VIRTUAL REALITY: HUMAN INTERFACE TO PRODUCT DATA

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ABSTRACT: Product models are far too complicated for everyday users to browse or edit without a graphical user interface hiding the complexity of the data structure. Public domain virtual reality browser can be used as an interface to a background application, like ProMoTe, capable of launching other applications like CAD programs, word processors, spread sheets and instance editors. All data linked to an instance can be browsed and edited by simply pointing the instance from the VR model and then selecting preferred operation from a popup menu. This enables editing of data in the model itself and editing of all external files linked instances.

If the product model is accessed through the Internet, VR model provides an ultra light interface to the shared model. When user makes a request to the server, it automatically generates a new VR model according to specifications in the data model. Downloading the generated VR model, user can select the instance he wants to browse. The actual transfer of data is controlled by the background application, which provides all the functionality required for the connection to the server. Also control over downloaded data, including the capability of launching the required applications for linked files, is provided by this background application.

Keywords: Product model, Virtual reality, Concurrent Engineering Environment.

1 INTRODUCTION

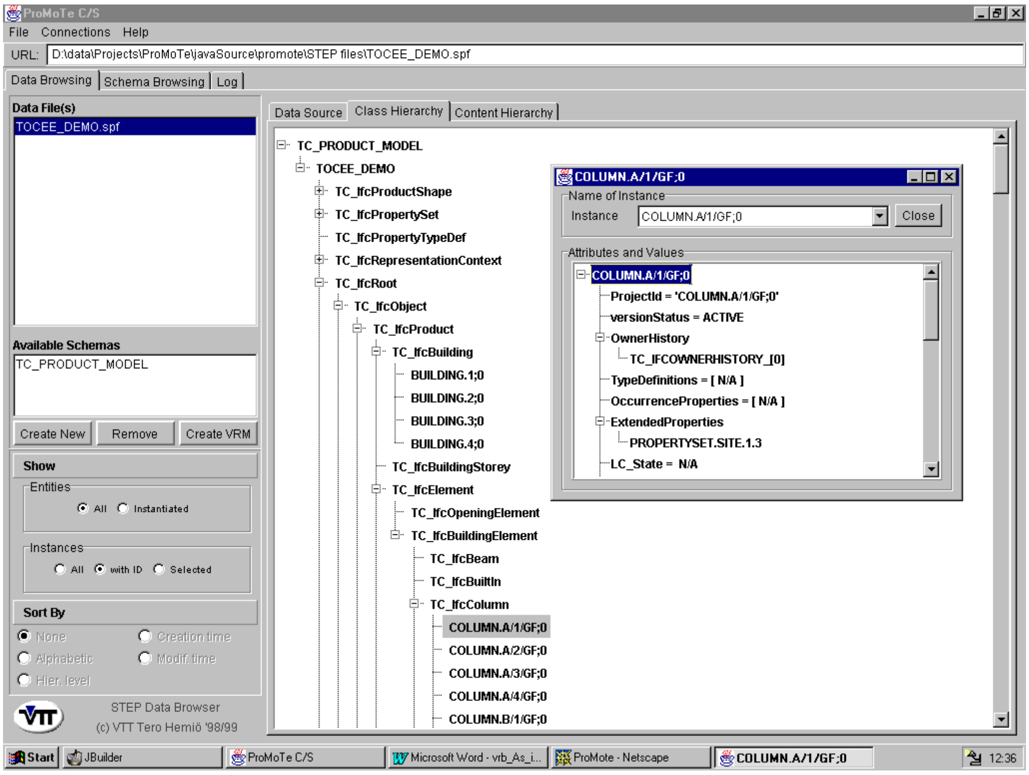
Product data technology (ISO 10303-1 IS 1994) is proliferating in facility management and construction industry. The emerging IFC (Industry Foundation Classes) (IAI 1997) product data model standard driven by International Alliance for Interoperability (IAI) is gaining wide support. The belief that product models are the foundation for information sharing in the future is becoming generally accepted. Data transfer in the future will be based more on sharing than sending.

This paper presents an overview of the solutions used in the implementation of an EXPRESS (ISO 10303-11 IS 1994) schema and STEP (ISO 10303-21 IS 1994) data browser ProMoTe (Product Model Technology). Schema and data browser functionality has been presented by Hemiö T. and Hannus M. 1999, and will not be discussed in this paper. The main interest of this paper is the creation of virtual reality models from product data and especially possibility to use those models as a 3D-user interface to product models and related documents over the Internet.

2 CREATING VIRTUAL REALITY MODELS

2.1 Introduction

In ProMoTe-program the data content is shown as a tree, where the instances of entities are shown as branches of each entity. Class name serves as a title providing an easy access to each individual instance as well as groups of instances. Data can also be shown as a tree created according to the content hierarchy specified in the model itself (Figure 1).



URL: D:\data\Projects\ProMoTe\javaSource\promote\STEP files\TOCEE_DEMO.spf

Data File(s): TOCEE_DEMO.spf

Available Schemas: TC_PRODUCT_MODEL

Show

Entities ● All ○ Instantiated

Instances ○ All ● with ID ○ Selected

Sort By ● None ○ Creation time ○ Alphabetic ○ Modif. time ○ Hier. level

```
TC_PRODUCT_MODEL
  TOCEE_DEMO
    TC_IfcProductShape
    TC_IfcPropertySet
    TC_IfcPropertyTypeDef
    TC_IfcRepresentationContext
    TC_IfcRoot
      TC_IfcObject
        TC_IfcProduct
          TC_IfcBuilding
            BUILDING.1;0
            BUILDING.2;0
            BUILDING.3;0
            BUILDING.4;0
          TC_IfcBuildingStorey
          TC_IfcElement
            TC_IfcOpeningElement
            TC_IfcBuildingElement
              TC_IfcBeam
              TC_IfcBuiltIn
              TC_IfcColumn
                COLUMN.A/1/GF;0
                COLUMN.A/2/GF;0
                COLUMN.A/3/GF;0
                COLUMN.A/4/GF;0
                COLUMN.B/1/GF;0
```

COLUMN.A/1/GF;0

Name of Instance

Instance: COLUMN.A/1/GF;0

Attributes and Values

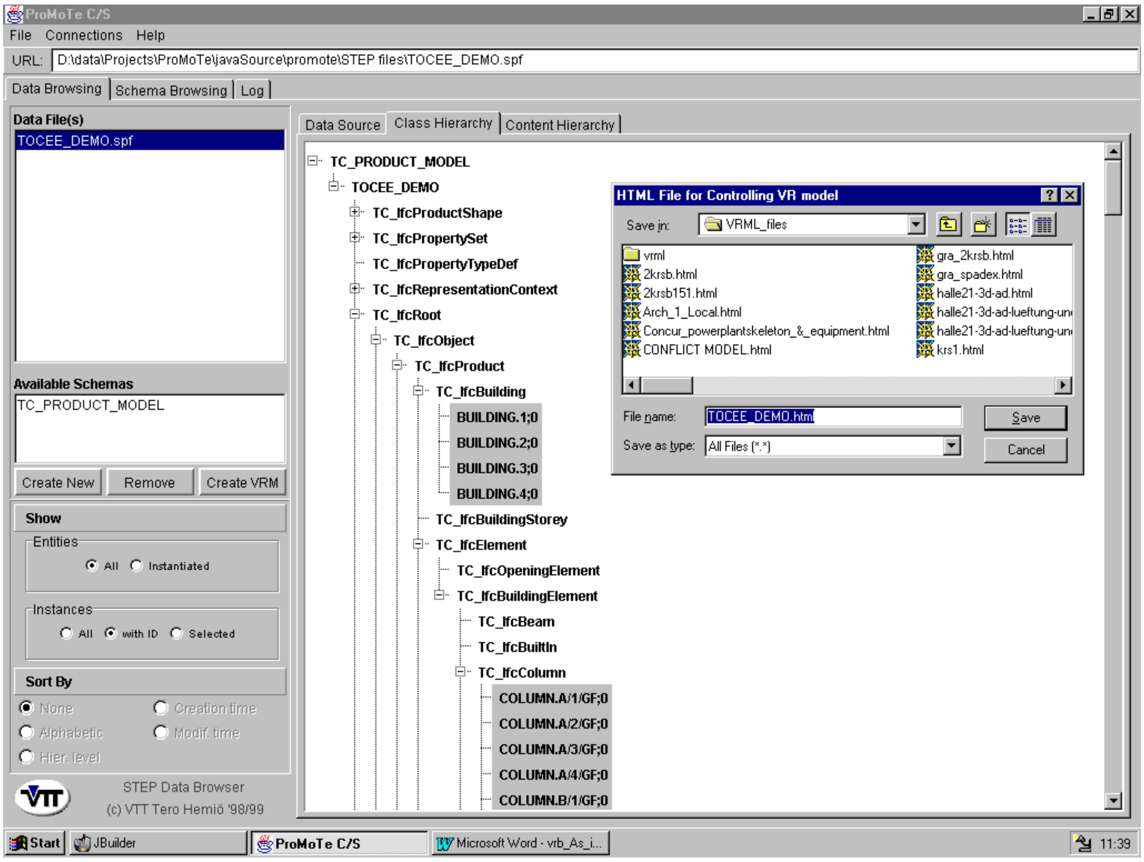
```
COLUMN.A/1/GF;0
  ProjectId = 'COLUMN.A/1/GF;0'
  versionStatus = ACTIVE
  OwnerHistory
    TC_IFCOWNERHISTORY_[0]
  TypeDefinitions = [ N/A ]
  OccurrenceProperties = [ N/A ]
  ExtendedProperties
    PROPERTYSET.SITE.1.3
  LC_State = N/A
```

Figure 1: Studying attributes of selected instance using ProMoTe-browser

2.2 Creating Virtual Reality Models

ProMoTe browser can create a VRML-files according to VRML97 (VRML97 1997) specification. Generated model can be viewed with public domain Virtual Reality Browsers (VRB) like Cosmo player. VR-models can be created from the models in the local computer or through the web from ProMoTe-server. Creation of VRML-files is schema dependent so pre-named methods have to be specified for each product data model to be able to create VRML-files.

VR-model can be created from the whole model or from only a part of it. Also VR-models referencing to each other can be created. Content hierarchy specified in the model can be used for this purpose. This makes it possible for the user to specify different kind of hierarchical VR-models for different kind of purposes in the project.



URL: D:\data\Projects\ProMoTe\javaSource\promote\STEP files\TOCEE_DEMO.spf

Save in: VRML_files

File name: TOCEE_DEMO.html

Save as type: All Files (*.*)

Figure 2: Creating VRML- model from selected instances using ProMoTe

When creating the vrml-file actually two files are generated. The other one is the actual vrml-file containing the specification of the model it self in vrml-format. The other one is html-file connecting the ProMoTe-applet and the VR-browser together. Html-file is also used to transfer some parameters to ProMoTe-applet. Example of this kind of html-file is shown below (Table 1).

In the actual vrml-file prototype-concept is used handle all instances. Values of attributes for one instance (“COLUMN.A/1/GF;0”) are shown in the example listing below (Table 2).

3 USING VIRTUAL REALITY BROWSER AS AN INTERFACE TO PRODUCT DATA

3.1 Introduction

A VRB can be used as an interface to product data, enabling selection of instances and triggering specified methods. In our case the public domain VRB Cosmo player was chosen as the graphical user interface (GUI). VRB is embedded in HTML-file with ProMoTe-VR applet, which enables connection from VRB back to ProMoTe via a socket. Values of attributes of instances can be viewed as well as documents linked to instances as if the instance was selected from the ProMoTe program itself.

Table 1: Example of html-file created by ProMoTe to connect VR-browser and ProMoTe-VR applet

```
<HTML>
<HEAD>
<TITLE> ProMote </TITLE>
</HEAD>
<BODY BGCOLOR=SILVER>
<CENTER>
<TABLE>
<TR>
<TD>
<CENTER>
<HR>
<H1>ProMoTe</H1>
<HR>
</CENTER>
<APPLET
 CODEBASE= "file:///D:/promote/Settings"
 ARCHIVE  = "PromoteVRML.jar"
 CODE     = "PromoteVRML.class"
 WIDTH    = 130
 HEIGHT   = 300
 HSPACE   = 0
 VSPACE   = 0
 MAYSCRIPT>
<PARAM NAME = "modelName" VALUE = "TOCEE_DEMO">
<PARAM NAME = "conflict00" VALUE = "CONFLICT">
<PARAM NAME = "conflict01" VALUE = "ROOFSLAB.B/1">
<PARAM NAME = "VersionNumber" VALUE = "1">
<PARAM NAME = "lastDay" VALUE = 30>
</APPLET>
<HR>
<FONT SIZE = 2>
Mika Salonen<BR>
Tero Hemiö</FONT><P>
<IMG SRC =
"file:///D:/promote/settings/vttlogo.gi
f">
</TD>
<TD>
<EMBED SRC = "vrml/TOCEE_DEMO.wrl"
 BORDER    = 0
 HEIGHT    = 560
 WIDTH     = 850>
</TD>
</TR>
</TABLE>
</CENTER>
</BODY>
</HTML>
```

Table 2: Specification of one column instance in vrml-file.

```
Group {  #'COLUMN.A/1/GF;0'
      children [
        DEF S2_SWITCH Switch {
          whichChoice 0
          choice [
            Group {
              children [
                Group {
                  children [
                    DEF T2_1_TOUCH TouchSensor {},
                    DEF P2_1_PROMOTE Promote {
                      fTranslation 0.2 0.2 1.4
                      rotation1 0.0 0.0 1.0 0.0
                      rotation2 -0.0 1.0 0.0 -1.5707963267948966
                      rotation3 6.123031769111886E-17 0.0 -1.0 -1.5707963267948966
                      fSize 2.8 0.4 0.4
                      fMaterial USE TC_IFCCOLUMN_MATER
                      labelOut "COLUMN.A/1/GF;0"
                      label "COLUMN.A/1/GF;0"
                      firstDay 1
                      lastDay 30
                      version 1
                    }
                  ]
                }
              ]
            }
          ]
        }
      ]
}
```

The ProMoTe-VR applet takes over the control of VRB, so properties of instances in VR-model can be changed using the applet. This enables turning on and off a specified instance or changing the colour of it. For example in visualisation of construction schedule instance hiding can be used to simulate construction of the building day by day. Changing the colour can be used to highlight instances, which are in a conflict, or to visualise changes in the model by showing different versions of instances in different colours.

3.2 Connection from virtual reality browser to ProMoTe

After the VRML-file and corresponding html-file have been generated, ProMoTe launches web-browser using the file name of the html-file as an argument. This html-file specifies the VRML-file to be used in VRB and also the location of the ProMoTe-VR applet to be embedded. ProMoTe-client is listening a specified port into which ProMoTe-VR applet creates a socket. This socket is used to transfer information between the ProMoTe-VR applet and ProMoTe program.

When an instance is selected from the VR-model and the show button is pressed, the id of the selected instance is sent to ProMoTe-browser. ProMoTe responses just the same way as if the instance was selected from the instance tree. Same methods are provided to the user, so the VR-browser operates just as an interface to ProMoTe enabling all the same functionality which can be used directly from ProMoTe.

3.3 Provided functionality

3.3.1 Selecting items

VR-browser provides methods for selecting only one item at the time. This restriction can be work out by providing a list of selected instances in the ProMoTe-VR applet. Cad-program like box-selection is not supported in the VR-browsers at moment.

3.3.2 Browsing the values of attributes of selected instance

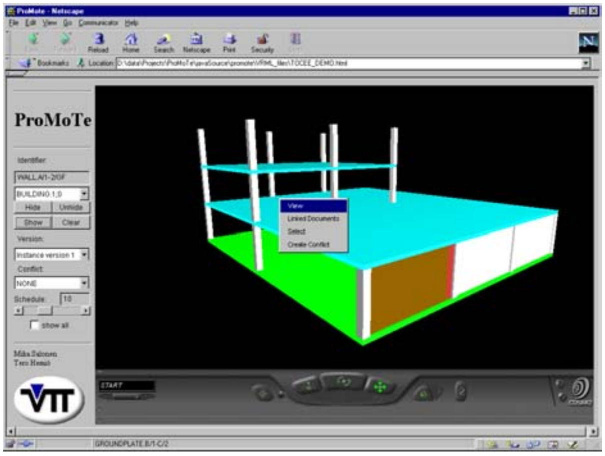
After the instance from the model has been selected and show button has been pressed a pop-up menu appear giving the user a selection of methods, which can be used. If "view" is selected (Figure 3) a window appears showing the attributes of selected instance (Figure 4). Values of attributes can be browsed in a tree like representation. Names of attributes are shown as branches of the selected instance and the values of attributes are shown as branches of the attribute names. If the value is a reference to other instance, the value can be browsed recursively.

3.3.3 Linking documents

Documents (files) can be linked to selected instances by selecting a document-file and specifying the application, which should be launched to view it. A document server is used to keep track of the documents and links to objects (Figure 5).

3.3.4 Highlighting items

Item can be highlighted simply by changing properties of it in the model. All properties of instances in VR-model can be changed runtime, so no reloading of the model is required. VRB takes care of all the operations required to show the updated model correctly. Highlighting can be used to visualise instances that have been changed or otherwise need attention. Specific models can be used to store information about the changes and possible conflicts in the model.


ProMote - Netscape
File Edit View Go Communicator Help
Reload Home Search Netscape Print Security
Bookmarks Location: D:\data\Projects\ProMoTe\javaSource\promote\VRML_files\TOCEE_DEMO.html
ProMoTe
Identifier:
Hide Unhide
Show Clear
Version:
Conflict:
Schedule:
show all
View
Linked Documents
Select
Create Conflict
START
VTT

Identifier: WALL.A/1-2/GF

BUILDING.1,0

Version: Instance version 1

Conflict: NONE

Schedule: 10

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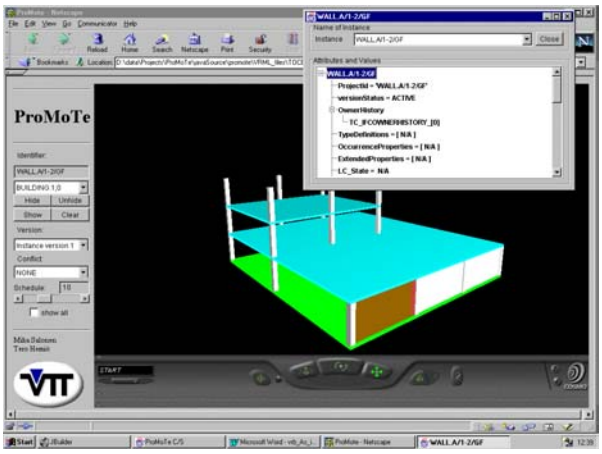
GROUNDPLATE.B/1-C/2

Figure 3: Pop-up menu for selecting the desired function



Instance: WALL.A/1-2/GF

WALL.A/1-2/GF
- ProjectId = 'WALL.A/1-2/GF'
- versionStatus = ACTIVE
- OwnerHistory
  - TC_IFCOWNERHISTORY_[0]
- TypeDefinitions = [N/A]
- OccurrenceProperties = [N/A]
- ExtendedProperties = [N/A]
- LC_State = N/A

Identifier: WALL.A/1-2/GF

BUILDING.1,0

Version: Instance version 1

Conflict: NONE

Schedule: 10

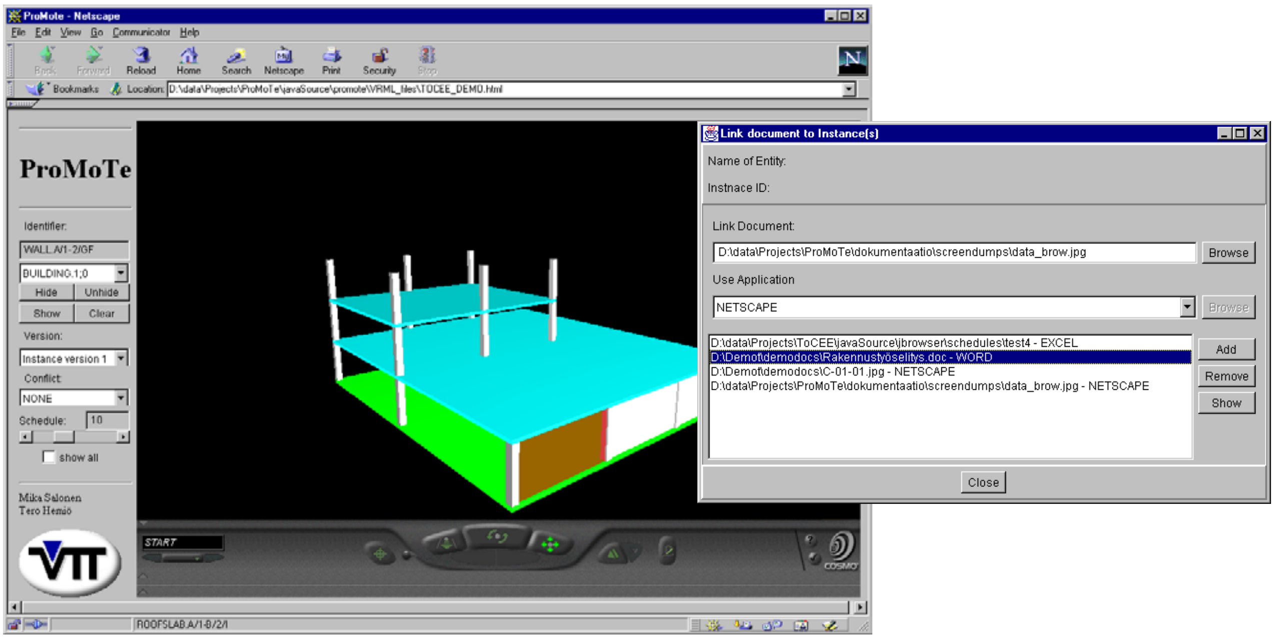
Figure 4: Attribute value browser window for browsing the values of attributes recursively

3.3.5 Comparing versions

Version comparison is very efficient way to compare two proposals or to check what has been changed in the model. Models to be compared are drawn in the same VR-model and the choice method of VRML-language is used to select the geometry to be shown. This enables switching between the different representations of the selected instance as well as changing between the whole models. It is also possible to show both representations of the instances at the same time. This is very convenient feature when the location or size of an instance has changed the user wants to compare the alternatives.

3.3.6 Showing and hiding items

Changing the number of items to be shown can be used to animate the construction process. Because the decision whether the instance is shown or not can be done runtime, the set of shown instances can be changed from the ProMoTe-VR applet. User can set the date when the status of the construction process is shown. A slide bar can be used to visualise the "construction" of the building from day one to the end of the project. This is very efficient technique to check the construction process and especially the space allocations during the process. Example of schedule visualisation is shown in Figure 6 - Figure 9.



ProMote - Netscape

Location: D:\data\Projects\ProMoTe\javaSource\promote\VRML_files\TOCEE_DEMO.html

Identifier: WALL.A/1-2/GF

BUILDING.1;0

Version: Instance version 1

Conflict: NONE

Schedule: 10

☐ show all

ROOFSLAB.A/1-8/2/I

Link document to Instance(s)

Name of Entity:

Instnace ID:

Link Document: D:\data\Projects\ProMoTe\dokumentaatio\screendumps\data_brow.jpg

Use Application: NETSCAPE

D:\data\Projects\ToCEE\javaSource\jbrowser\schedules\test4 - EXCEL
D:\Demot\demodocs\Rakennustyöselitys.doc - WORD
D:\Demot\demodocs\C-01-01.jpg - NETSCAPE
D:\data\Projects\ProMoTe\dokumentaatio\screendumps\data_brow.jpg - NETSCAPE

Figure 5: Linking documents to selected object using ProMoTe

4 CONCLUSIONS

Virtual reality models are very efficient and user-friendly way to provide access to product data. The possibility to generate models by demand from the server using only selected objects makes it very efficient also when the data is accessed through the web. Possibility to define hierarchical VR-models using the content hierarchy specified by the user in to the product model itself, makes it possible to generate different kind of hierarchical models for different purposes. Connection to document management through the instances visualised in the model provides easy access to all documents liked to the model.

Live demo is available at web site http://cic.vtt.fi/hemio/promote/ .

5 AKNOWLEDGEMENTS

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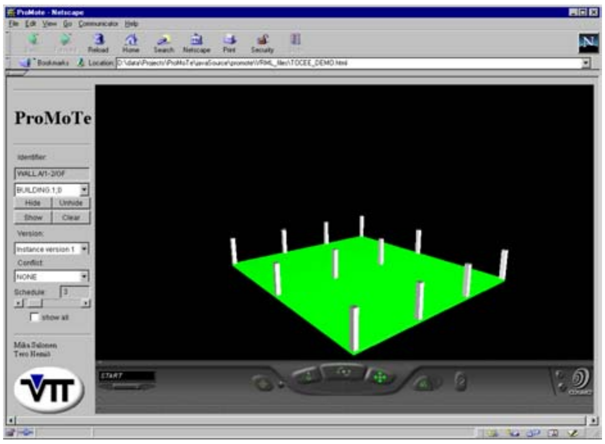
Contributions from other members of the project team is acknowledged: Juha Hyvärinen and Matti Hannus.



Identifier: WALL A/1-2/0F

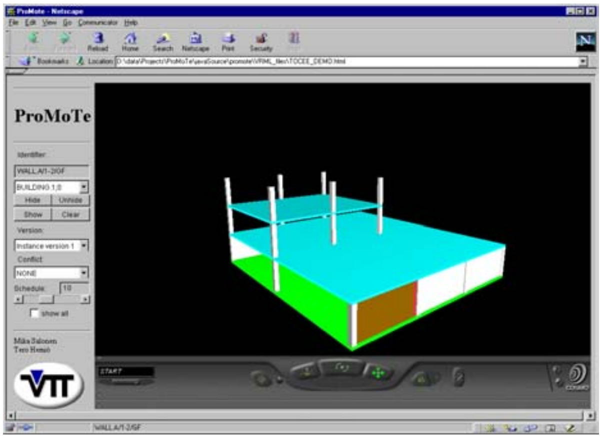
BUILDING 1.0

Version: Instance version 1

Conflict: NONE

Schedule: 3

Figure 6: Day 3



Identifier: WALL A/1-2/0F

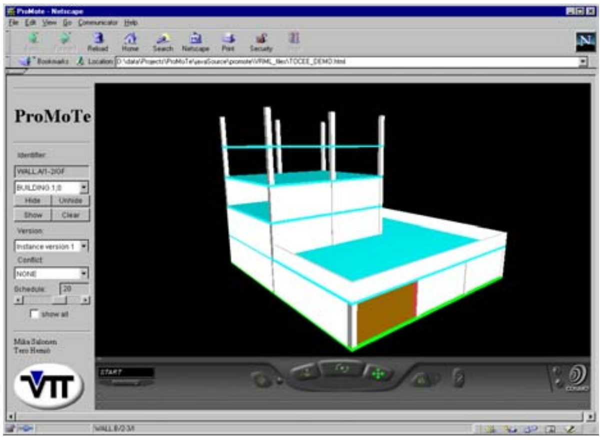
BUILDING 1.0

Version: Instance version 1

Conflict: NONE

Schedule: 10

Figure 7: Day 10



Identifier: WALL A/1-2/0F

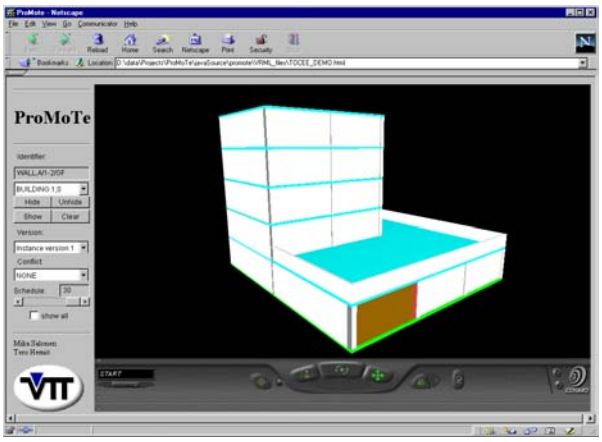
BUILDING 1.0

Version: Instance version 1

Conflict: NONE

Schedule: 20

Figure 8:Day 20



Identifier: WALL A/1-2/0F

BUILDING 1.0

Version: Instance version 1

Conflict: NONE

Schedule: 30

Figure 9: Day 30

6 REFERENCES

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