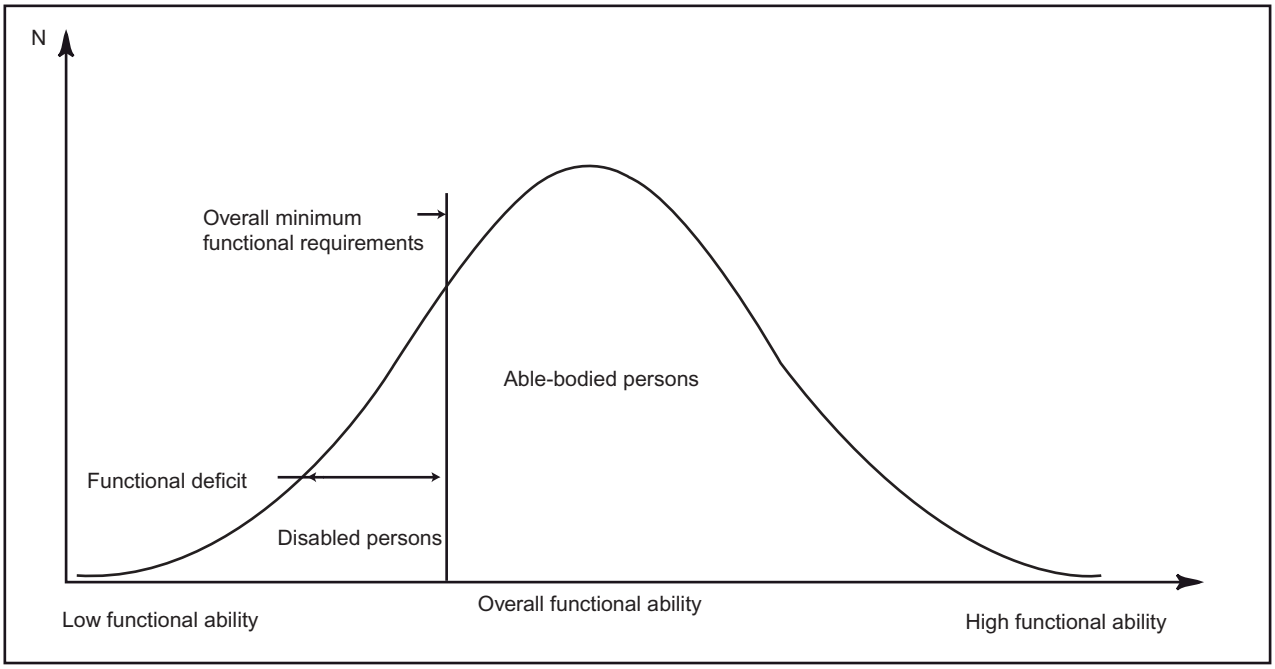

Figure 1. The functional abilitiy as a measurement of how well a person is able to overcome the overall requirements of the society (after Bringa, 1984).

Disability categories and dimensioning factors

Aslaksen *et al.* (1997) estimates that persons with disabilities, defined as people with permanent problems relating to essential areas of life, constitute 19 % of the population in Norway and other Western European countries.

Table 2 shows the distribution of various types of disability and their prevalence per 1000 of population.

Table 2. Disabled and elderly persons; prevalence per 1,000 of population

Disability group	Prevalence per 1,000 of polulation
Blind	1
Cannot use fingers	1
Dyslexia (severe)	10
Wheelchair users	10
Low vision	13
Reduced co-ordination	14
Reduced strength	27
Intellectually impaired	37
Cannot walk without aid	56
Allergic	100
Elderly	100
Hearing impaired	140

The table has been compiled by Woetmann Nielsen and Ambrose (1999).

It is not a coincidence that the accessibility requirements of persons seated in wheelchairs are highlighted even though wheelchair users are in fact among the least prevalent groups, according to Table 2. When planning and designing *e.g.* outdoor environments measures which takes into account the accessibility requirements of wheelchair users will also to a great extent be able to accommodate persons with other mobility problems such as stick users (Bringa 1984). The functional measurements of the wheelchair, whether it be a manual or an electric wheelchair, are the essential parametes in relation to turning space, width and length, the user's reaching distances, eye-height and the ability to propel the wheelchair unaided up ramps and across different surfaces. Thus, Bringa (1984) suggests that users of manual and electric wheelchairs are to be considered normative in relation to the planning of accessible outdoor environments.

Electric wheelchairs take up more space than do manual wheelchairs (Woetmann Nielsen, 2000). The majority of manual wheelchairs can be confined to a space of 70 x 120cm; the smallest turning space being 150 x 150cm. Some wheelchair users are able to manoeuvre in less space, but for the majority of wheelchair users less space is equal to many cumbersome and difficult manoeuvers. Electric wheelchairs for indoor use usually have a width of 65-70cm and a length of 90-135cm. The turning space should at least be 150 x 150cm but for wheelchair users with reduced strength in their arms a turning space of 170 x 170cm is more comfortable. However, the turning space for outdoor wheelchairs should be 180 x 180cm, preferably 250 x 250cm.

Goldsmith (1997), in his standard reference for architects and designers *Designing for the Disabled: The New Paradigm*, emphasizes the fact that able-bodied people comprise a homogenous population in terms of body and reach characteristics whereas people who are confined to wheelchairs make up a heterogenous population. Able-bodied people present body and reach characteristics that, when measured, enable reliable predictions to be made of the level at which a particular item ought to be placed so that it is convenient for 95 or 99 per cent of the population. Conversely, a sizeable proportion of wheelchair users have upper limb impairments that prevent them from using their arms to reach a given item, and among those who are able to stretch their arms the range af reach is very variable. The paraplegic-type wheelchair users with normal arm function cannot be held to be representative for all wheelchair users as they make up only a small minority in respect to the totality of wheelchair users. However, in formulating design specifications, the paraplegic has determined the presentation of reach criteria for disabled people in guidance documents issued in Britain, USA and elsewhere (Goldsmith, 1997).

In an attempt to define the specific accessibility requirements of people with disabilities with respect to the outdoor environment, the Danish design manual *Accessible Outdoor Environment* (DS, 1997) distinguishes five categories of disabilities:

Physical disabilities (or motor disabilities)
Persons with various forms of paralysis (such as paraplegics confined to wheelchairs and hemiplegics, *i.e.* ambulant or wheelchairbound people with one-sided paralysis), poor balance, amputations, rheumatism and arthritis, and persons with cardiac, pulmonary and circulatory diseases.

Visual impairments
Persons who are either blind or partially sighted.

Hearing impairments
Persons who are either deaf or have an impaired hearing ability.

Allergies
Persons with allergic reactions such as hay fever, asthma, urticaria, and eczema.

Learning disabilities
Persons with diseases of the central nervous system, brain damage (caused by accidents or cerebral haemorrhage), reduced mental capabilities/intellectually impaired, and various types of mental disorders.

Universal design

Technical aids such as lenses, hearing aids, rollators and other walking aids, manual and electric wheelchairs play a pivotal role in overcoming physical deficiences by compensating for individual functional reductions. Subsequently, these technical aids enable people with a wide range of disabilities to function more independently and equally in society, *e.g.* in the educational system or in the field of employment. According to Aslaksen et al. (1997), the use of assistive devices puts a demand on the very design of products and environments in order to realize equal participation. Thus, it is of growing importance that designers of products as well as environments cater for all kinds of functional limitations if people with disabilities are to exercise the same rights and obligations as other groups of citizens.

Compliance with the directions of DS (1997) ensures that the requirements of temporarily disabled persons, children and senior citizens are taken into consideration so that the changes needed to accommodate persons with disabilities will benefit everyone.

Traditionally, product designers have been trained to design for a mythical "average" group of persons. However, as Bringa (1984) and Story et al. (1998) point out, this group does not exist as any human characteristic that can be measured such as height, body and reach dimensions spans a broad range in any population. Where account is taken of average dimensions only, the likelihood is that in any specific case only about half of the population under consideration will be satisfied, and therefore account must also be taken of people whose dimensional characteristics deviate from the average in order to ensure that a broad range of a population is accommodated (Goldsmith, 1979). The human species is infinitely variable in terms of stature, motor capacities, hearing and visual faculties, and an understanding of human variation is therefore crucial in designing products and environments which embrace the needs of all users.

By applying the principles of *universal design* it is possible to design a product or an environment to suit a broad range of users, for example children, elderly people, people with permanent as well as temporary disabilities, and people of atypical size. Inherent in this approach is the understanding that everybody should have the same possibilities of participating in all aspects of life and that the needs of all users should be valued on equal terms.

Whereas assistive technology attempts to meet the specific needs of the individual, universal design strives, as pointed out by Story et al. (1998), to integrate persons with disabilities into the mainstream. In other words, the universal design approach takes into account the functional requirements of a very broad spectrum of abilities, rather than only those of the non-existing group of "average" persons, in the evaluation and design process.

Consequently, The Center for Universal Design at the North Carolina State University has defined universal design as *"the design of products and environments to be usable to the greatest extent possible by people of all ages and abilities"* (Story et al., 1998).

The Center for Universal Design has identified seven principles which can be applied to evaluate existing design, guide the design process, and educate designers and users about the characteristics of more usable products and environments.[2] The introduction of the universal design principles makes it possible to extend the user groups as well as broaden the functional requirements of the product or environment. The principles are briefly described below:

1. Equitable use
The design is useful and marketable to people with diverse abilities.

[2]For an in-depth description of the seven principles of universal design and their application, see Story et al. (1998: 32-124).

2. Flexibility in use
The design accommodates a wide range of individual preferences and abilities.

3. Simple and intuitive use
Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

4. Perceptible information
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

5. Tolerance for error
The design minimises hazards and the adverse consequences of accidental or unintended actions.

6. Low physical effort
The design can be used efficiently and comfortably and with a minimum of fatigue.

7. Size and space for approach and use
Appropriate size and space is provided for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

The difference between universal design and other conceptual design movements is that knowledge of requirements and functional ability is not compiled in order to design a specific product but is used as a tool in the design process of many different products.

Universal design does not, however, purport to make dedicated assistive technologies redundant. These technologies will invariably be required for coping with severe impairments.

By combining knowledge of the concept of functional ability, the accessibility requirements of disabled persons, and the principles behind the concept of universal design with the current household waste management schemes, criteria for informing users on waste seperation and disposal and for designing access routes, collection points and receptacles can be drawn up with the aim of accommodating the widest possible range of user needs.

Field tests with modified primary storage point receptacles

In recent decades, much attention has been paid to greater efficiency and improvement of refuse collection as well as the technical standards of the mobile waste containers which has resulted in the the drawing up of European Standards in this field (EN 840-1, 2, 3, 4, 5, 6) approved by the European Committee for Standardization (CEN) in 1996. Furthermore, these standards have been approved as Danish standards. Likewise, the workplace regulations for the refuse collectors have also been highlighted *vide* the Danish Working Environment Services (WES) guideline No. 4.1.0.1. on manual handling and transportation of domestic garbage, issued in November 1993. Less attention, however, has been paid to the aesthetical value of the primary source point storage receptacles as street furniture in the town scape and even less as regards the usability of the receptales, in particular in relation to disabled and elderly people.

A development towards improved receptacles that can be readily used by disabled and elderly people is desirable. However, the design of waste bins, containers and other receptacles is not assigned to norms in terms of user-friendliness. Thus, in continuation of the overall trend to focus on the needs of the users, it is essential to develop norms which can support such a design programme so that the widest possible range of the population can be accommodated. Therefore, on the basis of general user requirements, design guideines have been be drawn up in this study with the specific view of developing novel primary source receptacles that can be used safely, comfortably and conveniently by people of all ages and abilities.

EBO Consult and Danish Building and Urban Research approached R98 in early 1998 to make inquiries into the possibility of modifying standard primary source point receptacles to cater for the needs of persons with disabilities. The survey should assess whether an improvement in the user-friendliness could be obtained by making alterations to standard receptacles tested in selected housing estates in the municipalities of Frederiksberg and Copenhagen.

The following plan was drawn up by EBO Consult, R98 and Danish Building and Urban Research which included:

- Carrying out a pilot study to evaluate a selection of R98's receptacles in relation to the reach characteristics of persons with motor disabilities.
- Modifying standard receptacles for household refuse and recyclable fractions on the basis of the two Danish studies and the pilot study.
- Carrying out field tests with the modified receptacles in three selected housing estates in the municipalities of Copenhagen and Frederiksberg.
- Assessing the user-friendliness of the receptacles on the basis of questionnaries, in-depth interviews and testing in the three housing estates.
- Drawing up guidelines for the dissemination of information on waste separation and disposal, access route from the household to the primary source collection point, layout of the primary source collection point, and design of primary source storage point receptacles.

Pilot study. Evaluation of a selection of R98's receptacles in relation to the reach characteristics of physically disabled persons

In order to visualize the accessibility requirements of physically disabled persons in relation to current receptacles with a view to assessing the heights at which inlets and lid ought to be placed, a young paraplegic person seated in a standard wheelchair and an elderly person with a walking aid respectively were compared to a selection of R98's receptacles, drawn to scale. The illustrations of the two notional disabled persons and their reach characteristics are given in *Handicap et Construction* (Grosbois, 1996).

The technical specifications of the receptacles are shown in Table 3.

DS (1997) notes that a paraplegic-type wheelchair user has a range of reach of 50-130cm above the ground while persons with reduced arm function may have an even smaller range of reach. In the case of stick users, however, the range of reach is not given.

According to Grosbois (1996), a paraplegic-type wheelchair user has a range of reach of 40-140cm above the ground while the the stick user has a reach of 50-160cm.

However, it should be noted that paraplegics, as pointed out by Goldsmith (1997), cannot be held to be representative of all wheelchair users. Thus, the accessibility requirements of wheelchair users with reduced arm/hand function and ambulant persons with similar impairments using walking aids (*e.g.* sticks and rollators) have been highlighted as a target group in this pilot study.

Table 3. A selection of standard receptacles used by R98. All measurements are from the lower limit of the inlet (lid to the ground level.

Type of receptacle	Manufacturer	Height of inlet above the ground	Height of lid above the ground
240 litres 2-wheeled bin	P.O. *	-	101 cm
240 litres 2-wheeled bin for disposal of paper	P.O. *	112 cm	-
600 litres 4-wheeled bin	P.O. *	-	107 cm
600 litres 4-wheeled bin for disposal of paper	P.O. *	116 cm	-
900 litres bottle bank	J.T. **	122 cm	-
2,200 litres bottle bank	DRP ***	120 cm	-

* Plastic Omnium, France; ** Joca Trading, Denmark; *** Dansk Rotations Plastic, Denmark

240 litres and 600 litres wheeled bins

The 240 litres 2-wheeled bin (figures 2 and 4) and the 600 litres 4-wheeled bin (figures 3 and 5) for the disposal of household refuse are the most used receptacles in the two municipalities and are placed in the courtyards of multi-storey buildings.

The heights of lids, measured from the lower limit of the lid to the ground level of the receptacles, 101cm in the case of the 240 litres 2-wheeled bin and 107cm in the case of the 600 litres 4- wheeled bin respectively, are problematic for many as the lids are difficult to reach and awkward to handle by the majority of wheelchair users as well as stick and rollator users. In addition, wheelchairbound and ambulant hemiplegics find it impossible, to open the large lids and deposit household refuse at the same time. The 600 litres 4-wheeled bin can be supplied with two smaller lids instead of one large lid as standard equipment.

The 240 litres 2-wheeled bin is fixed so that it cannot roll away and thus functions as a supportive structure whereas the 600 litre 4-wheeled bin is not fitted with wheel-locks as standard equipment.

Both the 240 and 600 litres receptacles can be equipped with specially-designed inlets for the disposal of newspapers/magazines. Both models are placed in courtyards where access routes allow this.

However, the heights of the inlets, 112cm in the case of the 240 litres 2-wheeled bin and 116cm in the case of the 600 litres 4-wheeled bin respectively, prevent many of the target group from depositing paper waste.

Figure 2. A young paraplegic-type wheelchair user compared to a 240 litres 2-wheeled bin (in part from Grosbois, 1996)

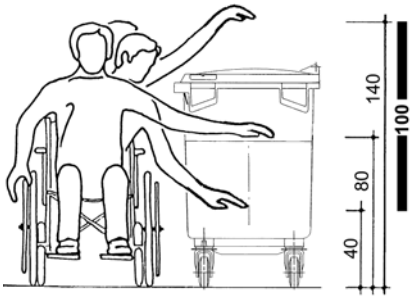

Figure 3. A young paraplegic-type wheelchair user compared to a 600 litres 4-wheeled bin (in part from Grosbois, 1996)

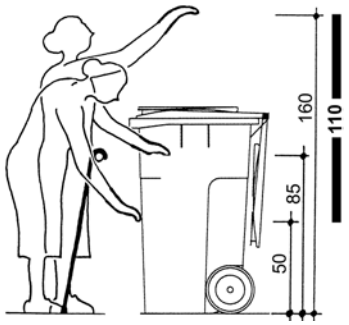

Figure 4. An elderly person with a walking aid compared to a 240 litres 2-wheeled bin (in part from Grosbois, 1996).

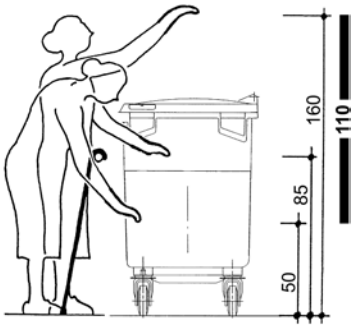

Figure 5. An elderly person with a walking aid compared to a 600 litres 4-wheeled bin (in part from Grosbois, 1996)

900 litres bottle bank

The 900 litres bottle banks (figures 6 and 7) are placed in courtyards where tenants pay an additional fee for the collection of bottles and glass.

The height of the inlet, 122cm above the ground, is not reachable for people seated in wheelchairs and ambulant people with reduced arm/hand functions.

The bottle bank is equipped with wheellocks.

2,200 litres bottle bank

The 2,200 litres bottle banks (figure 8 and 9) located outside the primary source premises are placed in public spaces such as pavements, parking lots and in front of supermarkets and other shops.

The height of the inlet, 120cm above the ground, is not reachable for people seated in wheelchairs and ambulant people with reduced arm/hand functions using walking aids.

Furthermore, the inlet is located in the "head" which is unfortunate because the user has to reach across the "shoulder" in order to dispose of the waste. In addition, the "shoulder" of the bottle bank is not level so that the user cannot place bottles on the shoulder while putting in the glass waste.

The 2,200 litres bottle bank is fixed so that it cannot roll away. However, this advantage does not compensate for the fact that the inlet is placed too high.

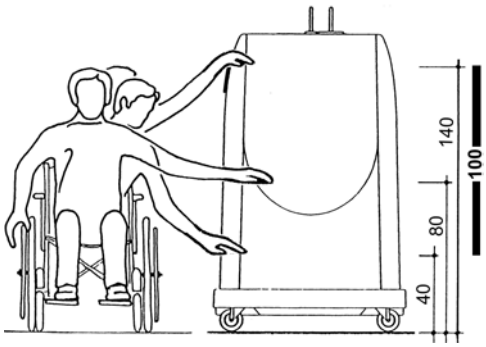

Figure 6. A young paraplegic-type wheelchair user compared to a 900 litres glass bank (in part from Grosbois, 1996)

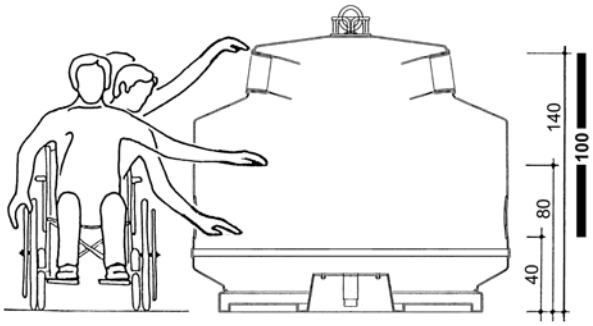

Figure 8. A young paraplegic-type wheelchair user compared to a 2,200 litres glass bank (in part from Grosbois, 1996)

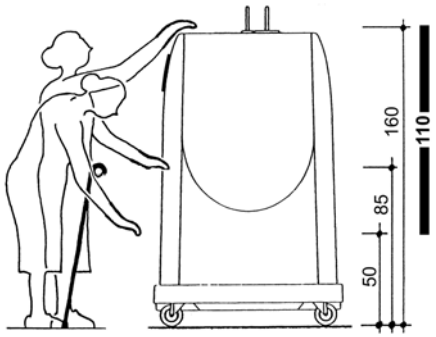

Figure 7. An elderly person with a walking aid compared to a 900 litres glass bank (in part from Grosbois, 1996)

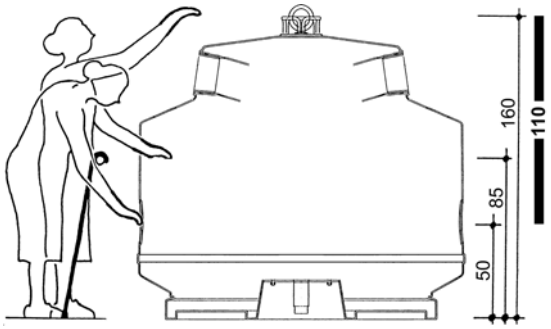

Figure 9. An elderly person with a walking aid compared to a 2,200 litres glass bank (in part from Grosbois, 1996)

Preliminary conclusions
In conclusion, the different types of standard receptacles did not meet the accessibility requirements of the two notional persons with motor disabilities as the heights of lids/inlets of the waste bins and banks are problematic for many and the lids/inlets are difficult to reach by a majority of wheelchair users and ambulant persons using walking aids. Thus, in the light of the pilot study, it is suggested that lids and inlets should not be placed higher than 75-100cm above the ground.

Modifications of current receptacles

On the basis of BUR (1991), Jensen (1997) and the results of the pilot study, R98, EBO Consult and Danish Building and Urban Research drew up preliminary guidelines in the spring of 1999 .

These guidelines included:

- Lids and inlets should be placed no higher than 75-100cm above the ground so that they are operable for persons with reduced arm/hand functions, from a seated and a standing position.
- Receptacles should be operable with one hand.
- Inlets rather than lids are preferred.
- Receptacles should be equipped with smaller and lighter lids.
- Wheeled bins should be equipped with wheel-locks.

With these specifications in mind R98 modified standard receptacles for the waste fractions: household refuse, paper and glass. The following modifications were carried out:

Figure 10. The 600 litres 4-wheeled bin was equipped with a top-hinged, 30 x 30cm inlet fitted at the receptacle's front as a supplement to the lid. The cut-out piece was used as an inlet: when pushed forward the bin bag is deposited in the waste bin. The height of the inlet, measured from the lower limit of the aperture to the ground level, was 70cm. The modified waste bin was equipped with wheel-locks.

Figure 11. The 600 litres 4-wheeled bin was supplied with two smaller lids instead of one large lid as standard equipment.

This receptacle was fitted with a hand-operated lever for one of the lids to make it easier for persons with reduced arm/hand functions to open the lid and dispose of the household refuse. However, a proportion of persons with motor disabilities would still have problems in disposing of the waste as the height of the lid was not altered (107cm). The modified waste bin was equipped with wheel-locks.

Figure 12. The 600 litres 4-wheeled bin was fitted with two inlets placed at different heights, a spring-loaded letterbox-type inlet asymmetrically placed in relation to an open inlet in the lid. The letterbox-type inlet is an existing product; however, the springload had been reduced significantly in order for disabled persons to hand in newspapers and magazines waste through the inlet. The height of the letterbox inlet, measured from the lower limit of the aperture to the ground level, was 85cm. Moreover, the modified waste bin was equipped with wheel-locks.

Figure 13. The 900 litres glass bank was fitted with two circular inlets, placed at different heights. The height of the lower inlet, measured from the lower limit of the aperture to the ground level, was 85cm. As standard equipment, the glass bank was fitted with wheel-locks.

Disadvantages of the modified receptacles
It should be noted that due to the placing of the lower inlets the modified receptacles cannot hold as much in terms of volume as the standard receptacles. This is a significant drawback as the frequency of collection of the modified receptacles will occur more often than is the case with the standard receptacles

Implementation of the field tests

In order to assess the user-friendliness of the modified receptacles, the above-mentioned bins and banks were tested in three selected housing estates in the municipalities of Copenhagen and Frederikshavn in the period July 1999 through to February 2000. Three housing estates were chosen for the field tests.

'Hørgården'
The housing estate 'Hørgården' consists of eleven five-storey concrete buildings, situated on the island of Amager in the municipality of Copenhagen (figure 14). The buildings were erected in 1967 and 1971, respectively, and consist of 672 dwellings.

'Hørgården' is equipped with indoor chutes for the disposal of household refuse in the stairwells. This, obviously, makes it easier to dispose of the refuse than the recyclable fractions (figure 15). However, glass and newspapers are often mixed with the household refuse.

Sack holders for the collection of organic waste are placed at strategic locations throughout the three courtyards which make up 'Hørgården' (figure 16). Unfortunately, the sack holders do not signal sufficiently what kind of waste fraction these receptacles are intended for. Thus, it is often impossible to reuse the collected organic waste as it is nearly always mixed up with household refuse and newspapers and magazines.

Figure 14. The housing estate 'Hørgården'.

Two experimental collection points were established in 'Hørgården' for the field tests. For the sake of tenants who might find the indoor chutes difficult to use, two modified 600 litres waste bins with quadratic inlets at the front as a supplement to the lids were placed in the collection points. Likewise, three modified paper banks as well as two modified bottle banks were erected.

Figure 15. Indoor chute for the disposal of household refuse.

Figure 16. Sack holder for the collection of organic waste.

'Den sønderjyske By'
The housing estate 'Den sønderjyske By' is an enclave of two-storey buildings, located in the western part of the municipality of Frederiksberg (figure 17). 'Den sønderjyske By' was built in 1921 in neo-classic style and consists of 301 dwellings. The composition of the tenants is characterized by a large proportion of elderly people compared to the proportion of elderly people in similar buildings in the municipality.

In one of the courtyards of 'Den sønderjyske By', in collaboration with the estate's caretaker, R98 put up five moditied 600 litres waste bins for the disposal of household refuse, three front-inlet models and two hand-operated lever models respectively, and two modified paper banks as replacement for seven standard receptacles. At the beginning of field tests, the modified receptacles were located at the house ends of one of the houses in the estate. Halfway through the field test, however, the receptacles were moved to a newly-erected garden house which functioned as a collection point.

Figure 17. The housing estate 'Den sønderjyske By' (photo PrivatBo).

Figure 18. The housing estate 'Roskildegården' (photo PrivatBo).

'Roskildegården'
The housing estate 'Roskildegården' is a five-storey building which is located in the western part of the municipality of Frederiksberg (figure 18). 'Roskildegården' was built in 1935 and consists of 209 dwellings. The composition of the tenants is characterized by a large proportion of elderly persons.

Distribution of the modified receptacles
The distribution of the modified receptacles is shown in table 4.

Table 4. The distribution of the modified receptacles at the three housing estates, located in the municipalities of Copenhagen and Frederiksberg.

		'Hørgården'	'Den sønderjyske By'	'Roskildegården'	Total
Lid at front	refuse	2	3	-	5
Lever	refuse	-	2	-	2
Paper	newspapers/ magazines	3	2	8	13
Glass	glass/bottles	2	-	-	2
Total		7	7	8	22

Assessment of the user-friendliness of the modified receptacles

In order to assess whether the modified receptacles are more user-friendly than the standard receptacles in the period July 1999 through to February 2000 the following surveys were carried in the three housing estates:

- Questionnaires distributed to 304 households, in 'Hørgården'
- Interviews with persons with motor disabilities, in 'Hørgården' and 'Den sønderjyske By'
- Interviews with caretakers, in 'Den sønderjyske By' and 'Roskildegården'
- Testing with blind and visually impaired persons from the user organisation Danish Association of the Blind's environmental group, in 'Hørgården' and 'Den sønderjyske By'.

Questionnaire survey

In order to assess the effects of the modifications to the primary source storage point receptacles, a questionnaire was prepared in collaboration with Green Guide[3] Bettina Fellov, 'Hørgården' and sent to 304 households, corresponding to 21 staircases, in the housing estate 'Hørgården' in October 1999.

At the same time, notices were put in the individual staircases with information about when the tenants could hand in the completed questionnaires. Moreover, the tenants could post their questionnaires in stamped envelopes addressed to the Danish Building Research Institute.

68 persons completed or partly completed questionnaires were returned corresponding to a reply percentage of 22, 4. This percentage is in accordance with R98's own surveys in multi-storey buildings.

The functional ability of the tenants and their attitudes towards outdoor surfacing

The questionnaires had been to a large extent completed by women (41 ot of 68). The average age of the respondents were 50, the oldest responent being 82. However, the younger age groups were underrepresented in this survey, and a large percentage of those who had completed the questionnaires were disabled persons. Furthermore, many of these had multiple disabilities, *i.e.* they had combinations of motor disabilities, sight impairments, hearing and allergy problems

Do you have mobility problems?
13 out of 68 persons (~ 19%) stated that they had mobility problems.

Do you suffer from visual impairments?
14 out of 68 persons (~ 21%) stated that they had visual impairements. Only one person was blind.

Do you suffer from hearing impairments?
6 out of 68 persons (~ 9%) stated that they had hearing impairements.

Do you suffer from allergy?
20 out of 68 persons (~ 29%) stated that they suffered from allergy in various forms, *i.e.* respiratory allergy, skin-related allergy, and food allergy.

Do you use any kind of technical aid?
8 out of 68 persons (~ 12 %) used technical aids. 3 were stick users, 1 used crutches, 2 were rollator users, 1 used a manual wheelchair, and 3 used electric wheelchairs. That the total number exceeded 8 means that some used more than one technical aid.

What kind of outdoor surfacing (paving) do you prefer?
It was easy for 74-79% of the respondents to go across sawn setts, firm gravel surfacing and lawns.

It was easy for 60-65% of the respondents to go across British setts, uneven paving stones and soft sand.

Conversely, it was impossible or with great difficulty for persons with motor disabilities to go across British setts 46 %, uneven paving stones 45 %, sawn setts 23 %, and lawns 15 %.

On the whole, the respondents preferred asphalt and even paving stones.

Tenants' attitudes towards the access route, indoor chute, sack holder and modified receptacles.

For each of the various types of receptacles, chute and sack holder key questions were

[3] A green guide is a local environmental/urban ecological adviser, financially supported by the Danish Environmental Protection Agency.

included which gave an indication of tenants' attitudes towards the nature of the access routes, chute, sackholder and the extra facilities with which the modified receptacles were equipped.

Indoor chute
Are you able to dispose of the bin bag in the chute?
Only 2 out of 68 persons (~3%) stated that they were unable to dispose of the bin bag in the chute.

Is it easier for you to dispose of the bin bag in the modified 4-wheeled waste bin with the inlet at the front instead of in the chute?
12 out of 68 persons (~ 18%) state that it is easier to use the modified waste bin than the chute.

Sack holder
Are you able to deposit the bin bag with the organic waste in the sack holder?
7 out of 68 persons (~ 10%) stated that they were unable to deposit bin bag in the sack holder. All seven were persons with mobility problems.

Do you consider the distance from your dwelling to the sack holder to be a problem?
9 out of 68 persons (~ 13%) stated that the distance from the dwelling to the sack holder posed a problem.

Over half of these persons were persons with mobility problems.

Paper bank
Are you able to deposit the newspapers and magazines in the paper bank?
4 out of 68 persons (~ 6%) stated that they were unable to deposit newspapers in the paper bank.

Which inlet is most convenient for you to use?
13 out of 68 persons (~ 17%) preferred the lower inlet. 3 of these persons had mobility problems.

The majority of the respondents, 57 persons (~76%), stated that it was easier to use the upper inlet. Over half of the persons with mobility problems preferred the upper inlet. However, it should be noted that several respondents had ticked off both the upper and lower inlet in the questionnary. This was interpreted as equal preference for both inlets.

Do you consider the distance from your dwelling to the paper bank to be a problem?
9 out of 68 persons (~ 13 %) stated that the distance from the dwelling to the paper bank posed a problem.

Only a third of the persons with mobilty problems stated that the distance posed a problem.

Bottle bank
Are you able to deposit glass and bottles in the bottle bank?
7 out of 68 persons (~10%) stated that they were unable to deposit glass and bottles in the bottle bank.

5 out of the 7 were persons with mobility problems.

Which inlet is most convenient for you to use?
17 out of 68 persons (~ 23 %) preferred the lower inlet. The majority of the respondents 48 persons (~ 65%) stated that it was easier to use the upper inlet. Over half of the persons with mobility problems (~54%) preferred the upper inlet, 38 % preferred the lower inlet.

It should be noted that several respondents had ticked off both the upper and lower inlet in the questionnaire. This was interpreted as equal preference for both inlets.

Do you consider the distance from your dwelling to the bottle bank to be a problem?
11 out of 68 persons (~ 16%) stated that the distance from the dwelling posed a problem.

Outdoor waste bin for the disposal of household refuse
Are you able to deposit the bin bag in the outdoor waste bin?
6 out of 68 persons (~ 9 %) stated that they were unable to deposit the bin bag in the outdoor waste bin.

Is it more convenient for you to use the inlet rather than opening the large lid?
21 out of 68 persons (~31 %) preferred the inlet at the front. 62 % of the persons with mobility problems stated that the inlet was easiest to use. 30 out of 68 persons (~44 %) preferred opening the large lid.

Do you consider the distance from your dwelling to the outdoor waste bin to be a problem?
11 out of 68 persons (~16 %) stated that the distance from the dwelling to the outdoor waste bin posed a problem.

Is it easier for you to dispose of the bin bag in the chute than in the outdoor waste bin?
43 out of 68 persons (~ 63 %), as a whole, and 53 % of persons with mobility problems, stated that it was more convinient to use the indoor chute than the outdoor waste bin.

Summary of the questionnaire
As mentioned above, the lower inlets of the paper bank and bottle bank as well as the front inlet of the waste bin were preferred by 17 %, 23 %, and 31 % of the respondents, respectively. Of the persons with mobility problems which make up 19 % of the respondents in the survey, over half find that it is easier to use the upper inlets of the paper bank and the bottle bank whereas over half find it is easier to use the inlet of outdoor waste bin rather than opening the large lid. It may seem contradictory that such a large percentage of the target group prefer the upper inlets of the banks, keeping in mind that the receptacles were dimensioned in order to cater for the needs of persons with motor disabilities. However, as pointed out by Goldsmith (1997) in the case of wheelchair users, people with motor disabilities comprise a heterogenous group with quite diverse disabilities. Thus, even though a person is walking impaired it does not necessarily mean that the said person experiences problems in terms of despositing waste provided that he/she has normal arm function. A hemiplegic or an ambulant person with reduced arm/hand functions, however, will always have trouble with disposing the waste fractions in the standard receptacles.

Interviews

'Hørgården'
Three women stated in their completed questionnaires that they wished to make a few comments in relation to the testing of the modified receptacles in the housing estate 'Hørgården'. Common to the three women was that they all had mobility problems and that they received home help, several times a week.

A walking-impaired woman of 82 years received home help twice a week. The home help disposed of the waste although the disabled women made sure that the organic waste was separated out. She did not venture out as she was afraid of falling due to dizziness. If she had not been so afraid of falling the modified receptacles would have helped her greatly - especially the lower inlets of the paper bank and the bottle bank.

A rollator user of 67 years received home help twice a week. Although she could persuade the home help to dispose of the waste in the receptacles, she wanted to be as self-reliant as possible and to do the domestic chores herself. She mentioned that it was impossible for her to approach the sack holder in order to deposit the organic waste due to inadequate paving. She used the lower inlets of the paper and glass bank which were easier for her to use than the upper inlets, and she emphasized that the quadratic inlet at the front of the outdoor waste bin was a good solution. As a rollator user she also stressed that having good access routes for persons that rely on walking aids was very imporant. Moreover, it was important that access routes should be kept clear of snow and leaves.

A wheelchair user of 35 years received home help three times a week but was, to a large extent, self-reliant. Thus, she was able to deposit the waste fractions herself. She pointed out, however, that she could not reach the inlet of the 2,200 litres glass bank but that she had no problems in delivering glass waste in the lower inlet of the 900 litres glass bank. Furthermorer, it was a great advantage for her that the modified glass bank was located in the immediate proximity of her dwelling. Similarly, she had no problems in depositing waste in the lower inlet of paper bank and the quadratic inlet of the outdoor waste bin.

'Den sønderjyske By'
The caretaker of the housing estate 'Den sønderjyske By' had not received many comments on the modified receptacles from the tenants during the field tests. On the whole, however, they were pleased that something was being done in order to alleviate the problems experienced by disabled and elderly persons. The able-bodied tenants did not feel that it was less of an effort to use the modified receptacles than the standard ones. However, the tenants used the inlets they were accustomed to. According to the caretaker, tenants with mobility problems persuaded the home-helps to dispose of their waste.

At the beginning of field tests, the modified

receptacles were located at the house ends of one of the houses. Halfway through the field test, however, the receptacles were moved to a newly-erected garden house. The caretaker was of the opinion that the tenants were more content with the location of the receptacles at the house ends.
A woman with mobility problems expressed satisfaction with the modified receptacles. She used a scooter-type wheelchair out-of-doors and a rollator at home. It was very difficult for her to open the lid of the waste bin for which reason the hand-operated lever was a great help. However, she emphasized that it was easier to use the quadratic inlet of the waste bin than the lever. She was also pleased with the lower inlet of the paper bank; prior to the field tests she had often struggled trying to deposit her newspapers and magazines in the upper inlet. In addition, it was an advantage that the receptacles were fitted with wheel-locks so that they acted as supports.

'Roskildegården'
According to the caretaker in the housing estate 'Roskildegården' the tenants were pleased with the letterbox-type inlets of the modified paper banks. It was emphasized that it was not only the elderly tenants who found that disposing of paper waste had become easier. All in all, it had become more convenient to hand in the newspapers and magazines. It was also an advantage that the paper banks were equipped with wheel-locks. The asymmetrical location of the two inlets enabled people to place piles of newspapers on the level top of the bank while depositing papers in smaller quantities. Furthermore, the caretaker noted that it was easier to use the letterbox-type inlet rather than the upper inlet when depositing old newspapers from a shopping bag leaning against the paper bank.

Testing with blind and visually impaired persons

Four members of the Danish Association of the Blind's environmental group participated in the testing of the modified receptacles in 'Hørgården' and 'Den sønderjyske By' in December 1999-January 2000.

The environmental group made following comments on the receptacles:

- The colour of the quadratic inlet in the waste bin should be in contrast - the inlet "blends in" with the surrounding grey surface making it very difficult to discern.
- In connection with the two inlets in the paper bank, references in the form of arrows should be made in order to show where to deposit newspapers and magazines.
- The two smaller lids in hand-operated lever model were more manageable and did not require much force to open.
- The inlets in the paper and glass banks should be clean and without sharp edges.
- Where the same type of bin is used to collect different waste fractions such as 600 litres 4-wheeled bins for the disposal of household refuse and paper waste the receptacles should be equipped with tactile pictograms, located at the same spot on the bins.

The members of the environmental group emphasized that it was important that the collection points were kept clean as the blind and visually-impaired cannot pick up newspapers and plastic bags lying on the ground. Also, it was important that the access routes are kept free of bicycles which are a hazard to persons with visual impairments.

The members further suggested that information issued by R98 such as timetables for the environmental vehicles and introduction of new receptacles should be issued in the recorded newspaper "Lydavisen Københavns Kommune", a municipal newspaper available on tape. Information of this kind would be of great value for the 480 subscribers of the newpaper which roughly corresponds to one third of the blind and visually-impaired people in the municipality. In addition, it should be noted that younger members of the association access the internet using speech output, and the recorded newspaper should therefore refer specifically to R98's web site.

Conclusions

The field tests of the user-friendliness of the modified receptacles in the three selected housing estates in the municipalities of Copenhagen and Frederiksberg have shown that it is possible to cater for a broader range

of user needs by altering the standard receptacles so that they accommodate the needs of persons with motor disabilities.

In the household waste project in the housing estate 'Rådhusdammen' (BUR, 1991) located in the municipality of Albertslund and in the survey on the user-friendliness of receptacles in the municipality of Køge (Jensen, 1997), the disabled persons in question put forward proposals to make the current receptacles more disability-friendly. Even though the present field tests were limited to three housing estates in the urban environment the results are in accordance with the two previous Danish surveys. It should be noted that disabled and elderly people are confronted with the same problems as regards the design of the receptacles, layout of the collection points, access routes, paving, etc. in the municipalities of Copenhagen and Frederiksberg and elsewhere. Thus, a larger survey involving more disabled and elderly people would, in all probability, not change the overall picture.

An important conclusion of the field tests is that other groups than disabled and elderly people find the modified receptacles easy to use. According to the caretaker in 'Den sønderjyske By', the tenants did not feel that it was more of an effort to use the modified receptacles than the standard ones. In 'Roskildegården', as a whole, it had become easier to put newspapers and magaziners in the modified receptacles than in the standard receptacles. But although the modified receptacles have been shown to be more usable for a broad range of users, it has not been possible to cater for all user needs in relation to altering waste bins and banks because of the different accessibility requirements of persons with disabilities.

As mentioned above, the modified receptacles cannot hold as much as the standard ones due to the placing of the lower inlets. Indeed, this was also pointed out in the household waste project in the housing estate 'Rådhusdammen' (BUR, 1991). Thus, it has been a significant drawback in the field tests that the modified receptacles were prone to be filled up more rapidly than the corresponding standard receptacles.

Thus, in the future, instead of modifying current receptacles to meet the needs of selected disabled persons and other groups the development should encourage the design of novel receptacles in order to ensure that the broadest possible range of the population is accommodated. The design of the future receptacles must take into account the functional requirements of a very broad spectrum of abilities, rather than only those of the non-existing group of "average" persons.

In the following, on the basis of the five categories of disabilities put forward by DS (1997), guidelines are presented concerning the dissemination of information on waste separation and disposal, the access routes from the household to the primary source collection point, the layout of the primary source collection point, and the design and dimensions of primary source receptacles.

Guidelines

The United Nations' document *Standard Rules on the Equalization of Opportunities for Persons with Disabilities* underscores the fact that accessibility, as regards access to the physical surroundings and access to information and communication, is crucial in the process of the equalization of opportunities in all spheres of socitey. Furthermore, the document emphasizes that the development of guidelines is an important step towards eliminating obstacles in the physical surroundings so that persons with disabilities may exercise the same rights and obligations as other groups of citizens.

Developing guidelines for accessible receptacles is seen as a prerequisite for involving disabled and elderly persons in waste separation and disposal activities as equally and independently as possible. However, it is important to view this problem from a holistic point of view rather than only focusing on drawing up guidelines for the design of receptacles that takes into consideration the requirements of persons with disabilities. It is also important to have guidelines for the dissemination of information on waste separation and disposal, access routes from the dwelling to the collection points, the layout of collection points and design and dimensions of the receptacles themselves.

These guidelines are aimed at the actors in the waste management field: national and international manufacturers of waste bins and containers, municipal planners, and collecting agents as well as housing associations and user organisations in the disability field. The drawing up of the guidelines with respect to the design of receptacles is based on

BUR (1991), Jensen (1997), Gelotte (1999) as well as the field tests at the three housing estates.

Preliminary guidelines for disability-friendly receptacles were presented at The *2nd International Conference on Integrated Sustainable Waste and Water Management and Green Procurement* in Copenhagen in June 1999, as a prelude to the field tests in the three housing estates in the municipalities of Copenhagen and Frederiksberg.

In addition, "The Good Building Project", a Swedish project involving seven disability organizations, published a booklet in May 1999 on waste separation and disposal from a disabled person' s point of view with concluding specifications for the design of the receptacles and for the physical surroundings (Gelotte, 1999). The Swedish specifications are, to a great extent, in accordance with the guidelines mentioned below.

Furthermore, the following publications have been consulted in preparing the guidelines

- The Danish Environmental Protection Agency's report on the design of receptacles (MS, 1991)
- Booklet on information issued by the Equal Opportunities Centre for Disabled Persons (Thorup Nielsen, 1995)
- The accessibility requirements in the Danish Building Regulations, BR 95 (Kennig, 1996)
- Danish Standards Association's *Accessible Outdoor Environment* (DS, 1997)
- R98's *Inspiration* on the lay-out of collection points in courtyards (R98, 1998)
- The seven universal design principles drawn up by the Center for Universal Design, North Carolina State University (Story et al., 1998)
- Danish Association of the Blind's book on the needs of the blind and visually-impaired persons in relation to the physical environment (Ingsholt, 1999)
- Danish Building and Urban Research's direction on accessibility requirements of wheelchair users to buildings and outdoor environments (Woetmann Nielsen, 2000).
- Danish Standards Associations *Tilgængelighed for alle* [General accessibility] (in preparation).

The guidelines have been drawn up as regards

- Information on waste separation and disposal
- Access route from the dwelling to the primary source collection point
- Layout of the primary source collection point
- Design and dimensions of the primary source storage point receptacles

in relation to the five categories of disabilities defined by DS (1997):

- Physical disabilities.
- Sight impairments.
- Hearing impairments.
- Allergies.
- Learning disabilities.

Legal requirements - recommendations

It is important to note that the guidelines do not distinguish between legal requirements and recommendations. In Denmark, there are few legal requirements in the disability field so the majority of the guidelines should be viewed as recommendations. As a rule, it may be said that the guidelines never recommend smaller dimensions than those required by relevant laws which were current at the time of publication

Information on waste separation and disposal	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Information					
Information on waste separation and disposal should be accessible for all.	●	●	●	●	●
Written information should be easy to read, with short sentences and using familiar words. Each sentence should not contain more than one item of information.					●
Written information should be accompanied by drawings and/or photographs as well as audiotape, *e.g.* recorded newspapers.		●			●
Pictograms affixed to the receptacles to identify different waste fractions should be used together with illustrations of waste fractions, receptacles and their location within the primary source collection point.		●			●
Pictograms should be enclosed in raised relief, supplemented with raised text and Braille lettering.		●			
Written information should be supplemented by visual information, *i.e.* local TV.			●		●
Written information should be supplemented by information on the Internet. The web sites of the collecting agents and municipalities should comply with the guidelines for accessible web sites.		●	●		
Information given in local newpapers and posters should also be given on audiotape.		●			
Radio broadcasts should be in digitalized form and supplemented by raised text and Braille lettering.			●		
Information given in order to motivate the tenants to separate waste fractions should comply with the above.	●	●	●	●	●
Information on particular service offers to specific user groups should be targeted towards these groups.	●	●	●	●	●

Access route from the dwelling to the primary source collection point	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Access routes					
The access route, defined as the route from the dwelling to the primary source collection point, should be accessible for all.	●	●	●	●	●
The access route must be safe to use and should be visible from the buildings.	●	●	●	●	●
The distance from the dwelling to the primary source collection point should be as short as possible not exceeding 40m, and 100m at the most. If the distance is greater than 40m, benches should be placed beside the access route.	●				
The width of the access route should be at least 150cm so that a pedestrian and a wheelchair user are able to pass each other. Over longer distances (over 50m) and much traffic at least 180cm; over shorter distances (under 5m) and limited traffic at least 120-130cm.	●	●			
Recreational grounds should be designed in a separate area outside the access route.	●	●			
Parking facilities for bicycles and prams should be designed in a separate area outside the access route where they do not inconvenience pedestrians, wheelchair users or persons with visual impairments.	●	●			
The access route must be in visual contact with communal rooms, recreational and playgrounds within the curtilage of the housing estate. Narrow passages and recreational areas adjacent to the access route should be avoided.					●
The height of the vegetation should not exceed 110cm in larger and unlocked courtyards.					●
The height beneath the lower branches of trees should be at least 220cm.		●			●
There should be landmarks which are useful as orientation cues.		●			●
Excessive noise should be avoided, wherever possible.		●	●		●
Traffic in the access route should be easy to see.		●			●
The access route should be kept clean of snow, ice and leaves, and these should be swept together outside the access route.	●	●			
The access route should be planned so that maintenance excavations can be carried out outside of the route.	●	●			●

Access route from the dwelling to the primary source collection point	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabilitites
The vegetation should not cause allergic reactions.	●	●	●	●	●
Wind-pollinated trees such as birch, alder, hazel and elm as well as flowering grasses should be avoided in the immediate vicinity of the access route.				●	
Walking surfaces					
The walking surface of the access route must have sufficient carrying capacity and surface hardness to resist indentation by footwear, walking aids, and wheels and to ensure low friction.	●	●	●	●	●
Asphalt, concrete, natural stone with an even surface, and firm gravel surfaces are preferred walking surfaces. Firm gravel surfaces, however, may require increased cleaning of indoor areas.	●				
The walking surfaces of the access route must be even and without surface irregularities.	●	●			
Surface irregularities due to poor maintenance may cause an unacceptably bumpy ride for wheelchair users and poor body balance for persons using walking aids.	●				
In cobblestone paving, two or three rows of kerbstones, or a row of kerbstones with a width of a least 90cm, enable persons with mobility problems to walk or propel themselves in wheelchairs. Cobblestones with even surfaces (sawn setts) rather than uneven surfaces (British setts) are preferred. As a general rule, however, cobblestone paving is only acceptable in historical environments.	●	●			●
Wooden and certain granite surfaces become very slippery in snowy and rainy weather and should therefore be covered.	●				
Deviations in evenness should be less than 2-3mm per meter in order to drain storm water and reduce the risk of stumbling.	●	●			
The lateral gradient of the access route must not be greater than that needed for drainage of storm water (max. 1:40). The water should be drained off effectively in gratings outside the route.	●				
The edges of the access route should be marked tactile and of a contrasting colour.		●			●
A tape in the walking surface of the access route with a contrasting colour and a different structure than the rest of the surface may be used to form tactile routes.		●			●

Access route from the dwelling to the primary source collection point	Physical disabilitties	Sight impariments	Hearing impairments	Allergies	Learning disabilities
The access route must be clearly separated from cycle path, vehicular road and parking area.		●	●		●
Combined cycle paths and pedestrian routes should be avoided.		●	●		●
The areas at the beginning and end of doors, ramps, passenger lifts, platform lifts and staircases as well as path intersections must be clearly marked tactile with different surfaces using contrasting colours.		●			●
Crossings at kerbstones should be established either by lowering the footway or raising the adjacent area or as a 50cm long kerbstone ramp (max. 1:10). Crossings with a difference in level of 2,5-3cm should have tactile markings.		●			●
Illumination					
The illumination along the access route should support the safe use of the route.	●	●	●	●	●
The illumination should not dazzle and give reflections. Lamps should be erected in the same side of the access route and function as tactile routes.		●	●		●
The illumination level should be brightest at entrance doors ramps, passenger lifts and platform lifts and stairways as well as at intersections. The indoor illumination levels should be brighter than the outdoor levels with an even transition between the two locations.		●	●		●
The illumination in the access route should be approximately 200 lux. Where access routes dictate greater alertness such as before entrance doors and stairs the illumination should be approximately 300 lux, as light enhances the orientation.		●	●		●
The illumination in connection with sign posts, operational panels etc. Should be 600-1500 lux.		●	●		●
The highest illumination intensity of the light cone should be below the eye height of a wheelchair user. The average eye height of an adult wheelchair user is 125cm above the ground level.	●	●			●
Ramps, passenger lifts and platform lifts					
Level access must be established everywhere.	●	●			
Level access must be established by levelling the terrain, ramps, passenger lifts and platform lifts.	●				

Access route from the dwelling to the primary source collection point	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Ramps, passenger lifts and platform lifts must always be supplemented by stairs.	●	●	●	●	●
Heights of edges or kerbs not exceeding 20cm shall be bridged according to the formula: 1:h (h = height in cm).	●	●			
Heights of edges or kerbs exceeding 20cm shall be bridged by means of levelling the terrain or using ramps.	●				
Maximum gradient of levelling the terrain: 1:25.	●				
Maximum gradient of a ramp: 1:20.	●				
Ramps that accommodate a difference in level of over 20cm must be equipped on both sides with hand rails at two of levels 60-70cm and 80-90cm, respectively, as well as raised wheel guards with a height of at least 10cm.	●	●			
Ramps that accommodate a difference in level of more than 50cm shall be equipped with rest stops at intervals of 10m.	●				
The walking surface must be altered at the beginning and end of ramps and should be marked by means of material and colour variation.		●			●
Handrails should have a circular cross section with a diameter of 4-5cm.	●				
Handrails must be extended approximately 40cm beyond the beginning and end of the ramp.	●	●			
Handrails must be made of materials that do not cause allergic reactions and do not conduct heat and cold.				●	
Passenger lifts are best suited to accommodate differences in level of over 2m and should be wheelchair-friendly with a clear area of 110 x 140cm, preferably 130 x 170cm. If a wheelchair is to turn 90° the area must be 150 x 150cm in the case of indoor passenger lifts, and 170 x 170cm in the case of outdoor passenger lifts.	●				
The lift door must be automatic and provide a clear opening width of at least 80cm.	●				
The internal operating panel should be placed horizontally or tilted at an angle of 45° at a height of 90-105cm above the floor and at a distance of at least 50cm from the nearest partition wall.	●	●			

Access route from the dwelling to the primary source collection point	Physical disabilitties	Sight impairments	Hearing impairments	Allergies	Learning disabilities
The external operating panel should be placed on the wall , at least 50cm (in the case of indoor lifts) and at least 70cm (in the case of outdoor lifts) from the nearest partition wall at a height of 90-105cm.	●				
The operating buttons should be placed on a separate unit made of a material that differs markedly from the rest of the wall. The operating buttons should be raised 0.5-1.2cm and be of a contrasting colour.		●			●
Figures or text must be as close as possible to the button in question, and must be in raised relief and, if possible, in Braille lettering. The figure 1 should indicate the 1st floor, the figure 2 the 2nd floor etc. An audible signal should be emitted as the lift passes each floor.		●	●		●
The stop button and emergency button should be placed away from the other buttons and have different design and colour than these.		●			●
Platform lifts may be better suited to accommodate differences in level above 50cm than ramps. They should be wheelchair-friendly, and the dimensions should follow those of passenger lifts.	●				
Conditions in older housing estates may render impossible the establishment of a platform lift and the available space may prevent the establishment of a ramp. In those particular cases, a ramp accommodating a difference in level less than 50cm with a gradient of 1:12 is better than a stairway. In other cases, however, ramps and stairs must always be supplemented by passenger lifts or platform lifts.	●				
A sufficient turning space is required at both sides of doors, ramps, passenger lifts, platform lifts, at intersections, and at suitable intervals at longer distances (over 100m).	●				
Turning speces must be planned with an area of at least 150 x 150cm for indoor wheelchairs, preferably 170 x 170cm, and at least 180 x 180cm for outdoor wheelchairs. Scooter-type wheelchairs require a turning space of 250 x 250cm.	●				
Stairways					
Outdoor and indoor stairways must be safe to use. Ramps, lifts and platform lifts should always be supplemented by stairways.	●	●	●	●	●
Indoor stairways should have a height of tread of no more than 15cm and a depth of tread of at least 30cm. Often a height of tread of less than 15cm is preferable. Indoor stairways are comfortable to use when the height and depth of treads are based on the formula: 2 heights + 1 depth = 61-63cm.	●	●	●	●	●

Access route from the dwelling to the primary source collection point	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Outdoor stairways should have a height of tread of 10-15cm and a depth of tread of 35-45cm. Outdoor stairways are comfortable to use when the height and depth of treads are based on the formula: 2 heights + 1 depth = 65-70cm.	●	●	●	●	●
The width of indoor stairways must at least be 100cm and width of outdoor stairways must correspond to the width of the access route, at least 150cm.	●	●	●	●	●
Within the same stairway the dimensions of the height and depth of treads must not vary.	●	●	●	●	●
Steps should be equipped with risers to avoid the risk of stumbling. The beginning and end of a stairway should be marked by means of material variation and of a contrasting colour. The tread nosings should be rounded and must not extend beyond the risers. The bottom of the riser should be approximately 3cm further back than the top. The depth of the tread must be even and provided with vertical edges on both sides.	●	●			
On each step, the tread nosings should be accentuated by a contrasting colour with a width of 5cm which is clearly visible when viewed from above or from below.		●			●
Flight of stairs of more than 8 steps (> 135cm) must be equipped with a landing.	●	●	●	●	●
The length of the landing should be equal to the width of the stairs: indoor at least 100cm, outdoor at least 150cm.	●	●			●
Change of direction at the landing must be 90 or 180º.	●	●			●
Staircases must be straight, *i.e.* spiral starcases should be avoided at all costs.	●	●			●
Freestanding stairways should always be covered.		●			●
Handrails should be designed as described under ramps.	●	●			
Doors					
The width of doors must be at least 10M corresponding to a clear opening of at least 88cm.	●				
In front of doors a level landing of at least 150 x 150cm must be established.	●				
If the door opens outwards, the width must be increased by 20cm along the facade, measured from the side of the door where the hinges are placed.	●				

Access route from the dwelling to the primary source collection point	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabiligties
Doors must be easy to operate. The force required to open and close a door must not exceed 2.5kg. The door handle must be placed at a height of 80-100cm above the ground.	●				
Automatic doors with a timed opening interval should be operated with a clearly-marked button at a height of 80-90cm and with a distance of 50cm from the nearest wall. Also, an audible signal should give notice of the opening doors. The doors must remain fully open for at least 6-7 seconds while someone is passing through them.	●	●			
Doors with a 90º opening must be closed automatically.		●			

Layout of the primary source collection point	Physical disabilitties	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Collection points					
The layout of the primary source collection point should be accessible for all. The collection point may be designed as a closed room or as a demarcated area in the open. The size of the collection point depends on the number of tenants, the number of waste fractions collected and the frequency of collection.	●	●	●	●	●
Due to the weather collection points for the collection of several waste fractions should be covered.	●	●	●	●	●
Collection points should be made of materials that are easy to clean and maintain.				●	
Collection points in closed rooms should be well-ventilated because of unpleasant odours emanating from the waste.				●	
Access to the closed room-type collection point should be established with a clear opening of at least 88cm corresponding to a 10M door. However, waste handling often necessitates a clear opening of 108cm corresponding to a 12M door. Automatic glass doors with a timed opening interval are preferred for security reasons. Dimensions of doors should follow those given on the preceding pages.	●	●			●
The height of surrounding fences must be 110cm at the most, preferably 90cm.					●
Blinding from daylight should be avoided.		●	●		
The layout considerations of collection points must take into account the possibility of the collection of additional waste fractions.	●	●	●	●	●
The receptacles for the various waste fractions should be placed jointly in logical order and in straight rows which make it possible to mark the location of the receptacles by surface characteristics, illumination and signposting.		●			●
Dimensions					
The width of passages between the receptacles as well as the location of turning spaces should allow wheelchair users to operate the receptacles from the right or left side of the wheelchair.	●				

Layout of the primary source collection point	Physical disabilitties	Sight impairments	Hearing impairments	Allergies	Learning disabilities
In front of the receptacles, an unobstructed space of at least 130cm, preferably 150cm, for smaller collection points, and at least 150cm, preferably 180cm for larger collection points, must be established.	●				
In front of the receptacles that are best operated from the front, such as indoor chutes, an unobstructed space of at least 150cm for wheelchair users must be established.	●				
Turning spaces should be established at the entrance and at the opposite end of the collection point. The turning space should at least be 150 x 150cm for indoor wheelchairs and at least 180 x 180cm for outdoor wheelchairs, preferably 250 x 250cm.	●				
Walking surfaces					
The surface of the collection point should be even and without surface irregularities.	●	●	●	●	●
Concrete floor or asphalt are preferred surface materials.	●	●			●
An alternative surface structure than the rest of the surface can be used to form tactile routes that highlight the location of the receptacles.		●			●
The surface should contribute to a visually-enhanced environment by virtue of its colour(s).		●	●		●
Illumination					
There must not be dark, unilluminated patches in connection with the collection point. The illumination must not dazzle or give reflections.	●	●	●	●	●
The illumination should light up the access route in front of the collection point and shine obliquely on the receptacles.		●	●		●
In closed room-type collection points it must be ensured that the the light is switched on automatically when entering the room and switched off when leaving the room.		●			●
The overall illumination level should be approximately 300 lux and should be supplemented with spots with an illumination level of approximately 1000-1500 lux directed specifically towards the lids and/or inlets of the receptacles.		●	●		●

Dimensions and design of primary source receptacles	Physical disabilities	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Accessible receptacles					
Access to and use of the primary source storage point receptacles should be accessible for all.	●	●	●	●	●
Only receptacles for the collection of the waste fractions: household refuse, newspapers and papers, and glass are described below.					
The receptacles should be made of materials that are easy to clean and maintain. The materials should not cause allergic reactions.				●	
The receptacles should be fitted with handles that are easy to grasp.	●	●			●
A receptacle with even, vertical, smooth surfaces without protuding objects is safer than a receptacle with protuding objects.		●			
A series of pictograms should be developed so that each waste fraction is assigned a specific, easy to understand tactile pictogram.	●	●	●	●	●
The receptacles should be equipped with tactile pictograms, text in raised relief and Braille lettering that signal where different waste fractions should be deposited.		●			●
Dimensions: receptacles					
The receptacles should be fixed so that they cannot roll away. In the case of 4-wheeled bins, the receptacles should be equipped with wheel-locks.	●	●			●
When applying a pressure of 50kg the receptacles should not be likely to move, tilt or overturn.	●				●
The height of inlets, as measured from the lower edges of the inlets to the ground, should be placed within the range of 70-85cm above ground level, preferably 70cm.	●				
The height of waste bin lids, as measured from the lower edges of the lids to the ground, should be placed within the range of 70-85cm above ground level, preferably 70cm.	●				
As a general rule, the heavier the load of the waste fraction, the lower the inlet or lid should be placed.	●				
Inlets and lids should be operable with one hand, left or right, and from a seated and a standing position.	●				

Dimensions and design of primary source receptacles	Physical disabilitties	Sight impairments	Hearing impairments	Allergies	Learning disabilities
Receptacles should be equipped with inlets rather than lids.	●				
The horizontal force required to deliver waste through an inlet must be kept to a minimum. The force must not exceed 0.2-0.3kg.	●				
The forces required to open and close a lid must be kept to a minimum. The force required to open a lid must not exceed 1kg. The force required to close a lid must not exceed 2kg.	●				
Waste bins should be equipped with smaller and lighter lids.	●				
In order to make it easier for persons with reduced arm/hand functions to open the lid hand-operated levers may be fitted. Hand-operated levers rather than foot-operated levers are preferred as wheelchair users are not able to use a foot-operated lever. However, levers must be regarded as secondary solutions.	●				
Edges of the inlets and lids should be rounded and dirt repellant.	●	●		●	
The dimensions of receptacles for the collection of additional waste fractions within the curtilage of the primary source premises should comply with the above.	●	●	●	●	●
The dimensions of communal receptacles located in the neighbourhood or in the district should comply with the above.	●	●	●	●	●
Dimensions: indoor chutes					
The height of inlet of the indoor chute, as measured from the lower edge of the aperture to the ground, should be placed within the range of 70-85cm above ground level, preferably 70cm.	●				
The inlet of the indoor chute should protude at least 30cm from the wall at a height of 70cm above ground level in order to accommodate the legs of the wheelchair users. A tactile indication must be established in order to prevent blind and partially-sighted persons from stumbling into the chute.	●				
If the indoor chutes are used for the sorting several waste fractions, the operating buttons for the choice of fractions must be operable with one hand and signal with a tactile indication what kind of waste fraction it refers to. The tactile indication should be supported by an audible signal.	●	●			●

References cited

Aslaksen, F., Bergh, S., Bringa, O.R. and Heggem, E.K. (1997) *Universal Design. Planning and Design for All.* The Norwegian State Council on Disability. Oslo.

Bringa, O.P. (1984) *Den dimensjonerende faktor*. [The Dimensioning Factor.] Norges Handikapforbund. Oslo.

BUR (1991) *Affaldssortering i husholdningen - sorteringssystemer, der kan anvendes af alle. Forsøg udført i Boligselskabet ALBO, Albertslund Kommune.*[Waste sorting in the household - recycling systems that can be used by all. Tests conducted in the housing association ALBO, municipality of Albertslund.] Byggeriets Udviklingsråd. Hørsholm.

DS (1997) *Accessible Outdoor Environment - Direction on planning and design for accessibility for all.* DS Handbook 105. Danish Standards Association. Copenhagen.

Gelotte, Inga L. (1999) *Sophantering*. [Waste sorting.] Neurologiskt Handikappades Riksförbund. Stockholm.

Goldsmith, S. (1979) Anthropometric data. Pp. 23-28 in: Tutt, P. and Adler, D. *New Metric Handbook.* Architectural Press. London.

Goldsmith, S. (1997) *Designing for the Disabled: The New Paradigm.* Architectural Press. London.

Grosbois, L.-P. (1996) *Handicap et Construction*. Éditions Le Moniteur. Paris.

Ingsholt, M.A. (19999) *Tilgængelighed i detaljen*. [Accessibility in detail.] Dansk Blindesamfund. København.

Jensen, P. (1997) *Barrierer for fysisk handicappedes deltagelse i løsning af byøkologiske opgaver - med affaldsordning i Køge Kommune som case.* [Barriers to the participation of persons with physical disablities in local environmental tasks: with waste sorting in the municipality of Køge as an example.] IFP rapport nr. 1/97. Institut for Planlægning, Danmarks Tekniske Universitet.

Kennig, B. (1996) *Bygningsreglement 1995 - Om tilgængelighedskravene*. [Building Regulations 1995 - On the accessibility requirements.] Center for Ligebehandling af Handicappede. København.

Moe, M. (1995) Environmental Adminstration in Denmark. *Environment News* 17: 1-209.

MS (1991) *Design af affaldsbeholdere - Vurdering af udstyr til opsamling af dagrenovation.*[Design of receptacles - Assessment of equipment for the disposal of household refuse]. Miljøprojekt nr. 171. Miljøstyrelsen, Miljø- og Energiministeriet. Copenhagen.

R98 (1998) *Inspiration*. [Inspiration]. The 1898 Public Cleansing Company. Copenhagen.

Nakajima Wahlström, G. (1997) *Avfallssortering möjlig for all? - en studie av förekomst af avfallsbehållere utformade med hänsyn til personer med rörelseshinder eller nedsatt orienteringsförmåga.* [Waste sorting possible for all? - an investigation into the occurence of receptacles tailored for persons with reduced mobility and orientation difficulties.] Rehabiliteringsteknik, CERTEC, Lunds Tekniska Högskola.

Skitt, J.(ed.) (1992) *1,000 Terms in Solid Waste Management.* ISWA (International Solid Waste Association). Copenhagen.

Story, M. F., Mueller, J. L. and Mace, R.L. (1998) *The Universal Design File: Designing for People of All Ages and Abilities.* The Center for Universal Design, North Carolina State University. Raleigh.

Thorup Nielsen, S (1995) *Sådan informerer du alle!* [Information for all.] Center for Ligebehandling af Handicappede. København.

Tilgængelighed for all [General accessibility.] Danish Standards Association (In preparation). København.

UN (1994) *The Standard Rules on the Equalization of Opportunities for Persons with Disabilities*. United Nations Department of Public Information. New York.

WHO (1999) *ICIDH-2: International Classification of Functioning and Disability. Beta-2 Draft, Full Version*. World Health Organization. Geneva.

Woetmann Nielsen, C. (2000) *Boligers tilgængelighed* [Accessibility of Housing]. SBI-anvisning 195. Statens Byggeforskningsinstitut. Hørsholm.

Woetmann Nielsen, C. and Ambrose, I. (1999) Lifetime Adaptable Housing in Europe. *Technology and Disability* 10/1999: 11-19.

This report focuses on the problems experienced by persons with disabilities and senior citizens in connection with waste disposal.
Two Danish studies show that the design of existing waste storage receptacles to a large extent precludes persons with disabilities from participating on equal terms in day-to-day waste disposal activities.
The report presents the results of field tests involving receptacles modified to accommodate requirements to functionality. They were tested by the residents in three housing blocks.
The last part of the report is prepared as a practical guide to user-friendly waste disposal for a wider group of users including handicapped and elderly persons.
The report is aimed at all actors in waste management field.