

Dwelling features that facilitate ageing-in-time

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Abstract—Ageing-in-time in the own dwelling nowadays is regarded a sound alternative for moving-home at growing age. from independent-living towards assistive residential housing. However with growing age all disabilities that are not fully healed, become chronic impairments. Impairments do change the housing demands of its disabled inhabitants. Thus causing misfits between required living conditions and present quality of the dwelling. Repairing this misfit is driven by motives in medicine and well-being. The repair itself requires knowledge of the design of the ambient construction of the dwelling.

This paper focuses on bridging the gap between requirements of the Physical Built Environment (PBE) and manipulating the features of building constructions for dwellings. In this paper are discussed the outcomes of a thesis-study (2004) [1] that assessed a set of performances for dwellings. Thus facilitating a directive engineering of the features of the ambient constructions of dwellings, suitable for independent living for life-span.

I. INTRODUCTION

Ageing-in-time in non-residential housing offers an opportunity for aging well without extreme rising costs for protracted assistive care and social security [2]. Chronic disabilities however are declining the possibility to live independent in non-residential housing without losing an appropriate level of quality of life(QOL). For many aging inhabitants in the rapidly gray growing European societies an extended independent living is foreseen despite their occurring disabilities. As a result of good medical care and good medicine in the Western hemisphere aging persons are more often surviving with chronic rest-disabilities. Nowadays a co-morbidity of four or more chronic disabilities in one older grown senior citizen is not a medical curiosity any more. In 1995 in the Netherlands more than 10 percent of its 2 billion senior citizen was suffering four or more chronic disabilities [3]. However P. Lawton did rely the increasing level of co-morbidity in individuals and their declining competence to fit with the environment [4]. Prevention for the potential expression of any disability is contributing to the competence of inhabitants to meet the requirements of independent living.

In order to realize the aimed extension of the independent housing period barriers in the building-constructions of the dwellings have to be deleted by renewal or to be avoided in the design of new dwellings.

Dwellings however are built “for eternity” [5] from point of view of its inhabitants. While the housing demands for

individual persons will change by hazard in a relative short period: from seconds in case of an accident until a life-time (of several years) in case of chronic disabilities. The moment that an older growing person is confronted with impairments cannot be planned generally. It is rather an occurring incident. However this incident mostly has the impact of an important life event.

Repair of misfit on individual level

Repair of the misfit between the changed housing demands of elderly inhabitants and their available living-conditions is an “exogenous” option from point of medical view[6]. Medical advise may vary from an “easy” instruction to change housing- behavior, up to an establishing the insight, that the current dwelling does not suit anymore the required living conditions. The medical advisor will soon reach the limits of his own competence in advising the client in the choice and quality level of required features of the dwelling. And the actions to be taken: moving home or renewal of the dwelling. Sometimes an ergo therapist will be sufficient to translate the doctor’s advise in practical advises for installing technical provisions that are efficacy.

Otherwise, the prospect of a major long-lasting renewal operation in an inhabited dwelling does frighten-off a lot of involved persons [7]. Besides, in a rental situation the inhabitant is to ask the house owner for permission to establish provisions that are not always appreciated by other persons. Thus the implementation of health supportive provisions is to be regarded a des-investment. Technical repair of a dwelling in order to lower its barriers is thus provoking high mental barriers. Building constructions that are adaptive to changing housing demands without the need of a major accidental construction- works, will stimulate independent living.

Repair of misfits on level house-stock

Institutional investors-both nonprofit housing corporations and profit sector are meeting the same kind of foreseen incidental renewal proposals in their house-stock. Moreover, the moment that their house-stock does not meet anymore the changed housing demands of an substantial part of their renters, their property becomes old fashioned en less lettable [8]. Thus threatening a long-lasting sustainable hiring. While the existing house stock has frozen its technical features in stone and concrete. A weakness in sustainable hiring is, that the moments for easy large-scale conversion of the existing housing stock are limited. Mid-term renovation (after 15 of 20 years) exploitation do suit, next to demolishing and erecting new dwellings on the arisen building site. Renewed – or rebuilt dwelling are giving an opportunity to establish dwellings that are easily adjusted to individual housing needs, including the technical provisions for compensating impairments.

Manuscript received April 28th, 2008

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From standardized towards customized production

Though i.e. accessibility for wheelchairs is an important item, it is but a part of the impairments that older-growing persons receive as a gift from continuing their life. In a large variety of given impairments and causes of losing vitality. And most important, aging inhabitants act as simply normal people: they want to decide for themselves "what is good for me". The lesson is that a general Brief Program for the Construction of Dwellings for Seniors-citizen should have the shape of a menu- card.

The card is allowed to be standard, the choices are made on individual demand/ wish and should mostly be fitting within the production-capacity in the kitchen. Restaurant-dish whether own dwelling construction, its comparable. Universal Design promotes *Housing* (that is suitable) for all citizen, inclusive the impaired fellow-citizen [9]. Allowing mass-production that suits all inhabitants.

Customization and building-process

The moment the menu-card is standardized, the ingredients for increasing the dwelling quality to individual standards will become transparent and clear. Thus provoking the merchandising instincts of providers of health supportive building-components. The constructor will simply continue in fitting or disconnecting building-components into one compilation of building-components, the whole dwelling. In the way he has always done. The compilation of building components itself functions as an ambient shell for the living environment. The combination of traditional qualities of a building-component with technical qualities that smartly are assisting the inhabitant is a *challenge* for the innovation in smart building [10]. Optionally building components will develop towards "smart instruments" that assist or support the inhabitant in his activities of daily life. *Ambient Assistive Technology* [11] in dwelling construction is born. But it has no content yet.

Communicating solutions, a problem

The problem is the choice of composing items, whether in the restaurant or in a design process. In a restaurant you may ask the head-waiter for an advice. The waiter is accustomed to communicate with "the kitchen" in order to produce a product (meal), adjusted to the taste of the client. In achieving individual assistive-housing conditions you should act the same. A medical advisor that is advising the client and that is instructing the "kitchen of dwelling production": designers and constructors. In order to produce a dwelling that is efficacy assisting the inhabitant in appropriately living-in time. However, medical advisors will advise about the *Psychical indoor Built living Environment (PBE)*, while builders are merely interested in quality aspects of the ambient compilation of building-components. In the second research line of the former TUE Institute for Gerontechnology [12] a couple of researches were initiated that focus on dwelling-features that promote independent living for life-span.

Aim

This paper focuses on bridging the gap between requirements of the Physical Built Environment (PBE) and the design decisions that concern the choice of features for the ambient housing constructions called dwellings.

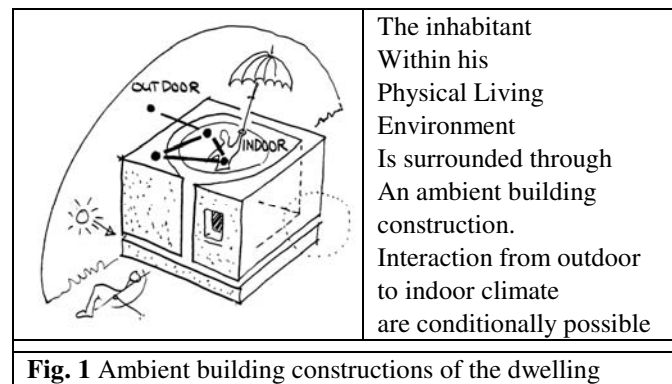
II. THEORETICAL FRAMEWORK

Outline

Firstly is given a theoretic framework of the research that was focusing on housing demands related to the features of the construction "dwelling". Secondly, a typical product that resulted from the research is presented: A score that is indicating the suitability of a dwelling design for independent living for life span. Thirdly is discussed the optional use of the retrieved score, and the required further research.

II-A. MODELLING AMBIENT BUILDING CONSTRUCTIONS

In the introduction is referred to ambient assistive technology (AAT) [11] and to communicate about the quality of the ambient building-construction. See figure 1.

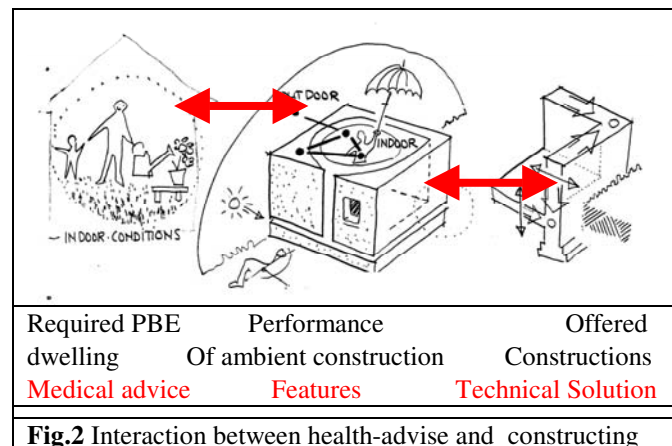


Communication that is starting with medical advice: requirements for the quality level of physical living environment PBE.

The quality of the physical living environment PBE results from a series of interactions (See figure 1):

- From ambient construction to indoor PBE;
- From outdoor PBE to indoor PBE;
- From housing behavior of inhabitant and PBE;
- From housing behavior to ambient construction?

The medical advisor will assist the inhabitant in retrieving more sound living conditions. See figure 2. Whether by changing the behavior or in changing features of the ambient building construction (by promoting renewal-action of by moving home) of his dwelling.

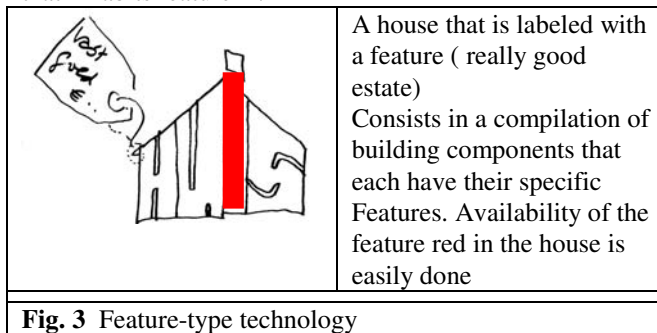


II-A FEATURES

In a design process for constructing a building the apart building-components are selected each with a set of required technical features. An *opportunity* for health-supportive constructing is present on the moment that health-supportive effects of apart building components are labeled in technical features.

In systems-language, the dwelling becomes a compilation of components in which a technical feature is present. By doing so the dwelling construction itself is easy to analyze as a compilation of components with a potential quality to promote a health-aspect.

Analyzing whether a feature A is present in the dwelling is done by searching for that typical building-component A, that inhabits feature A.



The brief program for new built dwellings has to involve several features that whether facilitate assistive care, compensate- or prevent for a wide spread of disabilities.

Towards purposive designing health supportive dwellings Feature-Type Technology [13] is providing the technology for achieving a database of health-supportive features, related to the application of certain building-components. In this approach Technical qualities are defined Features. While Building component with a Feature A are defined Feature-Types A. Including (nesting in) one Feature-Type component A in a dwelling will conditionally result in a dwelling that itself is a Feature type A.

Health-supportive Intervention in the performance of the dwelling is easily established by the following procedure: Assisted by his medical advisor, the client/ inhabitant chooses for a higher performance for the determinant A of the Physical Built living-environment.

In the protocol of the medical advisor is indicated a listing of relevant (building-) Features A.

The designer- real-estate advisor converses Feature A into a list of optional Feature-Types A.

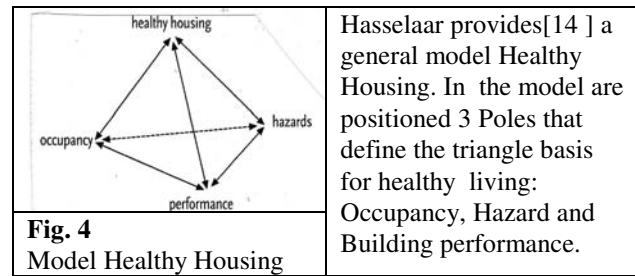
The constructor translates Feature-Type A in building-component available Products A with feature A.

Depending the individual choice of the inhabitant a mass-fabricated Building-component Product A is clicked in the dwelling construction, that is adaptable for product A.

II-B PERFORMANCE

Assistive technology in housing is part of the medical options: Whether medication, cure, preventive action or prevention. Prevention in gerontechnology is executed by elaborating the quality level of the exogenous disease factor Living Environment is chosen. However the dwelling itself is only a living-context, that conditionally

allows healthy housing. Housing habits, the actual way of living and the hazards in the physical environment are influencing the possibility to establish healthy housing.



For the dwelling construction the way dwellings are used and the general present hazards are a given item. That is eventually fixed in Building codes and standards.

In the intervention- model a medical protocol indicates the required level of building-performance. The performance is given in *Features* that are advised to be applied.

Or reverse: the suitability of extended independent living in a dwelling despite chronic impairment A is determined through an analysis of the compilation of building-components for the presence the *Feature-type A*.

This Feature Type A has to be written in the Brief Program of the Dwelling. Several ways are possible:

From directive demanding a Specified product, toward demanding a Product- specification and most global:

Demanding a performance for the Feature-type, versus the dwelling construction itself.

II C LEVEL OF IMPLEMENTATION

The interventions A in the dwelling plan will consist in whether prevention for dwelling-related diseases, in compensation for lost abilities, in facilities that are easing assistive care or in provisions that are enabling other social roles[]. As a minimum general Building Standards are given. The most interesting aspect is the extra quality that is provided in addition of minimum- standard level.

Levels of implementation of provisions where chosen similar on the study [15]:

- Level 1 on standard of *Building Code*;
- Level 3, *complete package of provisions A* that prevent for negative effects in patients that are suffering disability A. Assumed is that the inhabitants will stay on using the installed provisions. Which in average succeeds in 50 percent of households [16];
- Level 4, provisions A, *Installed in an Intrinsic way*. Bad behavior of inhabitants- resulting from lack of information, lack of compliance or contradicting housing needs- cannot influence anymore the positive effect of the intervention A. **The dwelling as a butler**, who knows “by instinct” what is best for you [17].
- Level 2, in between level 1 and 3. Possibility to rapidly installing the provisions of level 3, without the further need of structural construction works in the dwelling. During the building-in-use, attributes that are providing an intervention A are simply clicked-in. What requires a flexible way of *IntentionallyInstalled* building structures: *foreseen in plan, not installed yet*.

II-D AFFORDANCES

Intervention in the physical built environment is one of the optional ways to retrieve healing of the inhabitant. Next to the options medication, care-assist and cure that are beyond the scope of building engineering. Curing by offering health-supportive buildings will zoom in on the activities that are possible within a building. In top- down planning in architecture “*the function of a building or building part*” is the default way of arguing. In essence, the function of a space, room, building is not defining what behavior, cq. activities are possible. In defining intervention we need a method that defines the suitability of a space, a room or a building for executing a kind of behavior. In Design Decision Systems “*the Affordance*” [18] is defined as what an environment offers an organism. Organism is a wide definition that involves persons, for institutions, but also for animals or allergic agents. I.e. a dwelling with a door is an environment that offers the conditional (a key) opportunity for the inhabitant to enter by surpassing the closed skin of the dwelling.

Affordances enable elegant definition of health-supportive interventions. affordances. For example in social security: Affordance 1: the inhabitant is offered the opportunity to enter the home by passing the closed skin of the dwelling; Affordance 2: robbers, angry dogs, pests etc. are not allowed to pass the closed skin of the dwelling. Thus using “affordances” allows to define an intervention as a logical notation concerning the presence of an performance of the physical living environment PBE.

Which is executed in a PhD study [1]. For the human body 9 aspects of well-being where noted as an affordance. See table 1. The intervention for avoidance of negative aspects of a hampering motoric system is written down as: Intervention Motoric system
The dwelling affords all inhabitants to access all the rooms in the dwelling, even when this inhabitant is impaired by structural hampering of his motoric system. The affordance The performance Accessibility is realized in the dwelling when efficacy ergonomical provisions are installed.

| Table 1. Affordances that relate well-being with The presence of preventive performance | |
|---|--|
| Well-being and human body | Environment allows “performance” |
| Physics Motoric system Sense: pain | Accessibility, ergonomics |
| Physics Sense warmth Human body Metabolism | Stabile warmth, |
| Physics toxic, irritating skin | Emission free construction |
| Physics Sence Hear | Acoustical quality Not noisy, clear signals |
| Physics Sence See | Visibility, Light level Colours, gray scale |
| Physics sense nose | Fresh air, well ventilated |
| Physics auto-immune system | Allergen arm environment |
| Mind: Mental- social aspects | Social security, safety |
| Metabolism: vitamines C,D | Outside: sunny stay |

The application was focusing on the Dutch moderate sea-climate and a West-European housing culture. Design decisions for the performances of living environment are done in several phases of the design [19]. Four aspects that define functions, location, size and shape of the building, are relevant for the first design phases:

- Ergonomic layout that opens accessebility (partly);
- Transparent light and visible lay-out (partly);
- Social Security (of the neighborhood)
- Sunny, sheltered outdoor garden or balcony.

Five other aspects are relevant for phases of the design that define “ a composition of building materials”,

- Ergonomic layout that opens accessibility (partly);
- Visually clear and Transparent lay-out (partly);
- Stabile warmth (not too cool, not to warm)
- Emission free composing building materials
- Sound friendly (avoiding noise and loudness)
- Allergens-free (avoiding bad housing manners)
- Well ventilated (providing fresh air, not moisture)

II-E IMPACT OF INTERVENTIONS

Desk top literature research was done on the potential of intervention in exogenous determinants of the PBE. Reasoned was what interventions in the physical living environment theoretically do contribute in preventing for an expression of (part of) the burden of disease. Analysis of the architectural plan for a dwelling indicates the presence of provisions that are preventing for assistive-care in case the inhabitant gets a chronic disability. In the above study [1] is developed a score that indicates the level of *Potentially Prevented Burden-of-Disease in a housing-Plan (Score P3Z)*. The potentially prevented burden-of-disease for aged persons is larger than in a group of young citizen. The deduction of the total load of potentially preventable Burden of disease is not elaborated in this context.

III RESULTING SCORE P3Z

The nine performance-items of the physical built environment are represented in an windrose- diagram. The performances are split in two sections. One section for the architectonic aspect, the other section for the aspects that define “ a composition of building materials”. On the axes of each performance is fixed a scaling, that represents the level of implementation of the intervention.

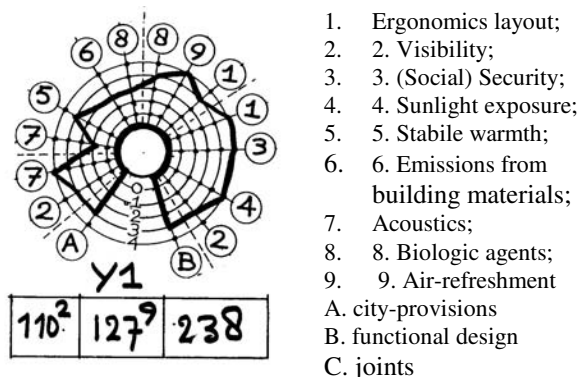


Fig. 4. Windrose diagram representing the implementation levels for 9 performances of Physical Living Environment

IV DISCUSSING THE OPTIONAL USE

The windrose-diagram results from a simple analysis of presence of provisions for 9 performances in the plan of a dwelling. In general experienced designers or constructors are able to execute the analysis.

Evaluation in one glance

The windrose-diagram allows global evaluation in one glance. For disabled citizen however, the level, of implementation of an apart performance might be most important. In example, the level of implementation of the performance “ergonomics” (vector 1) is very important for a wheelchair bound person.

Windrose diagram enables information exchange

Using the windrose diagram allows a proper discussion between medical advisor and inhabitant about the performances that are required in the own dwelling. It eases comparing the performance of the own dwelling with the requirements and with optional other dwellings (in case of intention for moving home). Which is very relevant regarded new legislation WMO 2007, [20] that brings Adaption of dwellings for disables back to the jurisdiction of local communities.

Bridging the gap between medicine and construction

Use of the windrose –diagram eases the communication about a required quality of living environment between medicine, inhabitants and building constructors/ architects.

Pilot application

Defining an implementation-level for a building plan will promote the design of health supportive dwellings, that are adaptable for inhabitants with impairments. In another paper is reported the use of this method in a pilot-project in Venlo, the Netherlands (2005-2008) [21].

Further validation of claim potential prevention

In the underlying study [1] a certain level of potentially prevented burden of disease was reasoned. For common building engineers, the estimations are already at the limit of his competence. Further validation is abbreviated.

Steering innovation

Producing a set of performances for the dwelling indicates optional contradictory technical solutions. Innovation of products starts when a technical problem is recognized. Solving these appearing technical problems will boost the innovation. At Technische Universiteit Eindhoven an innovative program for smart housing that supports independent living is elaborated [11] .

International comparison of prevention programmes

Estimating the level of potentially prevented burden-of-disease allows a comparison of the level of health-supportive construction of dwellings. Although, the lower the building standards, the higher the potential gain.

Performances starting point for Ambient Assistive living

Foreseen is a large scale innovation traject in the European Union that will focus on Ambient Assistive Living [12]. Though this program mostly focuses on the electronic provisions, the grass roots approach Intervening with smart application of building quality is a valid approach too. Besides for achieving implementation level 4 performance “Intrinsic Good “, the electronic butler has to be elaborated in a co-operation of gerontology advisors and engineers. At the end electronic devices will provide the difference: the electronic butler for all inhabitants.

V. CONCLUSIONS

Since the score P3Z methods and its windrose notation act as a shell for several apart health-supportive programs, it is enhancing further filling in by data, by validation, by formulating innovative new product-lines.

Windrose as a trophy for individual ageing persons

In general, using the windrose diagram enables a proper definition of required performance of dwellings. Thus giving tools to the inhabitant to describe the quality level of the desired dwelling. A tool that for empowerment of the inhabitants.

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