INVESTING IN POSSIBILITIES

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Abstract
Transformation of office buildings into housing or other functions is a possible way of dealing with structurally vacant office buildings, albeit previous research shows that there are many obstacles to be thrived. Although in the Netherlands several successful transformations of offices into housing were completed, transformations do not take place on a large scale. In addition to location characteristics, the main reasons relate to estimated financial non-feasibility. Hence, when developing new office buildings it seems logical to already consider a second use and anticipate upon future programmatic transformation. Designing and developing adaptability has been opted for during the last 40 years, but is still not very popular in the development of neither offices nor housing. Is it possible to anticipate future programmatic change? To which extent will anticipation on future possibilities influence building costs?

By reviewing existing studies we gather information about the building costs of transformations and the possible changes to allow for enhanced future adaptability. Henceforth, we study the building and transformation design and costs for new office buildings by design, focusing on two standard office building types, the tower and the slab, using the cost-model Parap.

Keywords: Transformation, conversion, adaptability, sustainability

INTRODUCTION

Two themes that currently dominate the developments in real estate are sustainability and the effects of the credit crunch for real estate. Though different themes, there are parallels and connections between the themes. In general, a crisis teaches us how to be more socially conscious about how we live our lives and how we run business, with the renewed knowledge that wealth is not granted. The interest for sustainable development currently increases, following the idea that sustainable real estate is less affected by the credit crunch.

In the Netherlands, approximately 6 million square metres office space was vacant by the end of 2008 (DTZ, 2009), a number that has been more or less constant since the last office market crisis in 2001. During these years, sustainable entrepreneurship and sustainable real estate development has gotten more attention. A reaction to the current crisis could be to develop office buildings that are protected against potential vacancy by enhancing their transformation potential. Hereby, the buildings lifespan is increased, something that contributes positively to the sustainability of the built environment. Adaptability as a means of enhancing usability and prolonging buildings functional lifespan has been discussed in Dutch architecture since the 1960s. Habraken (1961) published his book supports – an alternative to mass housing, claiming that a buildings structure should be separated from its interior, anticipating the large scale post-war construction of housing for the masses. In the same period, Jacobs (1961) presented her book "The death and life of great American cities", focussing on adaptability on an urban planning level and pleading for a more dynamic city, already reacting to the devastating urban developments fuelled by functionalist planning. Ever since, more studies are published that study the applicability of adaptable buildings (Duffy, 1998; Brand, 1994; Leupen, 2006). To make buildings more flexible, Brand (1994) advised to design the building as 6 separate layers: Site, Structure, Skin, Services, Space plan and Stuff. In the Netherlands, also the national research programme IFD (Industrial, flexible, demountable) was initiated in 1998, and several buildings were developed according to this programme (Groenendijk, 2000).

Since the references mentioned above are just a grasp of possible sources on adaptability, it seems that the subject is fully covered. However, from the commercial point of view adaptability is hardly accepted by the real estate market as an added value. Revealing the commercial potential of adaptable office buildings is the aim of this paper, focusing on the legal, technical and financial feasibility of adaptable offices, aiming to respond to the following questions: Which initial measures should be met in order to develop adaptable office buildings, and which costs are associated with these interventions?

OBJECTIVE

Several studies were conducted to define the residential transformation potential of standard office buildings (Geraedts and de Vrij, 2004; van der Voordt et al, 2007; Mackay, 2007; Remøy, 2007, 2008ab, 2009ab; Muller et al, 2009) describing financial, technical, functional, legal and cultural issues. Departing from these studies, this paper focuses on which physical characteristics of an office building need consideration in order to enhance the possibilities for future transformation into housing, without developing suboptimal offices.

Van der Voordt en Geraedts (2000) developed the Transformation meter consisting of a list of criteria to measure office buildings transformation potential. Geraedts and De Vrij (2004) and Mackay (2007) subsequently studied the transformation building costs, creating a point of departure for how to anticipate transformations in new developments. Following, Remøy considered several transformations ex-post (Remøy, 2007) and discussed transformation with different actors in the real estate market (Remøy and Van der Voordt 2009).

These studies have contributed to an extensive body of knowledge about transformation of existing office buildings. However, there is a missing link between the studies of transformation as a means of reusing redundant office buildings and the studies of adaptability of housing and offices. This paper aims at filling in the missing link by studying the possibilities of developing adaptable office buildings with potential of future transformation into housing, starting by revealing legal possibilities and thereafter describing characteristics of a location that may accommodate both housing and offices. Henceforward, the adaptability of office buildings is studied by focussing on two typical office building types; the single corridor and the central core building, studying which measures must be taken to increase the buildings adaptability. The financial consequences of changing the standard office building are thereafter studied using PARAP, a cost calculation programme developed by the TU Delft and The Government Building Agency.

From the studies mentioned above the key characteristics that influence buildings transformation potential can be extracted. By considering these characteristics in the designing phase of new offices the feasibility of transformation could be increased.

Table 1: *Characteristics influencing buildings transformation potential.*

Transformation potential	
Legal	Zoning plan
	Building decree
	Location (mixed use)
Technical	Construction: not load baring
	Technical state of the construction
	No prespanned prefab floors
	Ramovable and adaptable façade
	Consider reuse or refit of installations
	Possibility for horizontal extension
	Possibility for vertical extension
	No integration of structure and installations
Functional	Size of the structural grid to fit housing: relationship gross floor area vs usable floor area
	Position of entrances, stairways and elevators
	Daylight: depends on depth of the building and openings in the facade)
	Possibility for attaching interior walls to the façade
	Basement usable for storage or parking
Financial	The façade carries more than 20% of the total building costs
	Constructor costs
	Installations
	Structure

METHOD

This research started with a literature review of foregoing studies of the transformation possibilities and adaptability of (office) buildings, aiming to order and connect existing approaches (Groat and Wang, 2002). Subsequently, expert interviews were conducted to focus the study, and additionally two projects were studied that were developed for future adaptability, looking into technical, functional and financial discrepancies with standard office buildings. Based hereupon, a focus group interview with experts from the field of architecture, project development, structural engineering and mechanical installation advice was conducted (Miles and Huberman, 1994). The question to the focus group was: ‘Is it possible to anticipate future programmatic change?’

Though this research focuses on building characteristics that make transformation possible and that influence the adaptability of an office building, several other issues also influence the buildings transformation potential, of which some legal and location issues are of great influence.

LEGAL ISSUES

To increase the transformation possibility of offices is only interesting if legally possible. Legal impossibilities are described by the zoning plan and by the building decree. The zoning plan can accommodate transformation in two ways; by describing two or several functions, or by allowing for changes in the zoning plan. The second option allows the municipality a better grip on the urban development, and is preferred by the government.

The building decree applies different demands to housing than to offices on several aspects: First, the external influences of air quality, noise and thermal insulation place higher demands on the facades for housing than for offices. Secondly, rules for fire prevention and escape in case of fire add several differences, related to compartmenting the building, escape routes and fire safety of the structure. Except for the fire safety of the structure, the other issues are related to design decisions. Additionally, the building decree describes the functionality of some building aspects. These aspects change frequently, though the general trend is that aspects like the free floor height and the parking requirements for housing increase.

LOCATION

Not every office location is suitable for housing. 70% of the vacant office buildings in the Netherlands are located in monofunctional office locations. In such locations transformation is only possible as part of a large scale location transformation, as nobody would like to live in an office location. The Dutch housing market shows a trend of urbanisation (Houwelingen, et al 2007) and concentration in the “Randstad” area. Location characteristics are important for people’s choice of where to live, and distance to the city centre is an important aspect (Den Dekker, 2009). Areas with a functional mix are preferred and so transformation of offices in such areas is interesting.

BUILDING

This research defines two typical office types: a central core and a single corridor type. These two offices are the main types in numbers of commercial developments and therefore most relevant to this research. Other office building types are less frequently used or are based on the single corridor types, e.g. the double corridor type or L-shaped buildings, and so the study results of the single corridor type may easily be translated to comprise these types. The single corridor type is horizontally organised by a centrally located corridor with workplaces at the perimeter. Normally, this type has a structure of load bearing outer walls and hollow core beams, spanning the whole depth of the building. The standard measurement of these buildings is a depth of 14.4 metres and various lengths. The central core type is vertical in its orientation and is built up by a sturdy core and a structural grid of columns. The typical depth of this type is 9 metres from façade to core.

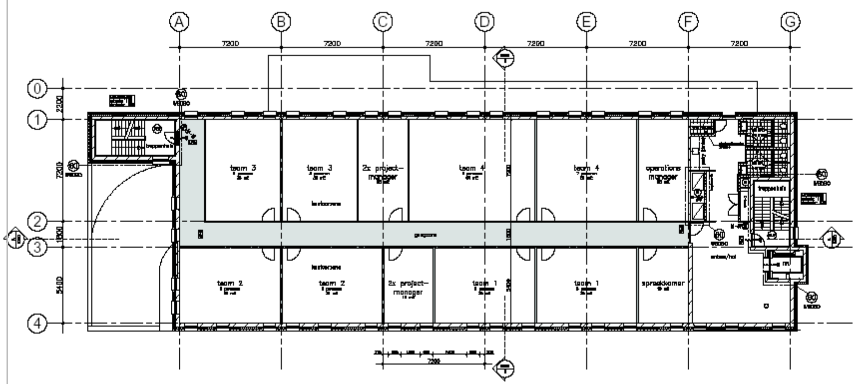
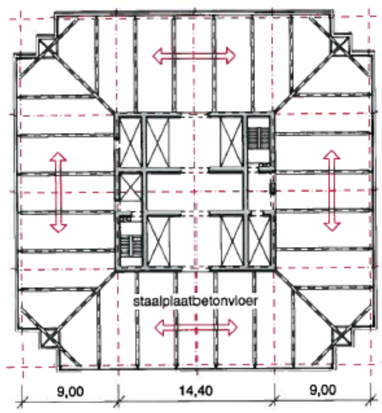
	

Figure 1: *Example single corridor plan*	*Central core plan*

In building construction, different developments move towards integration of building parts or oppositely, towards the separation between the different elements. Developments that aim at reducing the energy use in office buildings frequently search for an integral approach combining different building parts as to minimize the construction height. On the other hand, adaptability can be maximized by separating the different building elements according to the idea of the building as layers. This study shows that adaptability within and across the layers can be achieved by smart design of the measurements and positioning of the different layers and building elements. Next to the design steps, some technical measures are required. Where the design steps do not necessarily influence the building costs, the technical measures will.

Based on the knowledge of mentioned literature on transformation and the preferences of the focus group experts, the following measures should be taken in order to improve the adaptability and transformation potential of office buildings.

Table 2: *Possible measurements for improving transformation potential.*

Element		Argumentation	Consequences
Housing			
Single corridor		Apartments entrance via gallery or corridor	
Central core		Apartments with entrances around the core	
Construction			
Measurements	Structural grid	Multiple of 1.8 metres, fits offices and housing	Design
	(structure) Height	3.6 metre is the standard height (floor-to-floor) for offices and leaves room for transformation into housing	Design
	Width	7.2 metre is standard and also suitable for housing. 8.1 metre would also be suitable and would create even more possibilities for both housing and offices	Design
	Depth	Single corridor type: 10-14.4 metres. If the depth is increased, apartment entrance from a corridor is possible. Shallower offices are hardly found Central core type: 7.2-12 metres to the core The standard depth is 9 metres, 7.2 metres is a minimum depth	Design
Extendibility	Horizontal	Columns in the façade make extensions like balconies or small additions possible	Design
	Vertical	Normally two floors may be added as offices are calculated to carry more weight than housing	
Floors	Type	Using monolithic post-stressed floors makes it possible to apply shafts after completions, as opposed to precast hollow beam floors that are standard in single corridor housing. The maximum span width is 8-9 metres, meaning that a beam and row of columns will normally be needed	Technical
Entrances, stairs, elevators			
	Horizontal	Single corridor type: Gallery is preferred, as it makes two-sided orientation of the apartments possible Central core type: A corridor around the core makes escape in case of fire possible	Design
	Vertical	Single corridor type: stairs and elevators close to the north or east side of the building for addition of a gallery Central core type: Location of stairs and elevators in the centre of the core is good, 2 separate staircases required	Design
Facade			
replaceable		Not load bearing, easily demountable, replace or adapt to be decided if transformed	Technical

Element		Argumentation	Consequences
Adaptable		Adaptability increases the sustainability and reduces building costs of transformation Not load bearing Façade grid 1.8 metres or possibly 1.2 metres Insulation, fire resistance Anticipate higher floors after transformation Dilatations to fit housing	Technical
Preferences		Curtain walls are low-weight, easily replaceable and locally adaptable	
Building physics	Insulation	The demands to insulation change frequently and cannot be anticipated. Possibilities for adapting the building to new demands should be anticipated	
Installations		Not integrated with other building parts or layers	Design
Fire prevention	Structure	The main structure should keep its strength for 120 minutes in case of fire, according to demands for housing	Technical
Plinth function	Commercial	Commercial functions in the plinth may increase the feasibility of transformation into housing. The ground floor should be 4.5 metres high to accommodate commercial functions	Technical

BUILDING TYPE

Applying these measures to the two standard building types, it shows that the central core type already applies the most technical measures required for housing. This type can be adapted to apartments served by the core. The central shafts can be reused for the apartments and few or no new shafts are needed. Additionally, because of small floor spans monolithic post-stressed floors are often used in a central core building, again making it possible to cut holes for shafts if necessary. One small difference remains: the fire capacity of office buildings is normally 90 minutes, while for housing this should be 120 minutes. However, improving the fire capacity also means that the building will be safer, something that is also appreciated by office organisations. Furthermore, the adaptability of the central core type is good since apartments can be accessed from the central core and can be located on the buildings corners and therefore with a two-sided orientation, something that is seen as an extra quality. Another positive aspect for transformation of this type is a shorter construction period than the development of tall new buildings for housing. The long construction period is seen as a negative issue for the development of new tall housing projects (Den Dekker, 2009).

The single corridor type may also be adaptable, though the standard single corridor building is not! The standard hollow core slab and load bearing outer walls are the main obstacles for the adaptability of this building type. By designing single corridor buildings with monolithic post-stressed floors and curtain walls, these buildings would be adaptable. The quality of the apartments would need consideration because of the access and orientation.

BUILDING COSTS

Interventions that influence the building costs of the standard central core type are few; the standard single corridor type requires more changes, of which some do have impact on the building costs.

Table 3: *Interventions for a single corridor building*

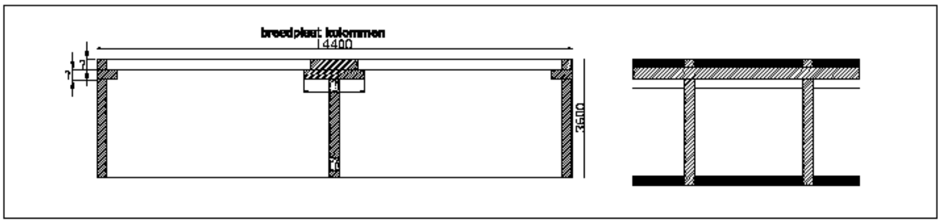
Interventions	Standard
Single corridor building	
Construction	
Columns on a structural grid	Load bearing outer walls
monolithic post-stressed floors 7.2 metres floor span 120 minutes fire resistance; floor thickness 240 mm Extra column + possibly a beam in the middle of the building	Hollow beam floor Floor thickness 320 mm for floor spans of 14.4 metres 90 minutes fire resistance
Facade	
Not load bearing: replaceable Locally adaptable	Load bearing Prefab façade elements
	

Table 4: *Interventions for a central core building*

Interventions	**Standard**
Central core building	
Construction	
monolithic post-stressed floors 120 minutes fire resistance; thickness + 10mm	monolithic post-stressed floors 90 minutes fire resistance
Facade	
Not load bearing: replaceable Locally adaptable	Not load bearing: replaceable Prefab façade elements

The building costs are retrieved from reference projects and material costs from commercial cost databases like archidat.nl. The different types of constructions are calculated using a structural grid of 7.2 metres by 14.4 metres and show the following differences in total cost per square metre.

Table 5: *Costs of interventions for a single corridor building*

Construction	**Facade**	**Costs per m2 GFA**
Hollow beam floors	Load bearing outer walls	€ 302
	Not load bearing curtain walls	€ 346
Monolithic post-stressed floors	Not load bearing curtain walls	€ 362
	Not load bearing prefab elements	€ 277

To calculate the cost differences of the total investments we used the building cost calculation program PARAP that was developed by the TU Delft together with the government building agency. The programme was developed to calculate single corridor office buildings. As the building costs are only part of the total investment cost, such a calculation is necessary to make the cost-consequences of adaptable buildings visible (Gerritse, 2005).

INVESTMENT		standard	adaptable
+	Land	€ 7.140.000	€ 7.140.000
-	Construction	€ 6.863.000	€ 7.303.000
+	foundations	€ 147.000	€ 149.000
+	structure	€ 825.000	€ 1.186.000
+	roofs	€ 68.000	€ 68.000
+	facade	€ 2.173.000	€ 2.213.000
+	interior walls	€ 1.334.000	€ 1.334.000
+	floors	€ 223.000	€ 223.000
+	stairs and ramps	€ 143.000	€ 143.000
+	ceilings	€ 88.000	€ 88.000
+	general construction costs	€ 1.835.000	€ 1.899.000
+	installations	€ 3.826.000	€ 3.826.000
+	immobile interior	€ 314.000	€ 314.000
+	site	€ 111.000	€ 111.000
+	interior and installations	€ 1.553.000	€ 1.553.000
+	additional costs	€ 7.302.000	€ 7.510.000
	total	€ 27.100.000	€ 27.700.000

Figure 2: *Summary investment costs in Parap (TU Delft, Centre of People and Building, 2008)*

From the table above we see that adaptable developments will marginally raise the building costs by 0.6 million euro on a total investment of 20 million euro (exclusive the land costs). This means a 3% increase of the building costs. The land costs are not added to this calculation, as the land price varies strongly between different locations. As part of the total investment costs including the land costs, depending on the location of the building the costs for an adaptable building are even lower than 3% of the total!

REFLECTION AND CONCLUSIONS

The adaptability of office buildings is determined by the buildings structure and separation of the different layers like façade and installations. Separate layers increase the possibilities for future adaptations. Decision making related to the choice of residential transformation or the type of housing should take place in the future at the time that the circumstances require such a decision. Anticipating on the directions of these decisions or the economical conditions leading to these necessities should be kept to a minimum, but creating opportunities enabling adjustments and adaptations for reasonable costs give an added value to the 'asset'. The marginal increase of the investment costs should in the initial decision making be related to the whole life costs of the project due to the possible life span expansions.

Adaptability will not have a high influence on the building costs; only minor costs for adapting the single corridor type and adaptability of the central core type does not imply extra costs. However, developing adaptable buildings only makes sense if located in a location where functional adaptation is possible, thus in dynamic mixed-use locations. These are the locations already described by Jacobs in the 1960s and that Brand also opted for by stating: 'You cannot predict or control adaptability. All you can do is make room for it' (Brand,1994).

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