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The Digital Dormer – Applying for Building Permits Online

J.P. van Leeuwen & A.J. Jessurun
Eindhoven University of Technology, Department of Architecture, Building, and Planning

E. de Wit
Municipality of Rotterdam, Department for Urban Planning, Housing, and Traffic

ABSTRACT: This paper discusses the objectives, functionality, and implementation of a tool that supports the online application for building permits for dormers. Using the simple interaction of this tool, civilians can design a dormer on their house and receive feedback on the necessity to request a building permit for the dormer. The tool also provides feedback on whether or not the design of the dormer passes the criteria that are posed by national and local authorities regarding the aesthetical aspects of dormers. The paper concludes with a discussion of future developments of this project as well as its impact for the innovation of civil administration.

1 INTRODUCTION

The municipality of Rotterdam yearly receives around 2,500 applications for building permits. Approximately 1,000 of these concern larger construction projects of new buildings, such as office buildings, housing projects, and single private houses. The other 1,500 permits are requested for smaller projects, mostly for extensions and modifications to houses. Of these, around 300 projects involve the extension of houses by placement of dormers. The construction-costs of these dormers vary between € 2,500 and € 35,000.

The licensing procedure for dormers is relatively straight forward, compared to that of most other building permits. The variety and complexity of this kind of constructions is limited and the regulations for approval are strictly defined by most municipalities. This offers an opportunity for automation of the process, from which we can learn to later address other, more complex, projects as well.

An example of how governmental services can be made available online, mainly by providing structured information to civilians and offering tools for the support of the application process, is found in the UK (Planningportal, 2004).

The objective of the project described in this paper is to ease both processes of applying for permits and granting permits for the construction of dormers. This is achieved by the development of a web-based tool, called the Digital Dormer, that allows civilians to 'design' the dormer on their house and to submit the information that is required to perform automatic checking with national as well as local regulations. Ultimately, the tool also generates all documents (forms and technical drawings) that are necessary to submit an online building permit application for the dormer.

Research on building codes checking already has some history. Acknowledging that the main problem is not just in formalising the building codes, but in unambiguously describing the building information, much effort has been targeted at standardisation of building models, e.g. (Vanier, 1995). More recently, other approaches have been developed that take advantage of more flexible technologies (Woodbury et al., 2000; Tang and Xiang, 2001).

While dormers as the targeted kind of construction work are relatively small, the technological challenges in developing the software for this tool are significant and the potential impact on further automation support of public procedures is considerable.

The main technological challenges for developing the required functionality in this project were:

- to offer sufficiently simple 'graphical design' tools for use by lay persons, with a good balance between the realism of the representation and the level of user-interaction required;
- to provide an attractive and informative feedback system that acquires all information from the user that is necessary to evaluate the design using criteria from zoning plans as

well as from the local policy on building aesthetics;
- to perform the checking of both geometrical and non-geometrical criteria regarding the position, size, and other characteristics of dormers with respect to the specific context of the house and its location.

Additionally, important requirements for the application were:
- to minimize the requirements of client-side software to what can be expected at people's homes: just a web browser;
- to have a flexible software architecture to be able to vary the context in which the software will be applied, regarding the type of houses and dormers and the contents of the criteria.

The paper describes how these challenges were countered in the developed application. It describes the functionality of the system which provides: parameterised stereotypes of houses and dormers; a graphical engine for dynamically rendering the visual feedback; code checking functionality; and a web application that provides interfaces for the users' activities.

The paper then discusses the further development of the system and concludes with a discussion of the potential impacts of this project.

First, however, we will briefly discuss the regulations concerning building permits for dormers in the Netherlands.

2 BUILDING PERMITS FOR DORMERS

The regulations concerning building permits for dormers in the Netherlands are established on both national and municipal level. At the national level, there are regulations by the Dutch Ministry of Housing (VROM) that state when a dormer can be build without applying for a building permit. This largely depends on a number of geometrical criteria for location and measurements of the dormer, and on the status of the existing building as a registered monument.

If the particular situation does not fulfil the criteria of these regulations, a building permit must be requested from the local municipality.

The local municipality will evaluate the building permit application on three aspects:

1. Zoning plan: does the spatial profile of the area in which the dwelling is situated allow the extension of the built space with this dormer;
2. Construction law: these are the building codes related to structural safety and, e.g., energy performance. Which of these codes apply depends on the type of permit that is necessary. Municipalities generally distinguish light permits (structural safety only) from regular permits, where the latter are required for larger construction plans;
3. Aesthetical aspects: The municipal aesthetics committee assesses applications on aesthetical aspects. Their working methods are generally laid out in a local aesthetics policy note. As of 1 July 2004, municipalities are by law obliged to provide this policy note. While these notes are the responsibility of municipalities, the Dutch Ministry of Housing aims to have these municipal notes as unambiguous as possible, in order to ensure equality of rights (VROM, 2004).
   The aesthetics policy note for Rotterdam is published in (Gemeente Rotterdam, 2003).

The project described in this paper addresses the automatic checking of the national regulations and of aspects 1 and 3 of the local regulations above. Building codes regarding technical issues are not automatically checked at this stage.

2.1 *Procedure of evaluation*

The procedure of evaluation of the building permit application is driven by the aforementioned criteria. The outcome of the evaluation of the criteria can be summarised in the following schema, which states the consequences of satisfying and not satisfying the criteria at the national and municipal level. It should be noted that the evaluation of the municipal criteria merely functions as an *indication* for the eventual outcome of the committee's assessment of the application. If these criteria are not satisfied, the normal procedure for building permits is followed.

	Satisfied	*Not Satisfied*
National criteria	No building permit required.	Building permit required.
Municipal criteria	Building permit likely to be granted.	Building Permit not sure.

2.2 *Criteria for dormers*

The criteria for the building permits for dormers mainly comprise the following types:
- Geometrical criteria. These relate to the dimensions of the dormer and its location on the roof. An example of these criteria is:
  "The distance from the side of the dormer to the edge of the roof is at least 0.5m; if the house is next to a public green space or road, this distance is at least 2m."

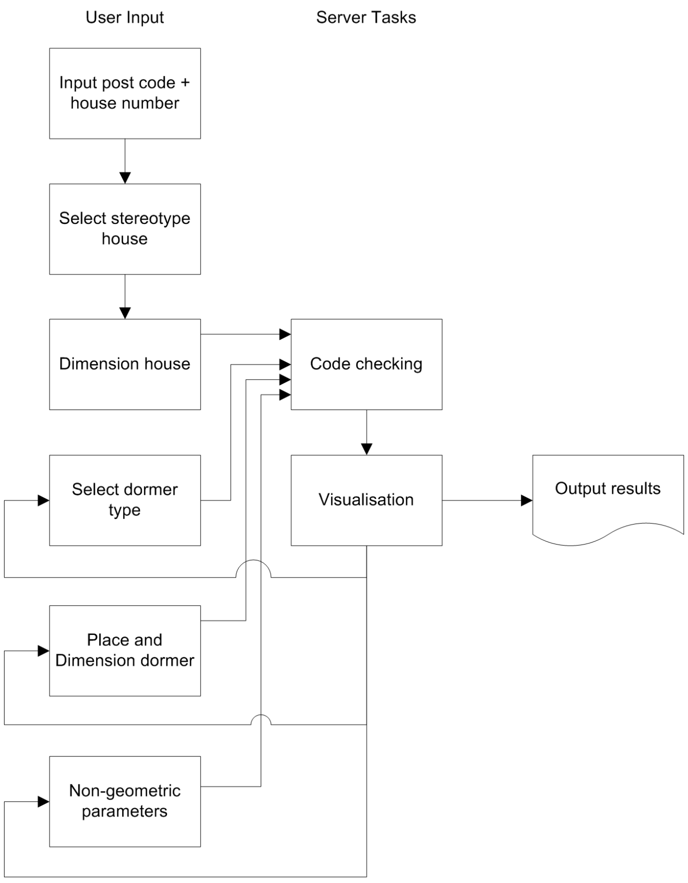


Figure 2. General flow of the dormer design process: six steps of user input integrated with two main server tasks.

- Design criteria: These relate to the shape of the dormer and, e.g., the design of its front.
- Material usage.
- Colour usage.

3 FUNCTIONALITY OF THE TOOL

The description of the functionality of the Digital Dormer website in this section is related to the general flow of the dormer design process (see Figure 2) that is offered to the user in six major steps. These steps are represented in the site's menu and the background process for these steps is integrated with the two main server tasks for code checking and visualisation of the house and dormer.

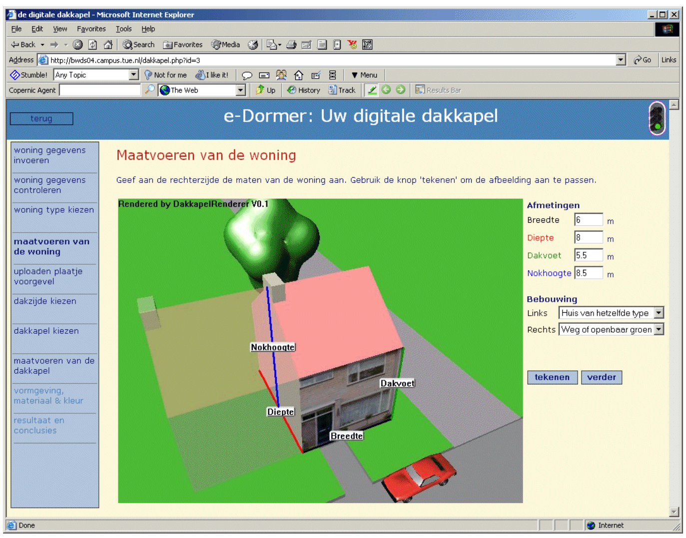


Figure 1. User interface for dimensioning the house.

3.1 *Selection of criteria by postal code*

The user enters the postal code and house number of his address. This information is used to verify the address and to select which local aesthetics criteria are applicable. Additional information regarding the nature of dwelling is asked, in order to perform the first checks with the national regulations on building permits for dormers. In case the building is registered as a monument, a building permit must always be applied for.

3.2 *Selection of stereotype house*

The design process in the application is based on stereotypes of houses and dormers, where the house stereotypes in fact concern roof types. There have been two reasons for this decision. One is that reduction of the design space, and thus simplification of the otherwise complex process, can be achieved this way. A justification for this is that 80% of the house stock can be covered with around 7 stereotypes.

A second reason is that the criteria for dormers are based on a number of variant roof types. It thus appeared logical to use these roof types as point of departure.

The stereotypes are represented by parameterised geometric models. After the user has selected his type of house, he can proceed to input the various dimensions for it.

3.3 *Dimensioning the house*

The number of parameters of the geometry of the house is reduced to the minimum that is required to perform the code checking. In the case of the most simple roof type, these parameters are:

1. Width and length of the house;
2. Height to the ridge and height to the base of the roof.

Figure 1 shows the user interface for entering these parameters. The image of the house is dynamically updated when changes to the dimensions are submitted.

In addition to the geometric parameters, there are two parameters that specify the usage of the neighbouring ground to the house. For either side, the user can indicate whether or not there is a connecting house or a green space or public road. These parameters also influence the applicability of the criteria, e.g. the minimum distance between the side of the dormer and the edge of the roof.

3.4 *Selection, location, and dimensioning of the dormer*

Similarly, the type of dormer and the values for its geometrical parameter must be specified. In addition, the user must indicate on which surface of the roof the dormer will be located.

At this point, a number of criteria are again checked. At the national level it is established that dormers located at the front side of the house cannot be built without a permit. The dimensions of the dormer and, in particular, the distances from the boundary of the dormer to the edges of the roof are bound by criteria at national and municipal level.

The code checking is performed at the background, on the basis of the value of parameters, but feedback to the user is presented directly in the interface. For details of the code checking, see section 3.6 and section 4.4.

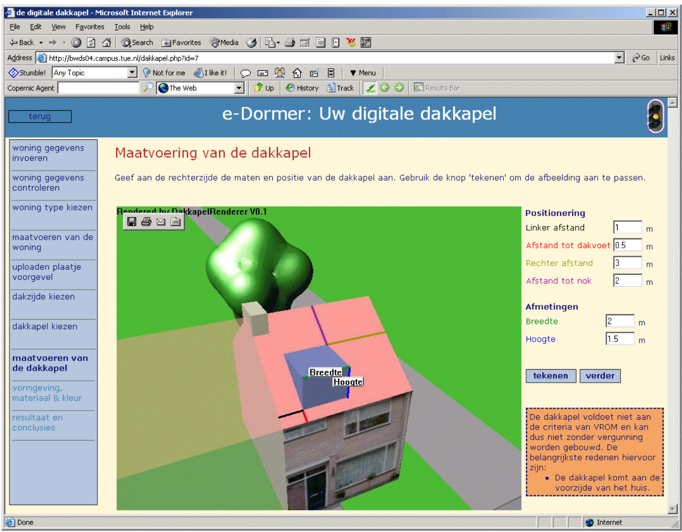


Figure 3. Dimensioning and positioning the dormer.

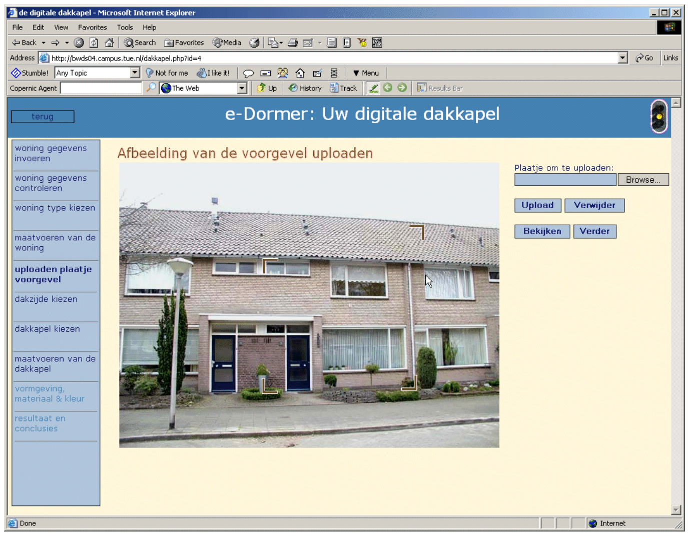


Figure 4. Cutting out the elevation from the photograph.

3.5 *Visualisation of house and dormer*

As shown in Figure 1 and 3, the actual state of the design is shown in a graphical representation of the parametric geometry. These are still image renderings of the 3D model, which can be easily incorporated into the application's website, without any requirements for client-side applications. In the configuration of the system, various camera viewpoints can be configured.

An additional feature of the system is that the user can upload a digital photograph of the front elevation of the house, which will then be used as a texture on the 3D model as shown in Figure 3. The portion of the photograph that contains the elevation is cut out by the user through a very simple point and click method, shown in Figure 4. The red corners are positioned according to the nearest mouse-clicks on the image.

3.6 *Code checking*

The application performs three types of code checking procedures. These procedures take place at server-side, invisible to the user, but feedback to the user is given at each relevant stage in the process.

1. Basic test.
   This is a geometrical check of the user's input. It checks the logical correctness of sizes. Examples are: all sizes > 0, height to roof-base < height to ridge, width of dormer < width of house, etc.
2. VROM test.
   This is a combination of geometric and non-geometric criteria that establish the necessity for a building permit at the national level.

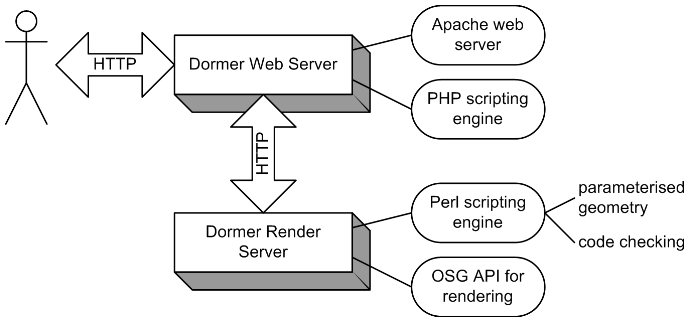


Figure 5. System Architecture.

3. Aesthetics test.
   This comprises the criteria used by the municipal aesthetics committee, a set of criteria comparable to, but more elaborated than, the VROM criteria. If these criteria are satisfied, the committee is likely to support the granting of a permit.

These three checking procedures are logically dependent as shown in Table 1. In the application's interface, visual feedback is given with respect to the status of the code checking, by way of a traffic light in the upper right corner. The table shows the meaning of the various lights.

4 IMPLEMENTATION ISSUES

4.1 *Modules of the system*

The system was designed as two communicating server applications.

1. The Dormer Render Server (DRS) is an internal process that contains the procedures regarding the parameterised geometry, produces the graphics of the requested geometry, and performs the code checking.
2. The Dormer Web Application (DWA) is a web application that generates the necessary web pages and processes the related requests for the interaction with the user.

These two applications communicate internally with XML formatted data and using the HTTP protocol in order to share the requested and generated data (see Figure 5).

4.2 *Technical approach*

The DRS application is a server application that accepts HTTP requests to perform two tasks:

1. Requests to render graphical images of the house and dormer geometry;
2. Requests to perform the checking of the three kinds of criteria.

The implementation of this application involves two modules. The Open Scene Graph rendering library is used to generate the images. A Perl scripting engine is used to generate the geometry for the OSG calls, and to perform the code checking.

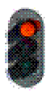
The DWA application is built upon an Apache web server and utlises PHP script to dynamically generate and handle the user interface.

The development of the system was mainly done using the following software tools and technologies.

- Microsoft's Windows 2000 Server operating system;
- Apache web server with PHP programming environment;
- XML data format for exchange between the two applications;
- Autodesk's 3D Studio Max for the generation of the basis geometries;
- Open Scene Graph for the production of the graphical representations;
- Perl script environment for the parameterisation of the geometries;
- Microsoft's Visual Studio 2003 for development of the DRS application.

While the objective of the project is to utilise only open source software and open standards, commercial software was utilised only for the development of the applications. The resulting applications can operate on an open source basis.

Table 1. Three types of test with interdependencies and visual feedback.

	when performed?	*if satisfied, then*	*if not satisfied, then*
Basic test	always	input is logically correct	 (blinking orange light) logical error in user input
VROM test	if basic test satisfied	building permit is not required 	 building permit is required
Aesthetics test	if VROM test *not* satisfied (a permit is required)	aesthetics committee is likely to agree 	 approval of aesthetics committee is not sure, at this stage the normal procedure for building permit application is followed.

4.3 *Parametric geometry*

The parametric geometry for the house and dormer types is generated from a geometric basis created in 3D Studio Max. Including its textures and light sources, this geometry can be exported using a plug-in for the production of Open Scene Graph files. This plug-in was enhanced for the purpose of this project to export a Perl script that contains a version of the geometry that includes labelled vertices. These vertex labels can be added to the geometry in 3D Studio Max by the developer, prior to performing the export. After this Perl script with labelled geometry is produced, it can be manually modified by the developer into a parameterised version, based on the parameters defined for the user interaction.

Besides the Perl script, a configuration file is exported that contains additional data concerning the configuration of the cameras.

4.4 *Digital format of the criteria*

The criteria from the Basic test, the VROM test, and the Aesthetics test were digitally represented in a dedicated XML format. In this format, references are made to the parameters used for the description of the house and dormer types. The criteria are specified within the XML format in the form of Perl expressions that can directly be evaluated by the Perl engine which is a module of the DRS application.

The tests are performed by the DRS application. This application contains an engine that can perform any type of test that is expressed in the defined XML format. The distinction between the three types of tests is not made within this engine. In fact, only the DWA application that sends the requests for testing to the DRS test engine presents the distinction between the three types of test in the textual and visual feedback to the user.

5 FURTHER DEVELOPMENTS

The procedure of applying for a building permit is not completely implemented with the current state of the project. Although much information regarding the dormer design is already acquired from the user at this point, some additional information will be necessary to generate the technical drawings required for the building permit application.

- Section drawing.
  The process of drawing a section of the dormer and roof will be implemented by means of standard details for the construction of dormers. A limited number of such standard details will be produced in parameterised form, representing the types of dormer constructions that are suitable for the various roof construction types. Probably another differentiation will be necessary for ranges of roof slopes. Additional user input that will be required includes the type of roof construction, the height of the floor level, and a floor plan.
- Floor plan.
  A drawing of the modified floor plan will be superimposed on a scanned image of the existing floor plan. Similar to the way the photograph of the elevation is applied as texture to the 3D model, the scanned floor plan can be used to generate the new floor plan from the available 3D geometry. Additional information regarding spatial layout and wall thickness can be obtained from the user either numerically or by graphical interaction with the uploaded scan.
- Administrative forms.
  With simple extensions to the web interface, the information concerning the applicant can be acquired and entered into automatically generated forms that will be used for online application at the municipality. In this context, collaboration in this project will be sought with another national initiative for the implementation of a central server for building permit applications.

Apart from the above-mentioned developments, an inventory of necessary improvements is made and reported for the subsequent stages of this project. Many of these regard the user interface and the enhancement of the feedback of test results. A detailed discussion of these issues is not relevant within the scope of this paper.

6 IMPACT AND UTILISATION

The potential impact and utilisation of the results of this project are manifold. Firstly, the type of technology developed and applied in this project enables civilians to be well informed about the possibilities of their plans without the need to go through lengthy procedures before taking any decisions.

Secondly, the online application for building permits is strongly supported by the tool: information is gathered, checked, and made available to municipalities in a format that is easy to handle. This will reduce the administrative workload related to these relatively low-cost construction works.

Thirdly, the organisational approach that underlies this project makes it possible for municipalities to promote best practices and preferred designs and constructions with respect to dormers. A commercial spin-off of this development could also be achieved by relating the site to a digital market-place for construction companies that specialise in this type of construction works. However, legal issues need to be studied with respect to such direct relationships with commerce.

Finally, while this project deals with permits to build dormers, it is part of a set of initiatives that aims to provide digital support for applying and granting building permits in general. As such, the Digital Dormer project functions as a pilot project in the context of the aforementioned initiative for a central server for building permits that centralises the communication between civilians and their municipalities regarding building activities. While these developments are still in preliminary phase, the Dutch Ministry of Spatial Planning, Housing and the Environment (VROM) has already expressed strong interests in these projects.

The Digital Dormer website will in the near future be made available to municipalities and civilians, probably under the management of a foundation. Municipalities will have access to tools that enable the specification of their local criteria. Civilians will have access to evaluate their plans and, with minimal costs, to apply for the permit if necessary.

Extrapolation of the concepts developed in this project, with respect to other kinds of building permits or even other kinds of civil services, may seem obvious but must be considered with caution. Much of the success of this project relies on the ability to express building information in parametric form. Whether this success can also be achieved in other circumstances remains to be proven. Also, a broad social discussion should lead to an indication of the limits to automating design and design evaluation processes. Although the authors believe that the increased responsibility and active participation of civilians in the development and design of our built environment are strongly desirable, the value of expert knowledge and experience must not be trivialised.

7 ACKNOWLEDGEMENTS

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8 REFERENCES

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http://www.vrom.nl/international (in English)
http://www.vrom.nl/woningwet (in Dutch)
http://www.vrom.nl/bouwvergunningen_online (in Dutch)
http://vrom.nl/bouwbesluit_online (in Dutch)

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Information regarding the open source software used in this project can be found here:

OpenSceneGraph: http://openscenegraph.sourceforge.net/
Perl: http://www.perl.com/
ActivePerl: http://www.activestate.com/Products/ActivePerl/
Apache Webserver: http://www.apache.org/
PHP: http://www.php.net/