National Standard Details Library – An Electronic Library of Parametric CAD Details

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ABSTRACT: This paper describes the development of a demonstrator library of parameterised standard CAD Details on the Internet. The library (National Standard Details Library) has been developed as part of a PII project funded by DETR (UK). The aim of the project has been to develop a framework for the development of standard CAD details for specific areas within the construction industry and to develop a prototype electronic library of parametric details that could be accessible from a number of different CAD applications. The paper discusses the issues arising from the development of such a system and the impact it could have on standards and best practice in the development and use of CAD details.

1 INTRODUCTION

Standard details represent those parts of engineering or architectural drawings that are often re-used. A number of standard details exist in organizations such as local authorities, supermarket chains, food outlet chains, and other organizations where building facilities are built repetitively. The details range from roads, drainage, sewer and other facilities. Most of these details are paper based and only a few are in electronic form. The details that are available in electronic form were developed for specific CAD applications are and not usually parameterised. These organizations would therefore benefit from a standard collection of details that can be re-used without having to be redrawn, saving on effort as well ensuring consistent quality.

There are no national standards governing the development of these details in a way that makes them reusable across different organizations. However there are a few guidelines for the development of CAD details in some sectors. For example, for sewer drainage details in the UK there is 'Sewers For Adoption' [WSA/WRc, 1995] and 'Drainage Details' [Leslie Woolley,1988] among others. In addition there is a British standard that specifies minimum access requirements to drainage facilities [BS, 1997]. There are CAD layering standards such as BS 1192 [BSI, 1998] in the UK and the AIA CAD layering guide [Scheley et al 1997] in the USA. These standards represent high level guidelines that are not sufficiently detailed to provide specific guidance to the layering of CAD details. The CAD Good Practice Guide [Ove Arup Partners, 1994], based on BS 1192 is quite detailed in as far as building construction is concerned but not particularly detailed for civil engineering facilities. Despite the limited usefulness of CAD layering guidelines in this context there is a basis for the development of standard details.

The ideal CAD detail library would be a central library with Internet access to cater for geographically dispersed clients. This would have the additional benefits of ease of maintenance of the details.

One of the main problems is that of the formats in which the details may be delivered to the users. While it is possible to develop a central library there are many different CAD tools supporting different file formats. A number of CAD vendors produce CAD object libraries, but these are developed for specific CAD applications. There are proprietary file formats such as Autodesk's DXF that are currently widely used. There are also industry standard neutral file formats such as IGES. In the STEP community there is ISO 10303 [ISO, 1994] for the exchange of product information and Part-Lib [ISO, 1998] for the exchange of parametric product data. Defining the details in a neutral file format would be the ideal solution.

The other problem is that it is impossible to cater for all the possible dimensional permutations and combinations by using static CAD details. Developing the details as parametric details appears to be the ideal solution. The benefits of using parametric include:

- A few details can be used to cater for a wide range of dimensions.
- The details can be better managed and maintained.

2 SYSTEM ARCHITECTURE

2.1 Motivation

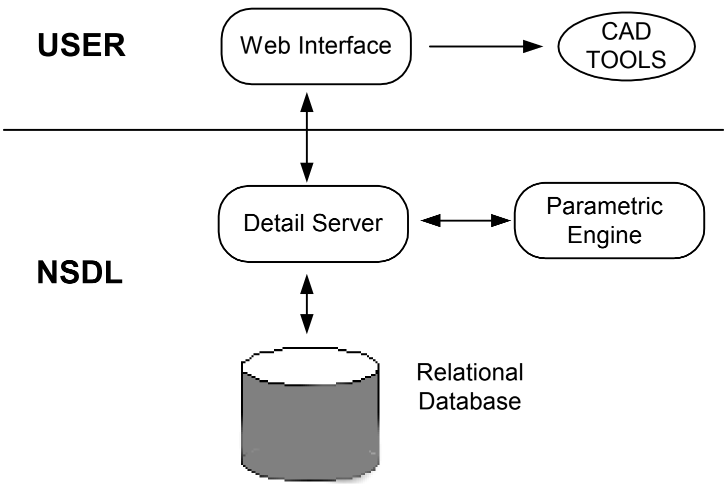
There are not many CAD applications that support parametric features and for those that do, there is no common file support for parametric features. Since only a few A/E/C CAD applications support parametric features the motivation behind the architecture of the developed system has been to develop a parametric CAD library for use with non-parametric CAD applications. This meant developing the parametric capability on the server side.

The problem with relying on common denominator file formats such as DXF is that it is possible that some information may be lost during the conversion between native representations of the applications and the DXF. Therefore to maintain the quality of the details, supporting as many native file formats as possible was considered the best option.

2.2 Overview of Architecture

The prototype National Standard Details Library [URL1] comprises a relational database, a parametric CAD Engine, a Detail Server and a Web Interface as shown in Figure 1. In this system CAD details pre-generated by a parametric CAD system are loaded into a database. The Detail Server handles the interaction between the user interface and the database. In the event that the detail meeting the requirements is not available in the database, the server loads a detail that closely matches the dimensions into the parametric engine to modify the detail to the required dimensions. The browser is used for capturing user input and displaying results. The CAD details can be previewed as DWF files, and downloadable in a number of file formats.

Figure 1: Architecture of the NSDL system



2.3 Detail Server

The Detail Server processes the parameters from the user interface, queries the database and formats the results from the database for display in the user interface. However for each object type there are only a few parametric details to cover a wide range of dimensions. In the event that the detail of the required dimension does not exist in the database, the Server retrieves a CAD detail of the closest dimensions, loads the detail into the Parametric Engine, which modifies the detail to the required dimensions and returns the detail to the interface.

2.4 Parametric Engine

Intergraph's Imagineer Technical release 2.0 was used as the server side parametric engine. Its features include a lightweight parametric engine that can used over the web with relatively low overhead, and a comprehensive ActiveX interface that lends itself well to automation.

Developing a parametric CAD detail involves establishing relationships between connected parts of the detail. Once developed, the detail's dimensions can be driven by a few key parameters using VBA or ASP scripts. In this system the key dimensions specified by the user are passed to the parametric engine, which in turn modifies the loaded detail to the required dimensions.

2.5 Database

The database used is a relational database of attributes that define the detail. For example, parameters required for driving the dimensions of a manhole detail are height, diameter of the largest pipe entering or leaving the manhole and the manhole type. The table in Figure 2 lists the key parameters required to drive the dimensions of a manhole parametric detail.

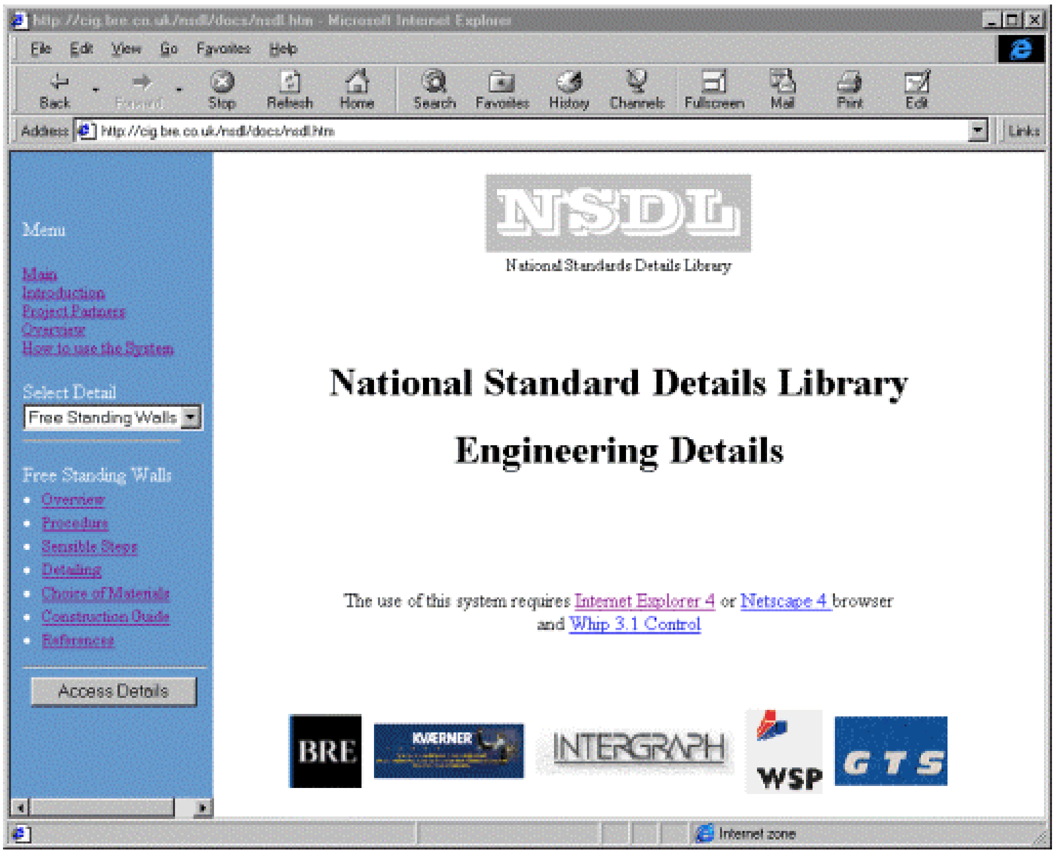
Figure 2: Database table definition for manhole parameters

Field Name	Data Type	Description
ID	Number	Detail ID
Manhole_type	Text	Manhole sub type
Height	Number	Overall height of the manhole
Pipe_diameter	Number	Pipe diameter of the largest pipe leaving a manhole
file_name	Text	File name of the base detail
Location	Text	The URL of the detail
Description	Text	Textual description of the detail

2.6 Web Interface

The web browser provides the user interface. It captures the user input and displays the returned CAD detail in DWF format. The entry point for the NSDL system is shown in Figure 3. It provides access to general information about the system, a listing of the CAD details available in the system and corresponding detailed information of the CAD details. The detailed information includes descriptions of the CAD detail, how the detail is used, the construction methods where available, and links to other supporting documentation. The interface displays the returned CAD details as well as links to the detail in other formats.

Figure 3: Main screen of the NSDL system

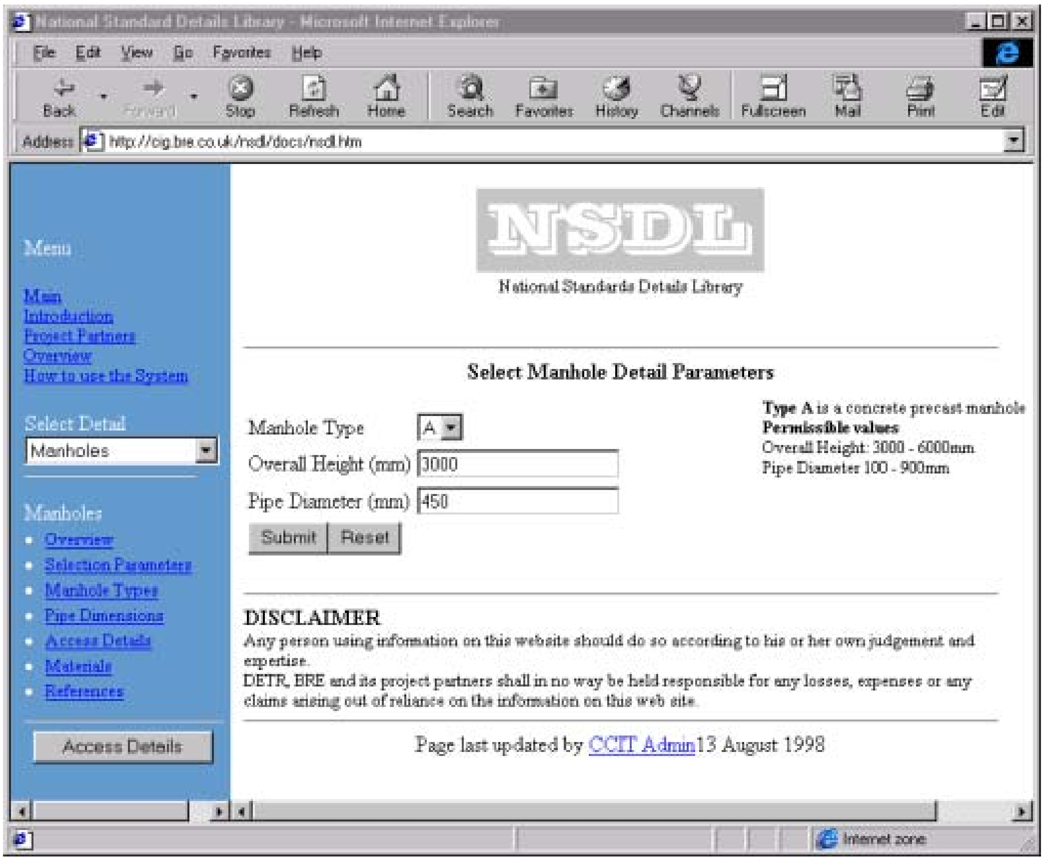


3 USING THE LIBRARY

3.1 Selecting CAD Detail Parameters

On selecting a detail category (see Figure 3), the parameter selection screen for the detail appears (see Figure 4). On specifying the parameters, the system validates the input before submitting the parameters to the Detail Server.

Figure 4: A screen showing parameter selection of a manhole detail

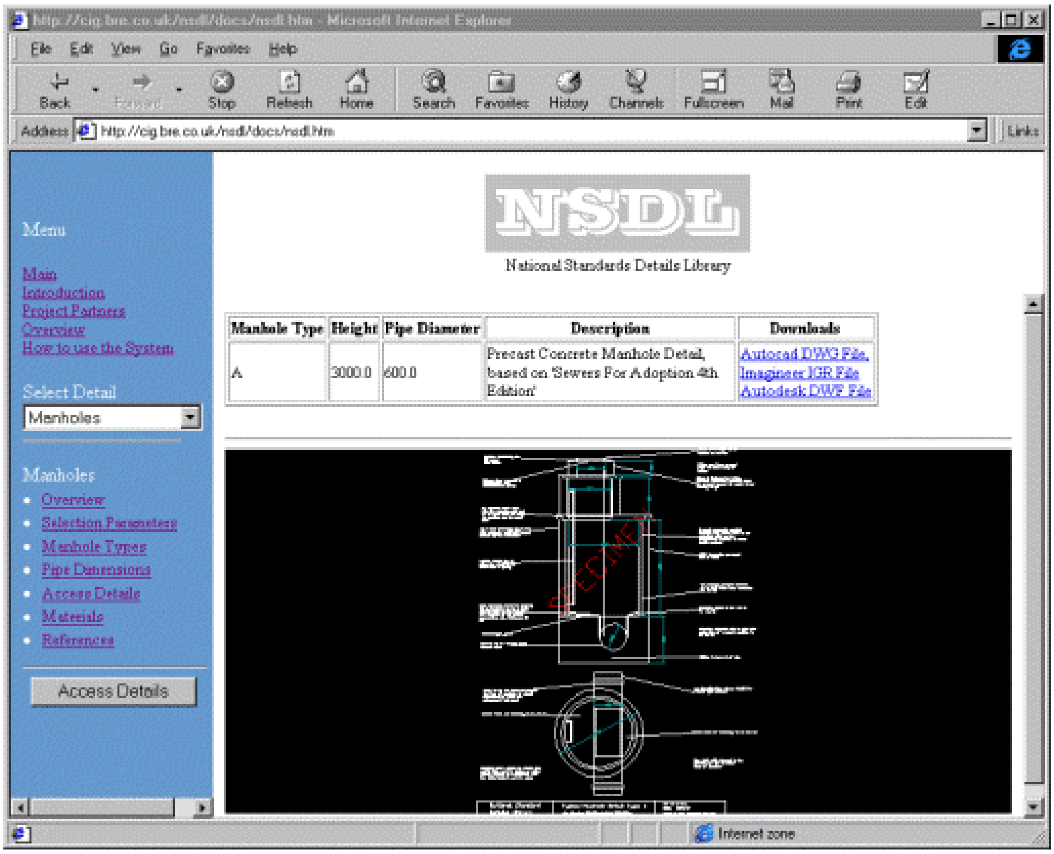


3.2 Viewing and Downloading CAD Details

On submitting the parameters, the server returns a screen with a display of the detail in DWF format (the web enabled version of the DWG format), a listing of parameters of the detail and links to the detail in other file formats. There is no limit to the file formats that can be supported by the system. However only the most commonly used file formats were supported in this system.

Users require a Whip control (Autodesk's DWF viewer) installed on their computer if they are to be able to view the detail. It is currently available free of charge at http://www.autodesk.com/products/whip/

Figure 5: A typical manhole detail in DWF format.



4 RELATIONSHIP TO OTHER DEVELOPMENTS

The CAD Details produced by this system could be used in conjunction with product data representations such IAI's IFCs, and XML amongst others. With manufactured products, for example, it is generally accepted that the IFC representation of the geometry of manufactured products is not expected to be included in the property sets defining the products owing to the large amount of data required to define the geometry.

The CAD details could be attached to the property sets or explicit classes defining the product, to represent the corresponding geometry. Examples of where it could be used with other data structures include ARROW [Amor and Newnham, 1999] and the IFC Release 2.0 External Product Library Demonstrator [Nyambayo et. al., 2000].

Arrow is a manufactured product access system that defines all manufactured products as explicit class extensions to the IFC model. A manhole CAD detail from the NSDL system could be attached to the 'ArrowManhole' class (defined in the ARROW system) as a document by using the 'ArrowDocument' class.

In the IFC Release 2.0 External Product Library demonstrator the manufactured products are defined as Property Sets. The same manhole CAD detail could be used to represent the manhole product defined as a property set, by using the 'IfcObjectReference' and 'IfcDocumentReference' classes.

Parametric CAD details can be used to ensure that the details attached to the product information conform to the specified dimensions.

5 CONCLUSIONS

The prototype system developed in this project demonstrates how a Internet based National Standard Details Library could be developed and used. The use of parametric CAD details provides a basis for a flexible set of details. This reduces the actual number of details stored in the library which may result in reduced maintenance cost. The use of a server side parametric engine is designed to cater for CAD applications that do not have parametric support.

The potential of such a library is considerable providing that a comprehensive set of commercial quality standard details can be developed. However, a considerable amount of effort is required to develop a set of standard CAD details for adoption. This requires an industry wide collaborative effort. But once such a library is established, the maintenance costs are expected to be low. With the harmonisation of standards through the adoption of Euro-codes, the authors believe that there is a potential for developing standard CAD detail libraries that can be used over a wide region.

The authors would like to hear from anyone who might be interested in such an initiative.

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