Track 1. Smart Sustainable Cities The Physical Transition.

Resilient refurbishment.

An assessment model for future-proof housing renovation.

At present, the Dutch housing stock includes 7.2 million homes. The average lifespan of a home is expected to vary between 120 and 400 years[1] and during that period, homes will be renovated several times. Three quarters of our current housing stock was built after World War II. As such, it is so young that exact deterioration rates are not yet available. The quantity of new housing that is being produced means that changing demands in the housing market will have to be met to a large extent by modifying the existing stock of housing. The age of houses leads one to conclude that they will be renovated on several occasions during their 120 to 400-year lifespan. This means that there will be a constant stream of properties to be renovated. It therefore makes sense to look for methods of renovation that take into account the need for future modifications to those homes. Such modifications will be important both for housing stock owned or professionally managed by housing associations and for homes in private ownership. Current practices in renovation focus on renovating in line with the demands of the moment. What is more, much renovation work is highly labour intensive and is carried out on site. This results in solutions which ensure that the house once again meets the required standards in the short term, but which take no account of changes that may take place in the future. The solutions applied may even make future work more difficult. Of course, alterations are necessary and inevitable, but how can we implement future-proof solutions that are applicable to a large portion of the housing stock?

In his introductory speech, Gruis suggests that it is time for new strategies when it comes to housing management and development.[2] Diminishing financial resources, fewer removals and more widespread homeownership are all leading to an understanding that greater account needs to be taken of the qualities of existing housing, neighbourhoods and residents. The actors involved are seeking ways to make sure that homes and neighbourhoods can remain attractive and quality of life can be maintained without large-scale intervention. This is happening against a background of relatively high levels of uncertainty. How will the economy evolve? What rules will housing associations and their local partners have to abide by? In the future, who will have the finances necessary for investment? The stock of private housing will also need solutions that enhance flexibility. It is rare for all homeowners, whether they are part of a homeowners' association or not, to want to undertake the same type of renovation at the same time. Renovation solutions that can deliver customized solutions for each property owner may allow owners who want to renovate more or sooner to invest earlier, after which other owners may do the same at a moment of their own choosing. This relates to research carried out by Kapteijns.[3] He states that renovation work can only take place if both the home and the neighbourhood are ready for this. He terms this the vertical renovation cycle. This research considers the possibility of achieving a horizontal renovation cycle through innovative renovation methods, by which houses can be renovated gradually, apartment by apartment or block by block.

This means it is important to look for future-proof renovation solutions that can be implemented using an incremental and flexible approach and that will not stand in the way of future renovation work, but will actually facilitate it. One answer may lie in increased flexibility and solutions that can easily be undone. It is possible to look for renovation solutions that can be changed or altered easily in the future and, additionally, that enhance the potential for alterations in the future. Examples may include flexible installations, flexible walls and components that can be installed onto or inside the dwelling.

[1] Van Nunen, 2010, Thomsen, 2007.
[2] Gruis, 2012.
[3] Kapteijns,1989.

For example, Heijmans has built a 'bathroom in a backpack' in Goes. This is a prefabricated bathroom that responds to the need to reduce the number of operations on the construction site itself, and provides a solution that is relatively easy to apply and just as easy to remove again. However, this bathroom can only be placed in a façade. Further development of this bathroom may one day mean that it can be used as an interior element too. This is a part of the home where many bathrooms are located and this installation option would provide more flexibility in using the façade and the interior space. Another example is Component Renovation (CR+) developed by the BouwhulpGroep in Eindhoven. Here, changes to the property are divided into components. Components are major parts of the building such as the roof, the kitchen, an exterior wall or an installation. By developing renovation solutions that apply to individual components, homes can be renovated in phases. When renovating one component, a client has to deal with a single party who is responsible for implementation, cost and quality. This means that renovations can take place at a time when both the owner and the occupants are ready for it. Component-based renovation can thus play a role in demand-led improvements in the social housing and private housing sectors.

To date, however, research into future-oriented and flexible construction has focused primarily on new construction. Little research has explored the opportunities that the housing stock and the construction industry can provide in terms of effective future-proof renovation with current and newly developing renovation solutions; neither has much research considered the question of how to determine whether and to what extent renovation solutions should be considered future-proof. We do not have sufficient knowledge of the possibilities that the housing stock and the construction industry can offer in terms of effective future-proof renovation with current and newly developing renovation solutions. For example, we do not know whether the existing bathroom or kitchen are easy to renovate; we are also ignorant of the opportunities created and limitations imposed by the load-bearing structure of the dwelling; and we lack knowledge of the limitations implied by the functional layout of a home. This research may reveal which possibilities (and impossibilities) are created by the characteristics of the current housing stock and the technical possibilities for future-proof renovation. It thus involves comparing the 'old' characteristics (of housing developed in the past) with the solutions that we are capable of developing today.

This research focuses primarily on homes that were built in the 1980s. The fact that these houses are now about 30 years old means that they qualify for major renovation. In this period, houses were built according to the principle of SDI (support and infill concept), which means that load-bearing walls and interior fittings are separated, a construction principle developed by the Foundation for Architects' Research (SAR).[4] In these dwellings, a distinction is made between the load-bearing elements of the property, which consist of the basic construction and the vertical transport of people and pipes, and the interior fittings such as partition walls that create the internal layout of the house. One of the central features of SDI homes is adaptability. That is precisely why it is so interesting to see whether these homes are future-proof, and whether there are lessons to be learned from this type of residential development. Research into homes from this period may therefore result in potential renovation solutions for large numbers of homes.

In this paper, we will develop a conceptual framework with which to analyse renovation solutions and evaluate the extent to which they are future-proof. To this end, we will explore the characteristics of the product and process through a number of research activities including literature-based research into future-proof construction. SAR is a prime example of this. The product features can be divided into material properties, prefabrication, construction technique, lifespan and reversibility. The process stages are divided into the management phase and participation by residents, the demolition phase or reuse, the design phase, the production phase and the realization phases. This enables a technical and process-based assessment of the renovation solutions and concepts that are available on the market.

[4] Habraken, 1961.

Using the 'DESTEP' structure, we also identify which environmental variables affect the future stability of renovation solutions. 'DESTEP' stands for demographic, economic, social/cultural, technological, environmental and political/legal factors. These factors allow us to form a picture of the external factors that are important in determining certain future scenarios. This method will be used to explore a number of important factors that are important when assessing renovation concepts. For each factor, the current situation will be described first, and this situation will be used to test renovation concepts for their durability over time.

Both these approaches are combined and translated into an 'assessment model for resilient housing refurbishment'. Using this model, it is possible to assess – using the criteria given – whether the renovation concept being considered will make houses more future-proof, or actually make them less so. The applicability of the conceptual model has been tested on the module solution of Faay and the Active House of BAM, Velux and the BouwhulpGroep.

The table below shows it is possible to assess the prefab module of Faay and the Active House of BAM, Velux and the BouwhulpGroep.

		FAAY		Active House	
		Impeding	Improving	Impeding	Improving
product features	Material Properties	X			X
	prefabrication		X	X	
	realization technique	X		X	
	lifespan	-	-		X
	reversibility		X	X	
process characteristics	management phase		X	X	
	demolition phase / re-use		X	X	
	design phase		X		X
	production phase		X	X	
	realization phase		X	X	
DESTEP	demographic		X	X	
	economic	X			X
	social/cultural		X		X
	technological		X		X
	ecological	X		X	
	political / legal		X	X	

Table 1: Assessment Table for Future-proofing (Brinksma, 2014)

The results of the research into suitability led us to conclude the following.

Expansion and contraction will play an important role as the result of future demographic developments. The possibility of adapting the property will not be put to use with any great frequency; however, changes in family composition and the ageing of the population will mean that more adaptable homes will be required. Clearly, Faay's module solutions will be applicable in a range of different situations. However, the size of the property cannot be changed with these modules. This is where a conflict arises with the current modules. The 'bathroom in a backpack' (Heijmans Goes) not only renews the bathroom but also gives rise to an increase in the overall floor area. The expansion of Active House is static and it will be difficult to change this in the future. Economic developments may mean that different budgets will be available for renovation work. This affects the way in which renovation work can be carried out. When only a limited budget is available, renovation must be carried out on several occasions. This means that renovations will not be carried out in one go, but can be completed in different phases. Opportunities not only to buy but also to lease components will increase. This will enable us to adapt more quickly to changing demands and return raw materials to the manufacturer quickly. This in turn will allow us to respond quickly to new developments, such as the installation of sensors and heat recovery techniques. The development of new techniques follows a different cycle to the renovation of our housing stock. Meanwhile, the ability to use newly developed products in our homes in a simple way will make these easier to deploy. A 'plug and play' system will make it easier for a range of applications, both existing and yet to be developed, to enter our homes. Changes to insulation systems will make it possible to

use existing products at different locations. Regulatory change occurs faster than our ability to adapt our homes. Any intermediate changes that occur may now be difficult to take account of, or not implemented at all. It is therefore necessary to ensure that the whole housing stock can be adapted when regulations change. This will make for a less rapid ageing of our housing stock, and smaller interventions will be needed as a consequence. We must also take climate change into account; the consequences of this are already in evidence in the form of noticeably heavier downpours. It is also possible that types of animals that we have not previously had to contend with (such as insects) will cause problems.

This leads us to conclude that the use of our assessment model could result in specific and practical recommendations for the design and re-design of renovation solutions, and could therefore contribute to renovation practices that take greater account of future developments.

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