Dutch dwellings

Dutch Dwellings

Prof.dr.ir. B. de Vries, A. van der Zee, MSc, J. Carp, MSc.
Faculty of Architecture, Building and Planning, Eindhoven University of Technology, The Netherlands.
e-mail: B.d.Vries@tue.nl

Abstract

Applying Generative Design (GD) for dwelling is not very common but it opens up the possibility to study whether GD systems can reproduce existing design typologies. Dutch dwellings as an exemplification of a design typology are analysed using the SAR methodology. Building regulations are used as input to a GD system along with the typical requirements for a family house. The results show that not all existing typologies can exactly be reproduced, but the generated designs have a remarkable resemblance with Dutch dwellings. They also demonstrate that Dutch dwelling identity is at least partially encoded in Dutch building regulations. Coding of yet unknown architectural identities requires new GD metaphors to support the architect.

1. Housing research

Housing research traditionally receives little attention. Many studies on social housing have been published but very little scientific research from an architectural point of view. One exception to this rule is the well-known SAR mythology that originated in the sixties last century in the Netherlands. First we will briefly explain the main aspects of the SAR methodology. Following, we will use this methodology to systematically classify traditional Dutch dwellings.

1.1 SAR

SAR stands for Stichting Architecten Research (in English: Foundation of Architect's Research) and was founded by Prof. John Habraken [1]. In the SAR-65 report he defined the term 'support' and 'infill'. Supports are realised by a project-oriented building process as is common practice for the building industry. The infill is not project-dependent, but directs itself to facilities produced by the industry of durable consumer goods. These two aggregation levels are not only related to design and construction but also to responsibility and decision. The support includes all decisions in the dwelling that may be taken communally and the infill all the decisions that may be taken individually. Since infill and support were strictly separated a method was needed to systematically research the infill possibilities, given a specific support. For that purpose the design taxonomy was introduced as described and applied in the next section.

1.2 Dwelling taxonomy

The term taxonomy originates from biological research and refers to the organization of plants, animals, and other organisms into categories based on similarities. For a specific domain many taxonomies can be proposed that are good as long as they are useful. In this paper we will propose a taxonomy for Dutch traditional dwellings.

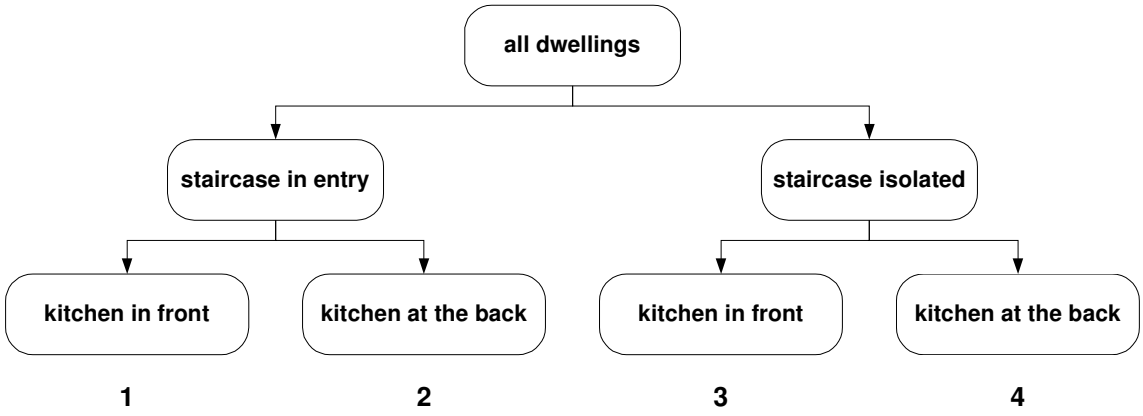
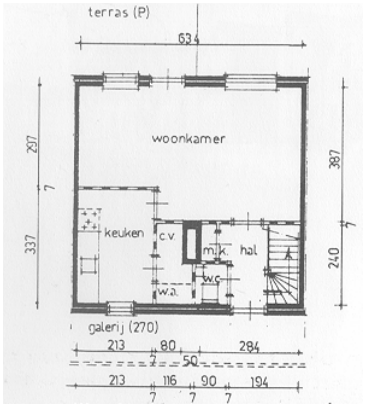


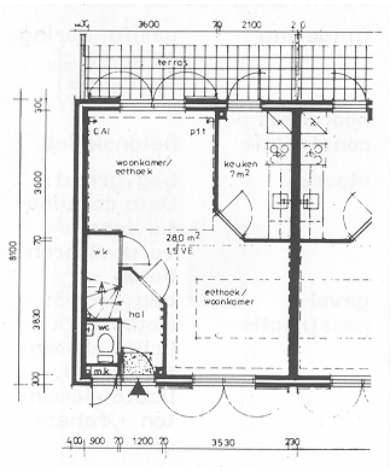
Figure 1: Dwelling taxonomy

For each of the leaves of the taxonomy tree, a typical example is presented if Figure 2.

Ground floor

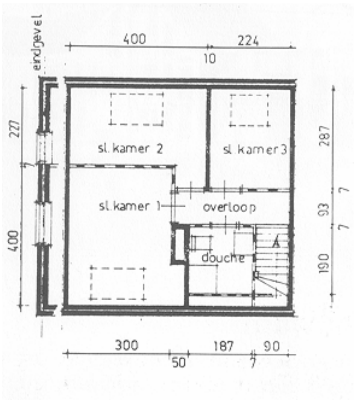


Dwelling type 1:
Staircase in entry & Kitchen in front

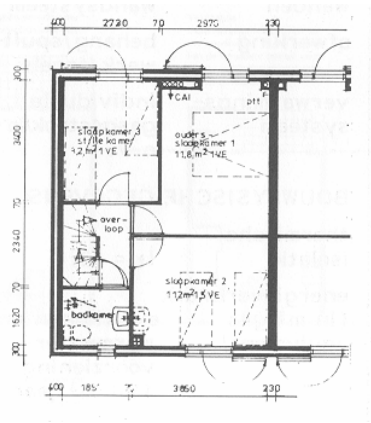


Dwelling type 2:
Staircase in entry & Kitchen at the back

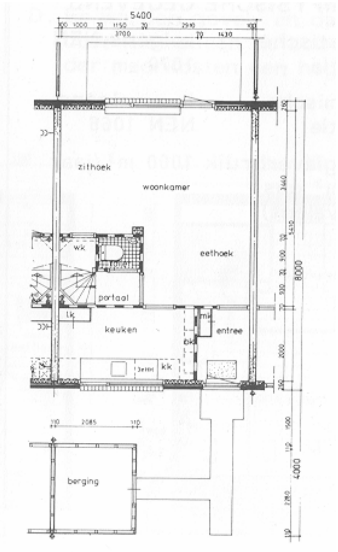
First level



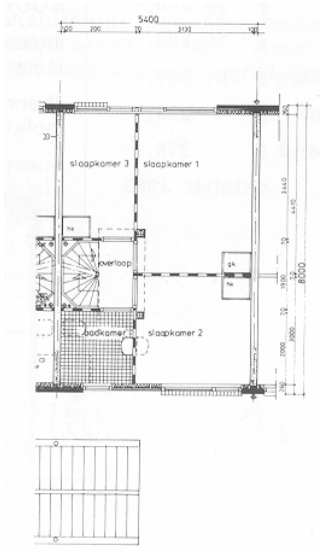
Dwelling type 1



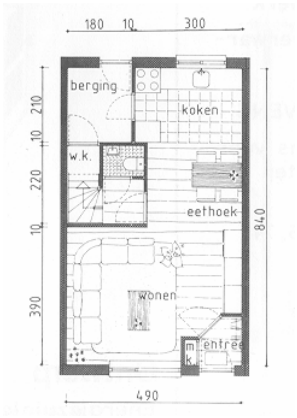
Dwelling type 2



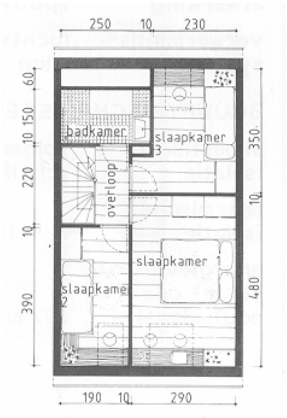
Dwelling type 3:
Staircase isolated & Kitchen in front



Dwelling type 3



Dwelling type 4:
Staircase isolated & Kitchen at the back



Dwelling type 4

Figure 2: Dwelling samples

2. Dutch Identity

Identity according to Oxford Reference [2] is the quality or condition of being a specified person or thing. In our case it is the quality of a house being specified as a Dutch dwelling. The perception of this quality by human beyings is determined by the spatial organisation of the dwelling and the material use. In return, these two aspects are strongly related to geographical location, cultural history, etc. The Dutch identity is instilled in the Dutch codes and regulations. These formal descriptions specify the common understanding and agreement of living in the Netherlands and thereby also of Dutch dwellings.

Our approach to Generative Design takes the Dutch building codes and regulations as a starting point. In the following section we will apply our GD system and imply current codes with respect to lighting, energy consumption and minimal requirements for furnishing.

3. Generation of Dutch Housing

The GD system we implemented is based on the well-known GA algorithm and described in detail in [3] and [4]. Input to the system are the requirements that are common to dwellings for family housing, presented in the following screenshots from the application:

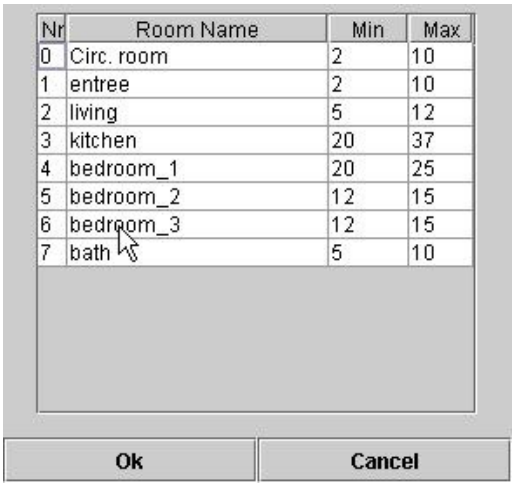


Figure 3: Spatial requirements

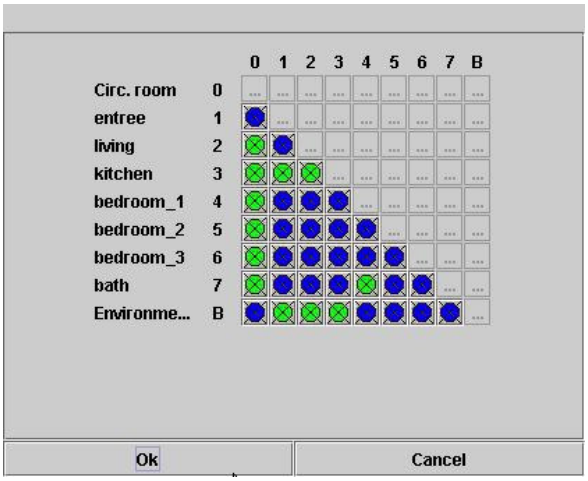


Figure 4: Spatial relationships

Figure 3 expresses the minimum and maximum area in square meters per space. Figure 4 shows the preferred relationships between spaces (Green/Light = direct relation, Blue/Dark = No relation). On top of that the span width between the bearing walls is fixed to 6.00 meter, which most frequently used in new housing projects in the Netherlands (see Figure 5). Extensions in the front and in the back are allowed within the limit of 2 meter.

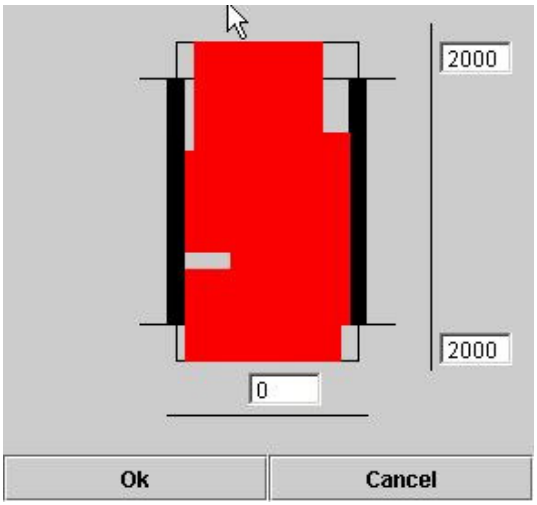
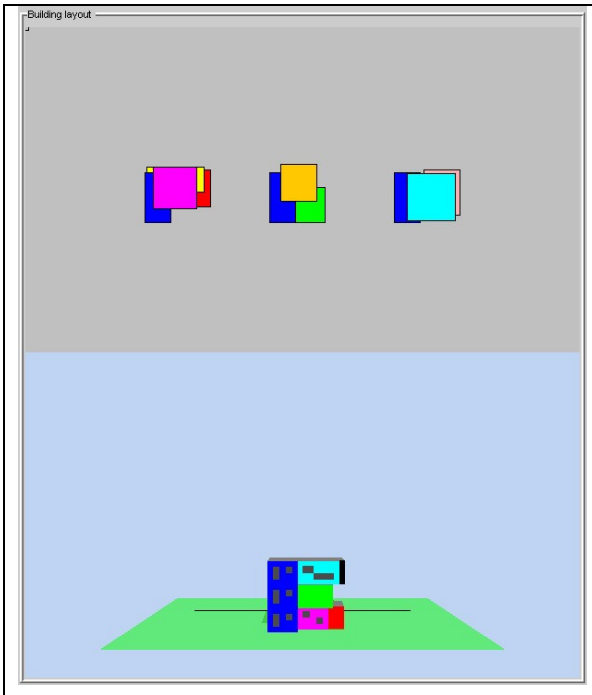


Figure 5: Site constraints

4. Discussion of Results

Screenshots are presented in the table below from a selection of the results of the runs of our GD system. In de upper half the ground floor, the second floor and the top floor (attic) are presented from left to right. In the lower half of the image a 3D overview of the design is presented. The index of the colour coding is as follows:

Blue	= Circulation space (Staircase)
Red	= Entry
Yellow	= Kitchen
Purple	= Living
Light blue	= Bedroom 1
Green	= Bedroom 2
Dark yellow	= Bedroom 3
Pink	= Bathroom

	A 3-storey house is generated with the entry and staircase on the opposite side of the living room. The kitchen is connected to the entry. The bedrooms are on the first and second floor. The bathroom is on the second floor (attic). This house type is somewhat similar to dwelling type 3. It is a bit hard to decide what the front of the house is. Bathrooms on the top floor are very uncommon.

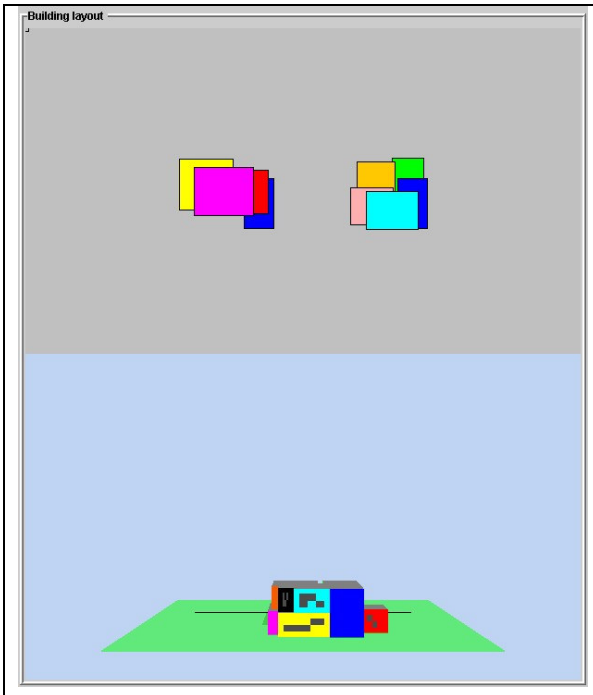
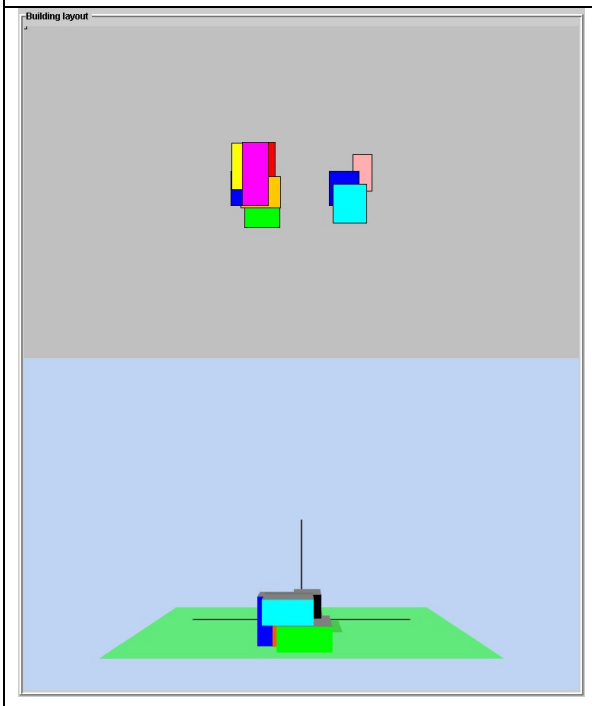
	Entry and staircase are strongly connected. The kitchen is wrapped around the living room. All bedrooms are on the second floor as well as the bathroom. The bathroom is not directly accessible from the circulation space. This house is most similar to dwelling type 2. No direct entry from the circulation space is not usual but either uncommon.
	Entry and staircase are completely separated. The kitchen is at the same side of the house as the entry (the front). The bathroom and two bedrooms are located on the ground floor, while the other bedroom and the bathroom are located on the first floor. This house type is similar to dwelling type 3. More common is, the location of one bedroom and the bathroom on the ground floor in case of housing for elderly people.

Figure 6: GD results

As can be seen from the table above, not all Dutch dwelling types from the dwelling taxonomy could be reproduced closely in this small-scale experiment. Perhaps simply more runs are needed or possibly our GD system gets stuck in some local optimum of the fitness function and does not 'discover' other optimums. Overall the results of the GD system are not as neatly and smoothly as the examples from practice. More iterations also don't bring the results closer to reality. Presumably this is exactly the bandwidth that does not bring

significant reduction of energy consumption (the imposed building codes) within the minimal requirements of lighting and furnishing. In this bandwidth aesthetic and constructive efficiency considerations prevail.

5. Can Identity be coded

Architectural identity is defined by the spatial organisation and material use of a building. The creation of such identity is traditionally reserved for the architect. With Generative Design, identity can possibly be generated by computer systems. Every GD system operates upon a basic set basic of primitives, namely the geometry representing space or material. Coding of an identity can be implemented with fundamentally different methods, namely:

1 Recombination of primitives: Identity is in the primitive

The operational procedure changes the ordering of the fixed primitives that constitute a design. E.g. through a cross-over in a Genetic Algorithm [5].

2 Transformation of primitives: Identity is in the transformation procedure

Soddu [6] generates design by specifying the transformation procedure that operates upon a set of primitives. The transformation procedure is fixed, while the primitives are adapted.

3 Equilibrium of primitives within constraints: Identity is in the constraints

From the Constraint Satisfaction Problem (CSP) research domain many algorithms have emerged to solve complex numerical problems. The constraints are fixed and determine the boundaries of the design solution space.

4 Hybrid procedure

Many GD systems, like ours, follow a hybrid approach

The Dutch dwellings example demonstrates that Dutch dwelling identity can be reproduced from implying Dutch codes. This outcome underlines the value of GD as an architectural design analysis and exploration method. Coding of yet unknown architectural identity requires much more. Ultimately a one-to-one mapping of the architect's mind into computer system format is needed. Apart from the question whether this is desirable, we can conclude for now that there is a long way to go. In the current state, a lot of effort is spent on coding computer systems, which requires a formalisation of design considerations that conflicts with the typically ill-structured and ill-defined architectural design process. The research challenge is to develop metaphors that can bridge this gap and open up the possibilities of GD for architects.

References

[1] Bosma, K., D. van Hoogstraten and M. Vos (2000). *Housing for the Millions: John Habraken and the SAR (1960-2000)*, NAI Publishers, Rotterdam.

[2] www.oxfordreference.com

[3] Zee, A. van der, and B. de Vries (2003). Checking interactive generated design against distributed objectives, In: C. Soddu (ed.) *Proceedings of the 6th International Conference on Generative Art 2003*, Milaan, pp. 19-28.

[4] Zee, A. van der, and B. de Vries (2004). Interactive generated design alternatives constrained by technical and spatial conditions, In: *Proceedings of G-CAD Conference*, Pittsburg. (to be published)

[5] Holland, J.H. (1992). *Adaptation in Natural and Artificial Systems*, MIT-press, Cambridge, Massachusetts.

[6] Soddu, C. (2003). Visionary Aesthetics and architecture Variations, In: Celestino Soddu (ed.) *Proceedings of 6-th International Conference on Generative Art*, Milan, Italy, pp. 5 – 18.