Stichting NIOC en de NIOC kennisbank

Stichting NIOC (www.nioc.nl) stelt zich conform zijn statuten tot doel: het realiseren van congressen over informatica onderwijs en voorts al hetgeen met een en ander rechtstreeks of zijdelings verband houdt of daartoe bevorderlijk kan zijn, alles in de ruimste zin des woords.

De stichting NIOC neemt de archivering van de resultaten van de congressen voor zijn rekening. De website www.nioc.nl ontsluit onder "Eerdere congressen" de gearchiveerde websites van eerdere congressen. De vele afzonderlijke congresbijdragen zijn opgenomen in een kennisbank die via dezelfde website onder "NIOC kennisbank" ontsloten wordt.

Op dit moment bevat de NIOC kennisbank alle bijdragen, incl. die van het laatste congres (NIOC2023, gehouden op donderdag 30 maart 2023 jl. en georganiseerd door NHL Stenden Hogeschool). Bij elkaar bijna 1500 bijdragen!

We roepen je op, na het lezen van het document dat door jou is gedownload, de auteur(s) feedback te geven. Dit kan door je te registreren als gebruiker van de NIOC kennisbank. Na registratie krijg je bericht hoe in te loggen op de NIOC kennisbank.

Het eerstvolgende NIOC vindt plaats op donderdag 27 maart 2025 in Zwolle en wordt dan georganiseerd door Hogeschool Windesheim. Kijk op www.nioc2025.nl voor meer informatie.

Wil je op de hoogte blijven van de ontwikkeling rond Stichting NIOC en de NIOC kennisbank, schrijf je dan in op de nieuwsbrief via

www.nioc.nl/nioc-kennisbank/aanmelden nieuwsbrief

Reacties over de NIOC kennisbank en de inhoud daarvan kun je richten aan de beheerder:

R. Smedinga kennisbank@nioc.nl.

Vermeld bij reacties jouw naam en telefoonnummer voor nader contact.

Hogeschool van Arnhem en Nijmegen
HAN University of Applied Sciences

Generatieve applicatieontwikkeling: Masteronderzoek in de praktijk

"A generic transformation approach to application migration from Windows to Web of the HAN Individueel Onderwijs system"

Misja Nabben, 20130404

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Contents

- **Personal background**
- **Project background & definition**
- **Materials and methods**
  - Introduction Data – Meta data – Meta meta data
  - Application Generators
- **Project results, conclusions & future research**

Personal Background

- **Lecturer in bachelor of ICT and master MISD program**

- **Member of the HAN research group Model Based Information Systems (M-BIS)**

  https://www.han.nl/onderzoek/kennismaken/technologie-en-samenleving/lectoraat/model-based-information-systems/

  Lector emeritus Guido Bakema.
  Lector Dr. Stijn Hoppenbrouwers

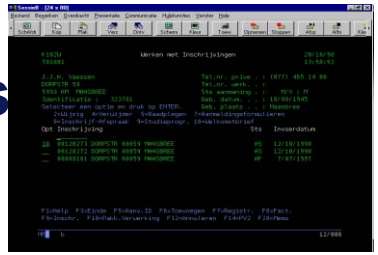
Background | M-BIS

- **Fact Oriented Modeling (FOM), Meta modeling**
- **Application & code generation/interpretation**
- **Model to model transformations**
- **Tool development:**
  - Model driven application generating engines
  - Generic graphical drawing engine
  - Fact based modelling tool
  - From code to data using thin clients
- **Application development using these tools**

>> Project HAN Individueel Onderwijs

Project | Background information

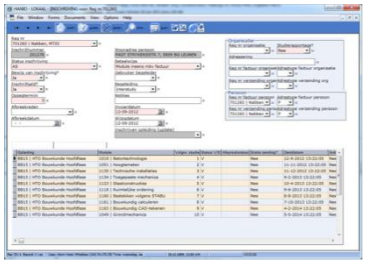
2002 : the HAN acquires PBNA modules



2003 : project HAN Individueel Onderwijs (HAN IO) started

research project Application Generator (UFG) started in parallel

2004 : project HAN IO implemented for 'HAN Centrum voor Post-Bachelor- en Master' (HAN CPM) opleidingen



Project | Background information

2008 : HAN IO students should be finished,
HAN IO should be stopped

2010 : first problems HAN IO on Windows 7

2011 : analysis on upgrading HAN IO

2012 : Windows 7 rollout planned
project HAN IO II started

Project | Problem statement

HAN IO is based on Application Generator developed in Delphi:

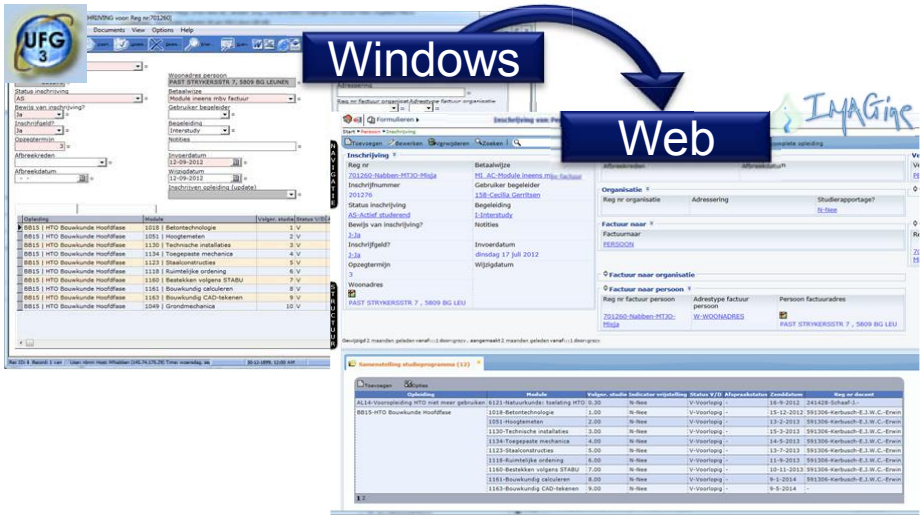
- **Delphi is no longer supported on Windows 7**
- **Database version MS SQL 2000 outdated**
- **HAN IO should end in 2008, no functionality is added since 2004.**

Project | Objectives

- **A system that**
  - Can support the process of distance education
  - Has at least the same functionality as HAN IO
  - Can easily adapt to new functionality
  - Could be used in the future by students
  - Is easy to use by the current end users
  - Fits in the HAN architecture
  - Is easy to maintain
  - At the lowest cost…

Project | Assignment

“A generic transformation approach to application migration from Windows to Web of the HAN Individueel Onderwijs system”



Materials and Methods

A web based application interpreter called 'Information Model Application Generating engine (IMAGine)'

The relational database management system MS SQL Server

Transforming the business model and application model to this new platform by model to model transformation and code generation

Side step:

Introduction of

Application generation,

Model to model transformations,

Data - Meta data – Meta meta data,

4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

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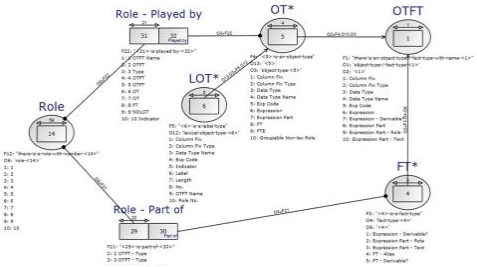
M3

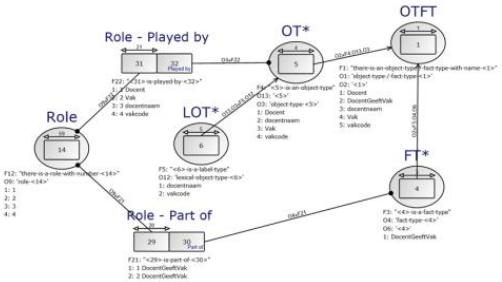


Metametamodel

Foundation for a Metamodeling Architecture.

Defining the language to describe metamodels

M2

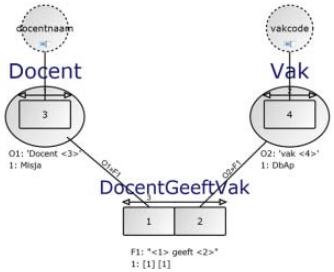


Metamodel

An Instance of a metametamodel.

Defining the language to describe models.

M1



Model

An Instance of Metamodel. Defining a language to describe the information object domain.

M0

Docent	Vak
Arnoud	WebTech
Eddy	DbAp
Eddy	DIS
Misja	DbAp

Domain

An Instance of a Model.

Defines specific information Domain

Using 4 layered Meta Object Facility (MOF) standard.
See UML 2.0 Infrastructure Specification; OMG Adopted Specification ptc/03-09-15

4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

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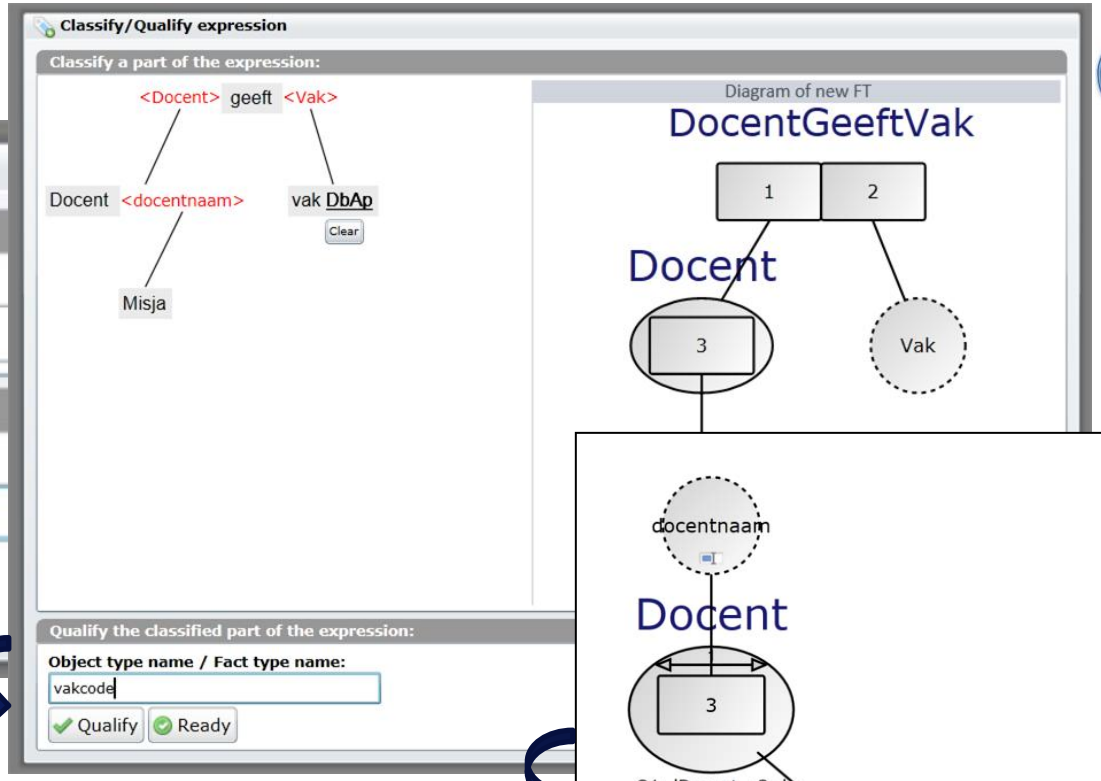
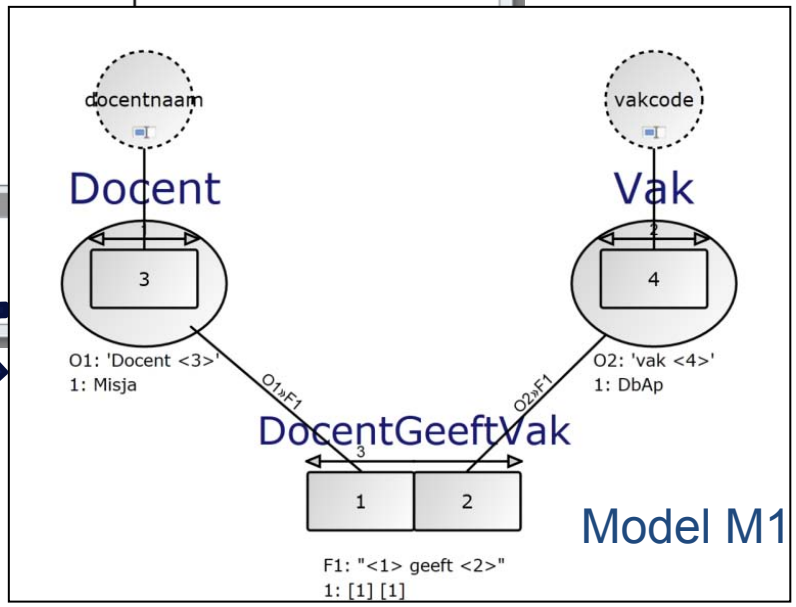
M1 : Information modeling of the domain

Domain M0



Graphity



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Fact Oriented Modeling using Fully Communicated Oriented – Information Modeling (FCO-IM)

<< back

4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

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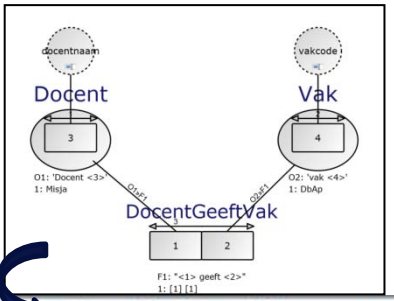
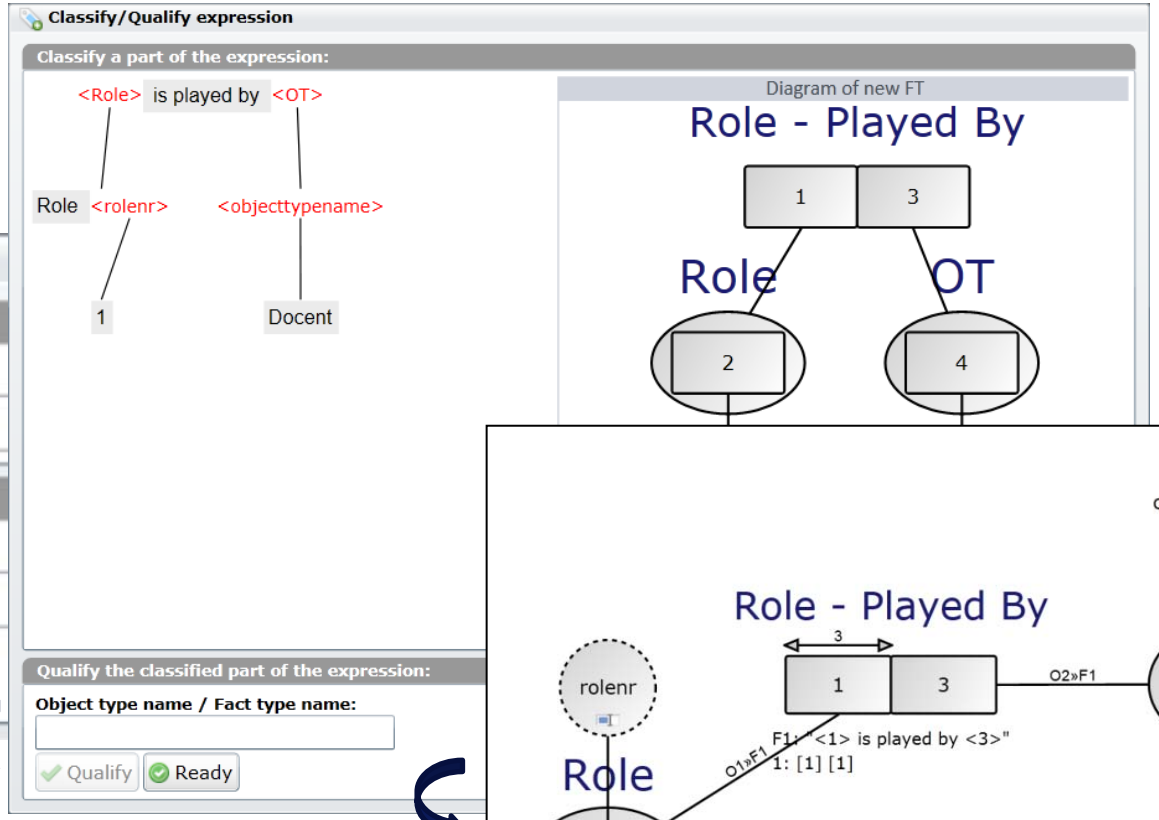
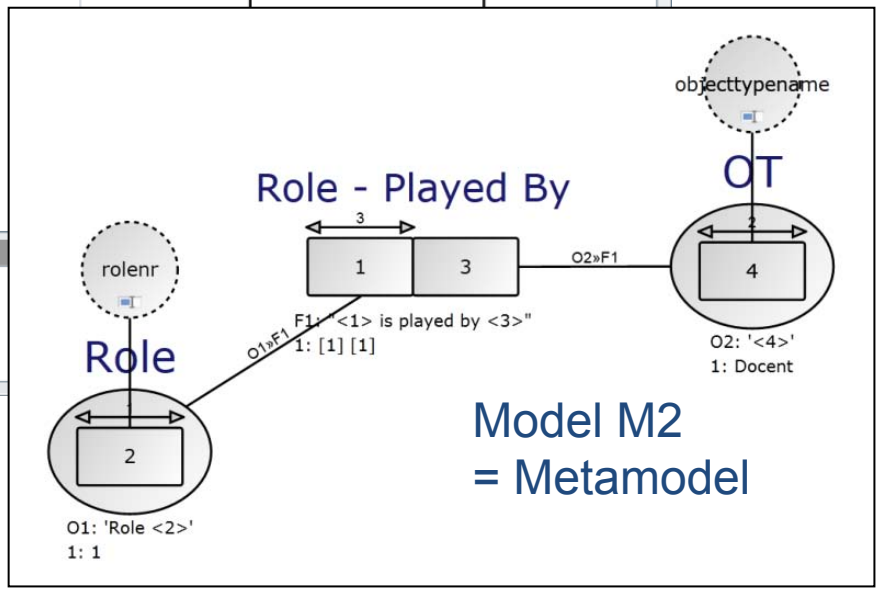
M2 : Information modeling of the model

Domain M1







Model M2
= Metamodel

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4 layered metamodel of Fully Communication Oriented - Information Modeling (FCO-IM)

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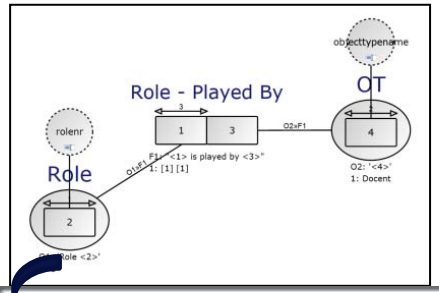
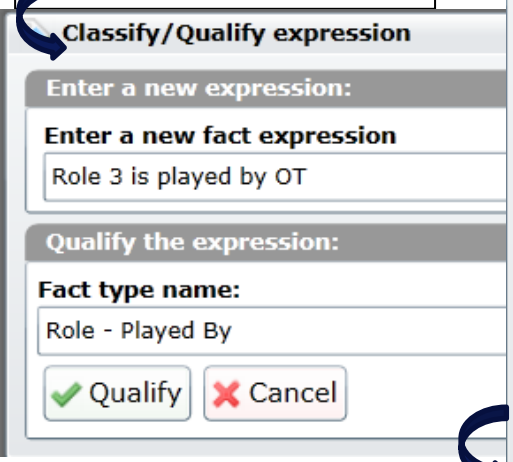
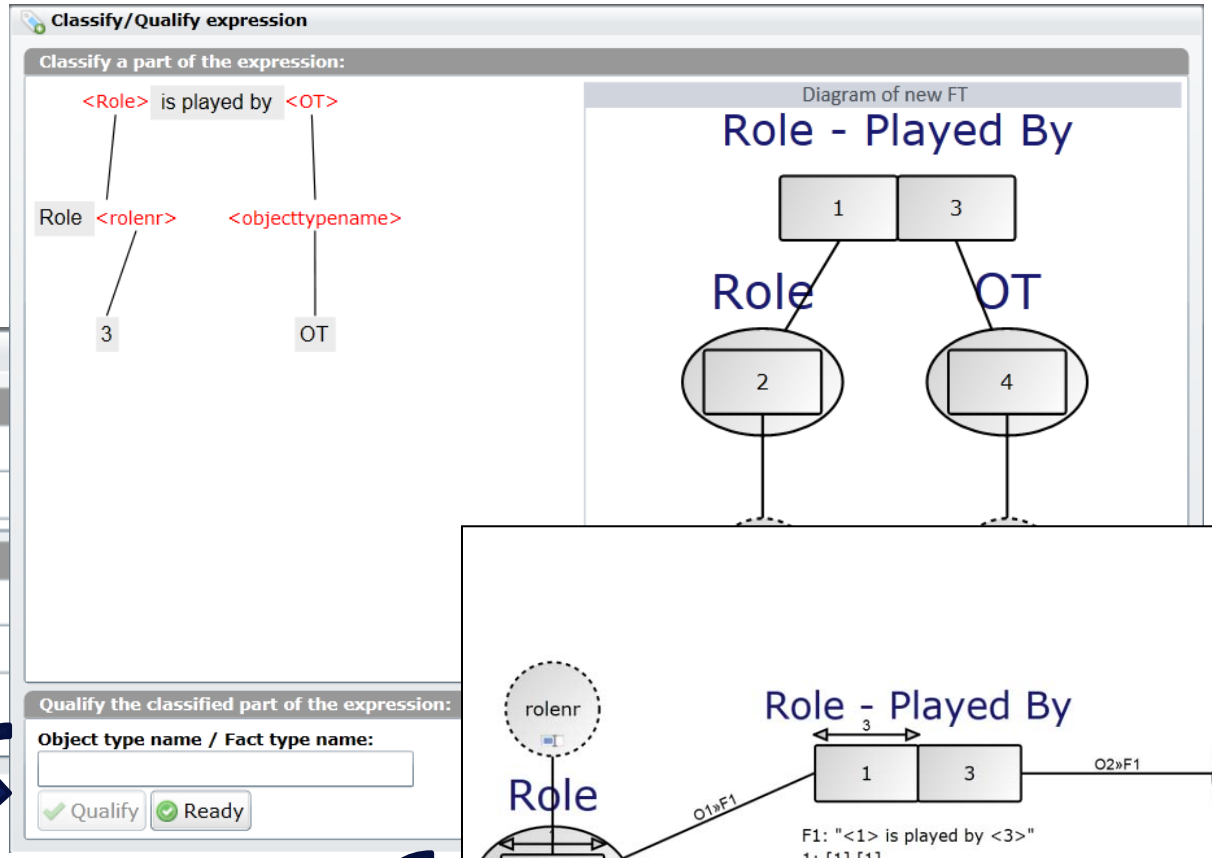
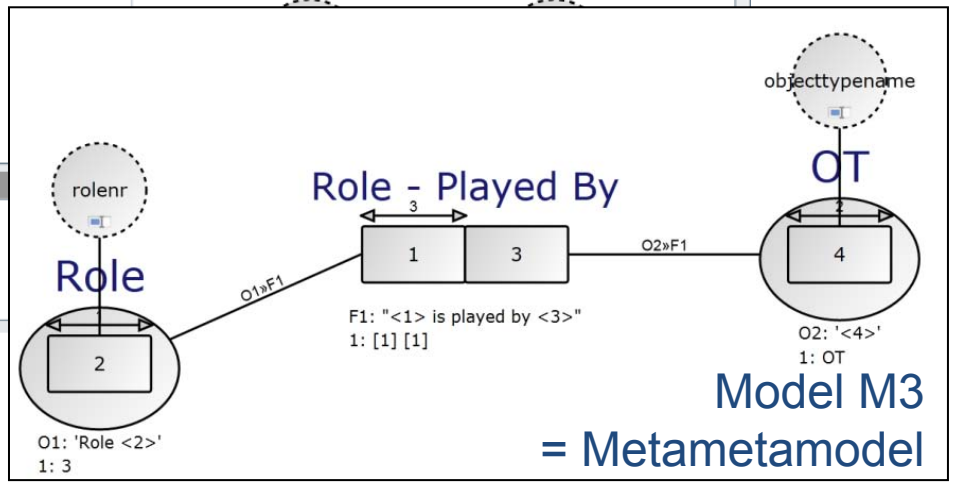
M3 : Information modeling of the metamodel

Domain M2
= Metamodel









Model M3
= Metametamodel

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Similar for a Relational Model

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M3 — Metametamodel

TABLES
TABLE_NAME
TABLES
COLUMNS

COLUMNS	
TABLE_NAME	COLUMN_NAME
TABLES	*TABLE_NAME*
COLUMNS	*TABLE_NAME*
COLUMNS	*COLUMN_NAME*

M2 — Metamodel

TABLES
TABLE_NAME
Docent
Vak
DocentGeeftVak

COLUMNS	
TABLE_NAME	COLUMN_NAME
Docent	*docentnaam*
Vak	*vakcode*
DocentGeeftVak	*docentnaam*
DocentGeeftVak	*vakcode*

M1 — Model

Docent
docentnaam
Misja

Vak
vakcode
DbAp

DocentGeeftVak	
docentnaam	vakcode
Misja	*DbAp*

M0 — Domain

Docent	Vak
Arnoud	WebTech
Eddy	DbAp
Eddy	DIS
Misja	DbAp

Extended with an Application Interface

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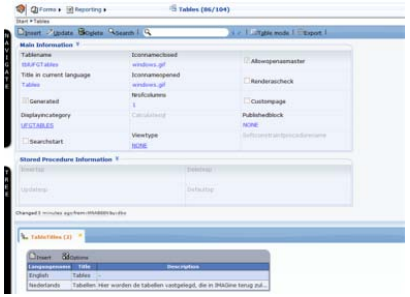
M3 — Metametamodel

TABLES
TABLE_NAME
TABLES
COLUMNS

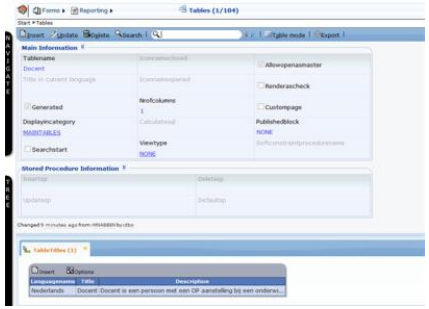
COLUMNS	
TABLE_NAME	COLUMN_NAME
TABLES	*TABLE_NAME*
COLUMNS	*TABLE_NAME*
COLUMNS	*COLUMN_NAME*



M2 — Metamodel

TABLES
TABLE_NAME
Docent
Vak
DocentGeeftVak

COLUMNS	
TABLE_NAME	COLUMN_NAME
Docent	*docentnaam*
Vak	*vakcode*
DocentGeeftVak	*docentnaam*
DocentGeeftVak	*vakcode*

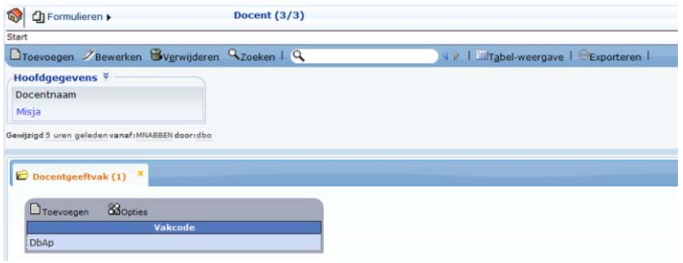


M1 — Model

Docent
docentnaam
Misja

Vak
vakcode
DbAp

DocentGeeftVak	
docentnaam	vakcode
Misja	*DbAp*



M0 — Domain

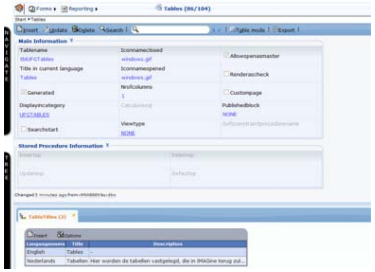
Docent	Vak
Arnoud	WebTech
Eddy	DbAp
Eddy	DIS
Misja	DbAp

Application interpreters & repositories

M3 — Metametamodel

TABLES
TABLE_NAME
TABLES
COLUMNS

COLUMNS	
TABLE_NAME	COLUMN_NAME
TABLES	*TABLE_NAME*
COLUMNS	*TABLE_NAME*
COLUMNS	*COLUMN_NAME*



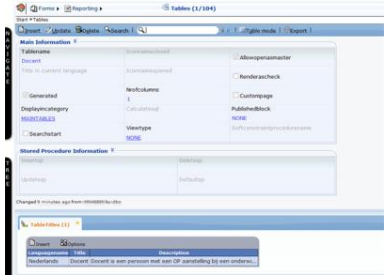
TABLES
TABLE_NAME
TABLES
COLUMNS

TABLE TITLES		
TABLE_NAME	LANGUAGE_NAME	TITLE
TABLES	*Nederlands*	*Tabellen*
TABLES	*English*	*Tables*

M2 — Metamodel

TABLES
TABLE_NAME
Docent
Vak
DocentGeeftVak

COLUMNS	
TABLE_NAME	COLUMN_NAME
Docent	*docentnaam*
Vak	*vakcode*
DocentGeeftVak	*docentnaam*
DocentGeeftVak	*vakcode*



TABLES
TABLE_NAME
Docent
Vak
DocentGeeftVak

TABLE TITLES		
TABLE_NAME	LANGUAGE_NAME	TITLE
Docent	*Nederlands*	*Docent*
Docent	*English*	*Lecturer*
Vak	*Nederlands*	*Vak*
Vak	*English*	*Course*

M1 — Model

Docent
docentnaam
Misja

Vak
vakcode
DbAp

DocentGeeftVak	
docentnaam	vakcode
Misja	*DbAp*

Lecturer
lecturer name
Misja

Course
course code
DbAp

LecturerOfCourse	
lecturer name	course code
Misja	*DbAp*

M0 — Domain

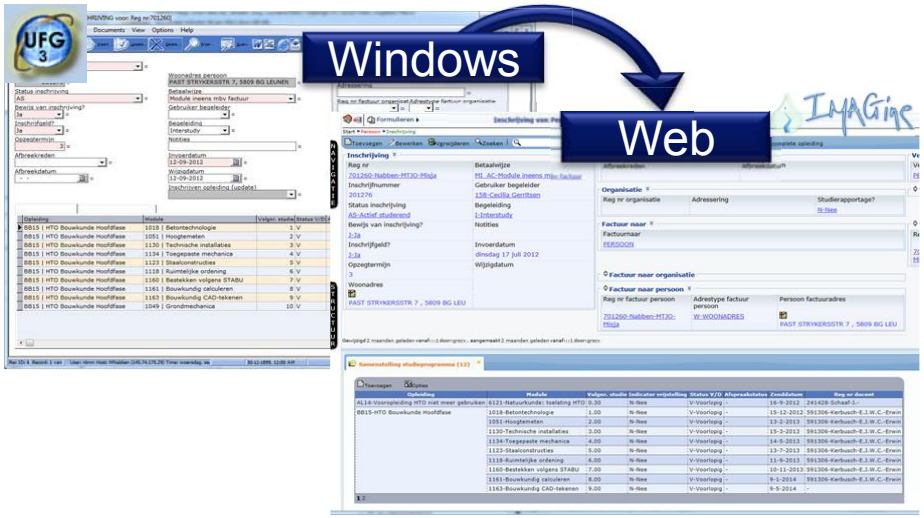
Docent	Vak
Arnoud	WebTech
Eddy	DbAp
Eddy	DIS
Misja	DbAp

Back to the Project Assignment

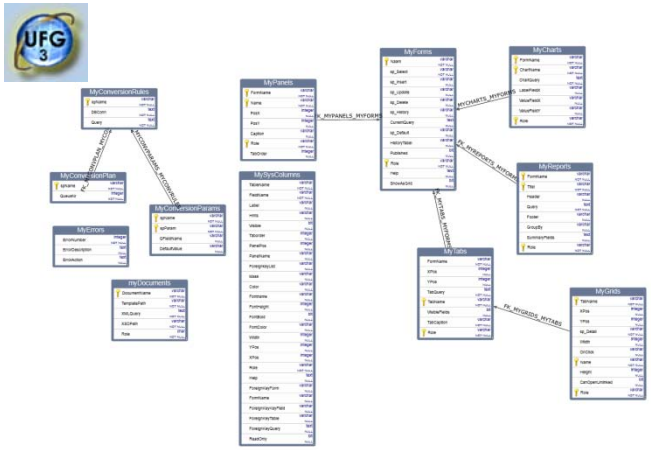
“A generic transformation approach

to application migration from Windows to Web

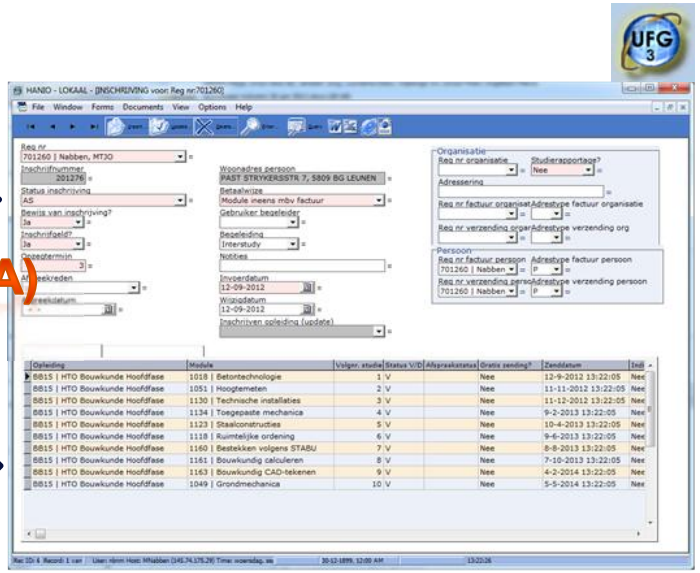
of the HAN Individueel Onderwijs system”



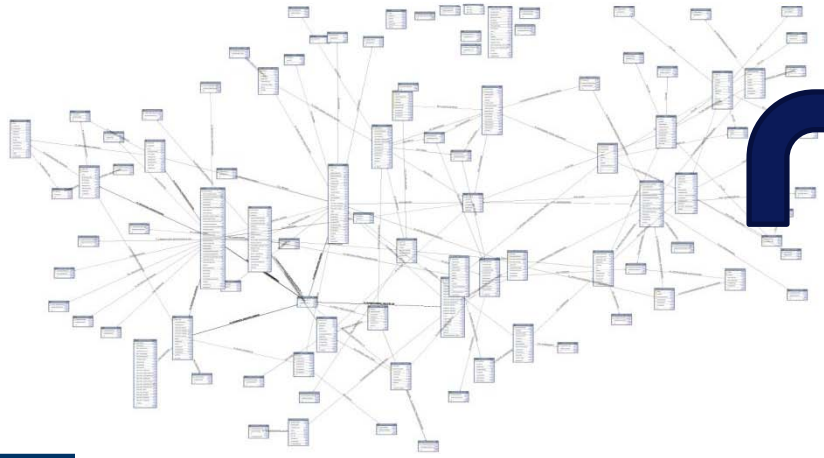
Old situation:
Application interpretation using UFG



UFG APPLICATION REPOSITORY (METADATA)



HAN IO APPLICATION



HAN IO DOMAIN MODEL (DATA)

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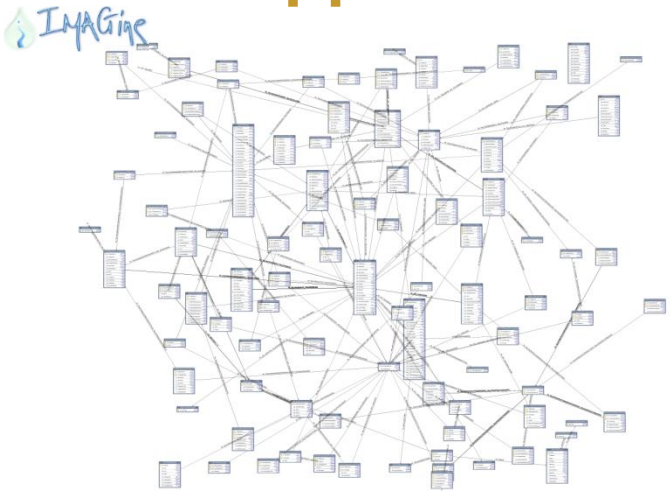
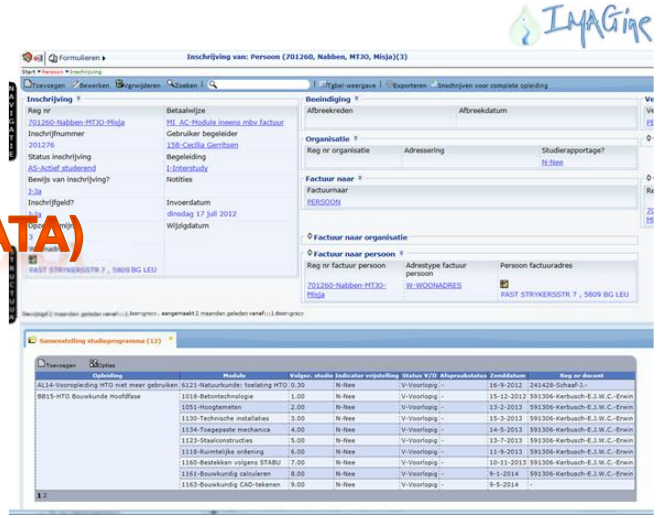
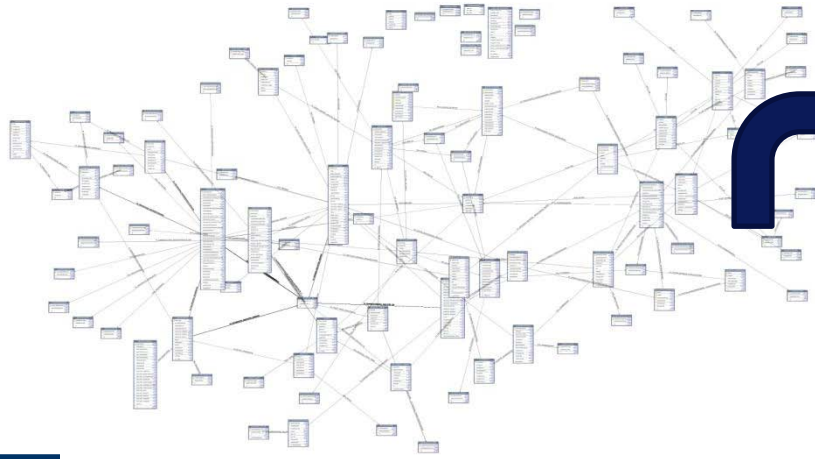
New situation:
Application interpretation using IMAGine



IMAGINE APPLICATION REPOSITORY (METADATA)



HAN IO II APPLICATION



HAN IO II DOMAIN MODEL (DATA)

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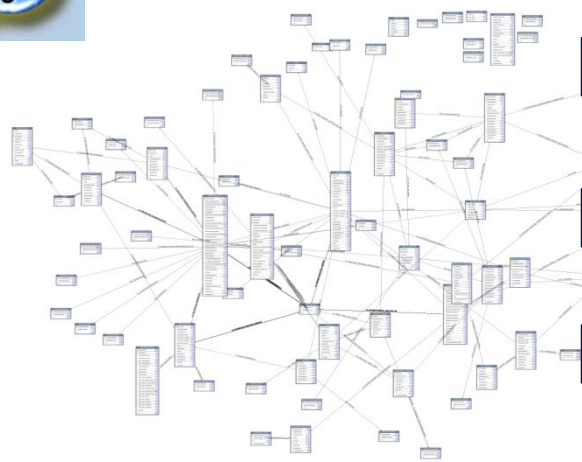
Design of the transformations
Global overview

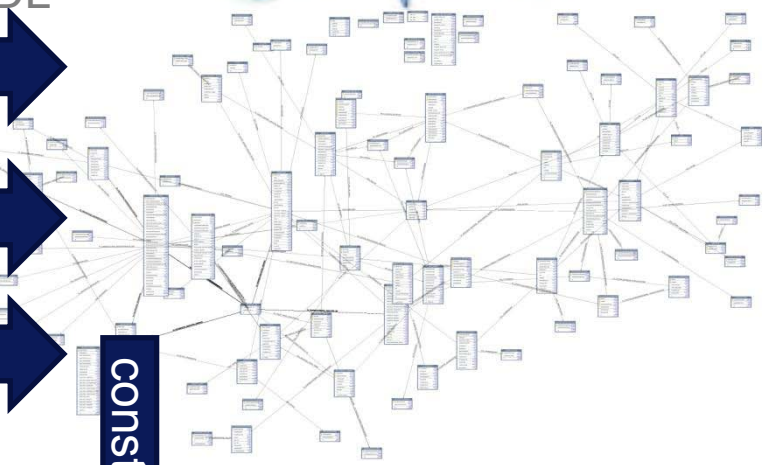


HAN IO DOMAIN MODEL

SQL-DDL
model

SQL-DML
business data

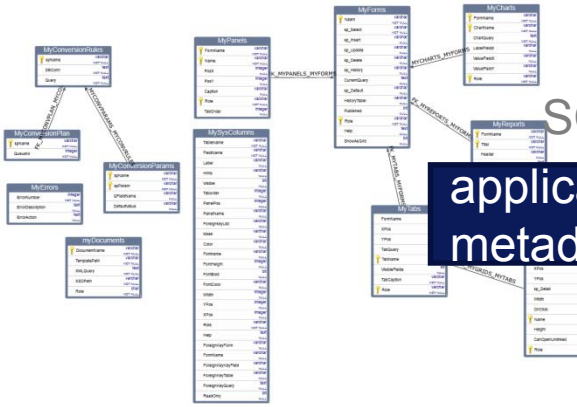
constraints/rules
SQL-DDL



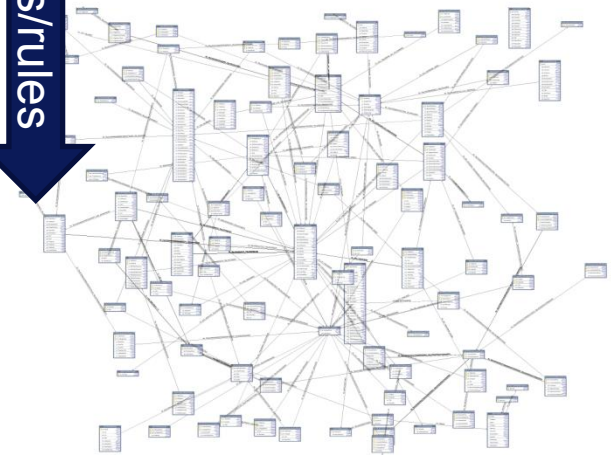
HAN IO II DOMAIN MODEL

constraints/rules

SQL-DML
application
metadata

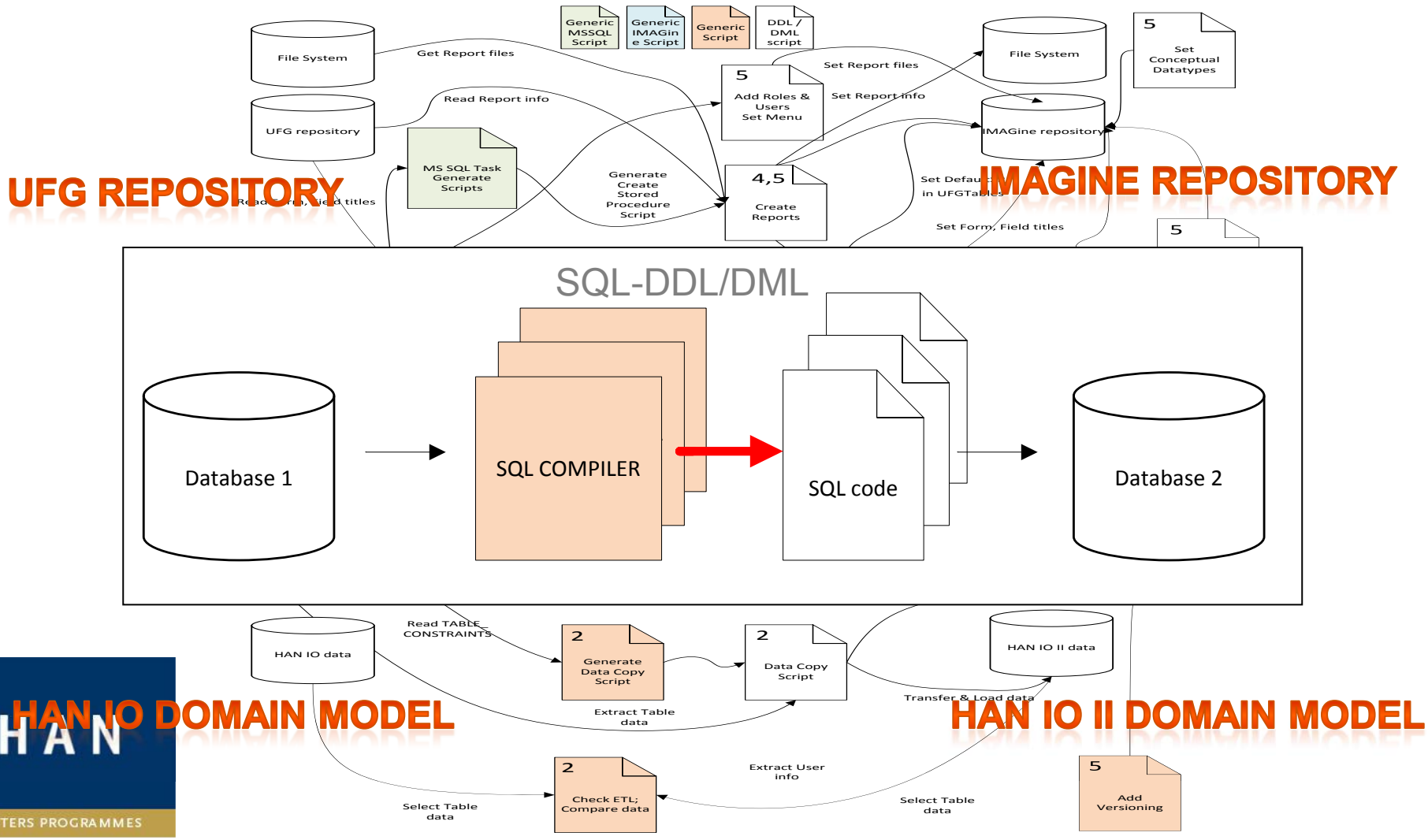


UFG REPOSITORY

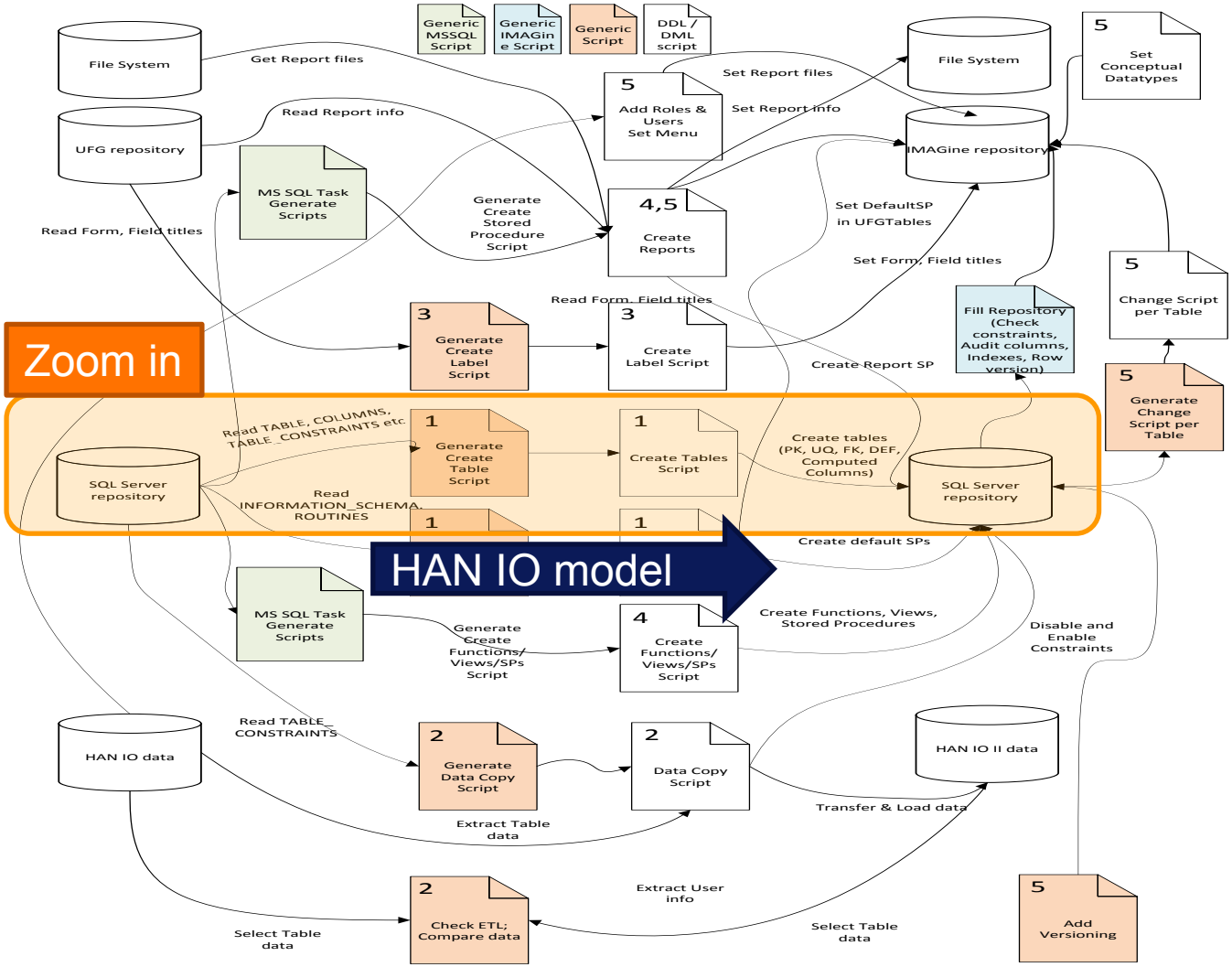


IMAGINE REPOSITORY

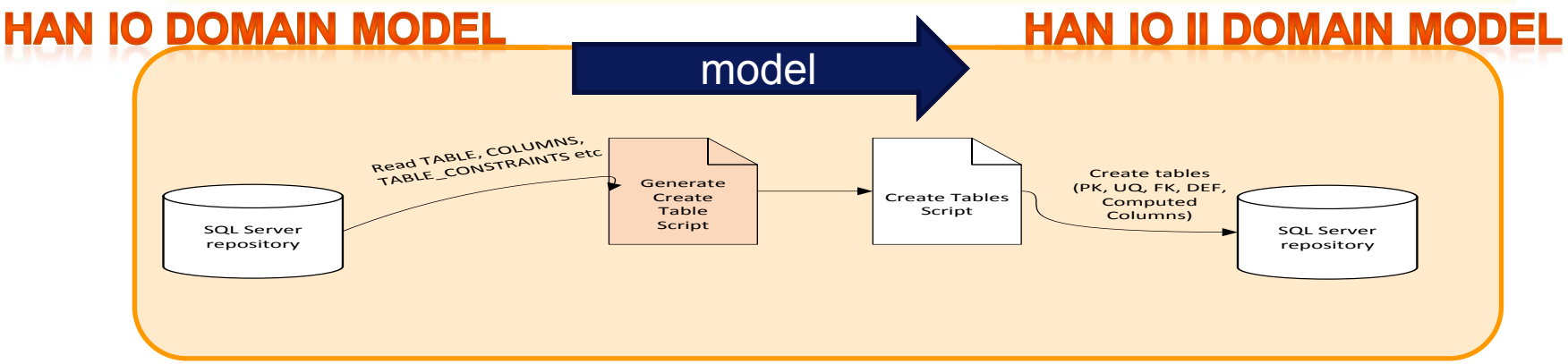
Design of the transformations
Detail overview



Development of the transformations



Development of the transformations



- **CREATE TABLEs**
  - Column; data type, length, mandatory, identity, calculation
  - Primary key definition
- **ALTER TABLEs**
  - Foreign key definition
  - Unique key definition
  - Check constraints
  - Default constraints (+ default SP's)

Development of the transformations

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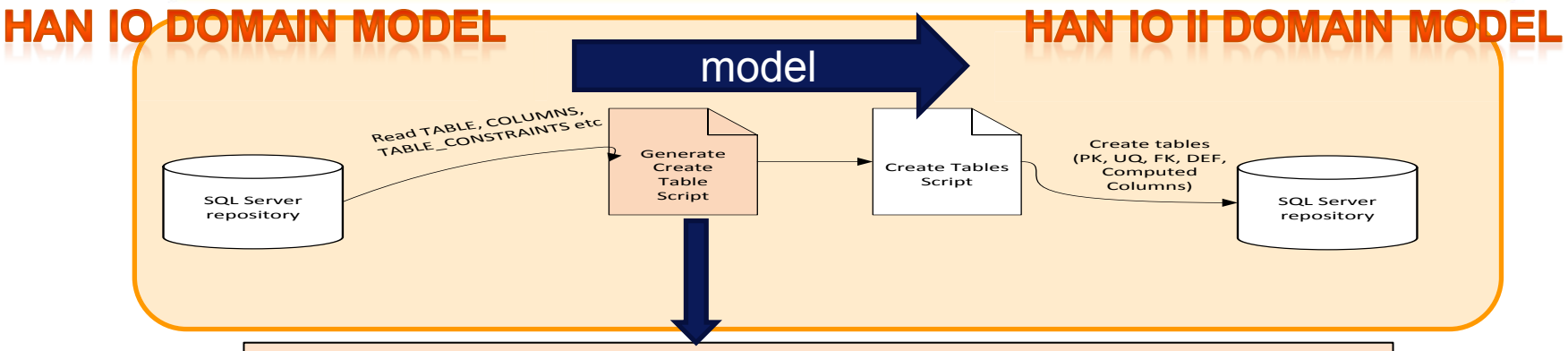


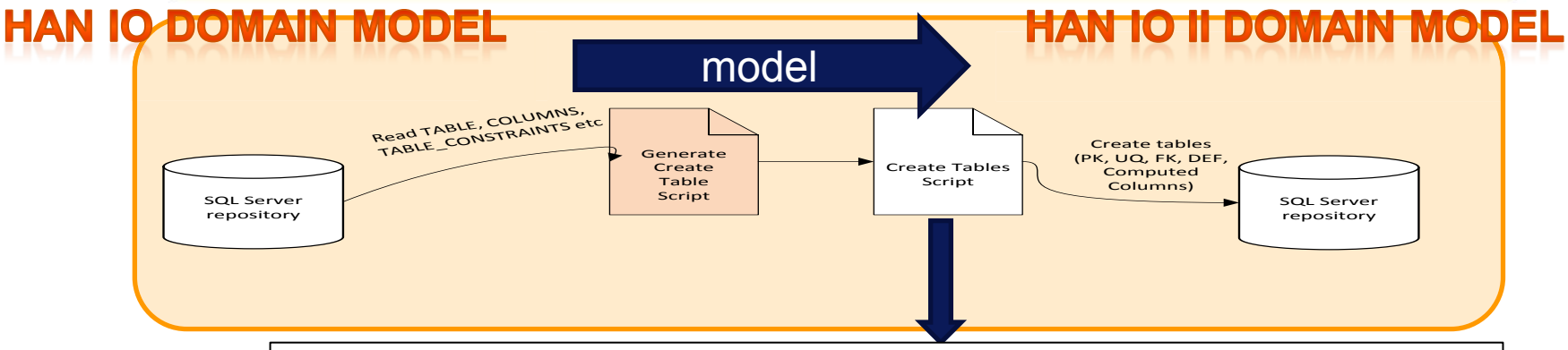

```
USE HANKC_PROD
GO
--Tables to be excluded by the script
DECLARE @IgnoreTables AS XML
= (SELECT Item FROM (
VALUES
  ('sysdiagrams')        --exclude system table for storing diagram definition
, ('%_HISTORY')          --exclude History tables
, ('My%')                --exclude UFG Repository tables
, ('dtproperties')       --exclude system table for storing diagram definition
) AS List(Item)
FOR XML PATH(''), ROOT('List'))

--Columns to be excluded by the script
DECLARE @IgnoreColumns AS XML
= (SELECT Item FROM (
VALUES
  ('chg_User')           --exclude UFG change user column
, ('chg_Host')           --exclude UFG change host column
, ('chg_Time')           --exclude UFG change time column
) AS List(Item)
FOR XML PATH(''), ROOT('List'))

EXEC SP_CREATETABLESCRIPT '%', @IgnoreTables, @IgnoreColumns
```

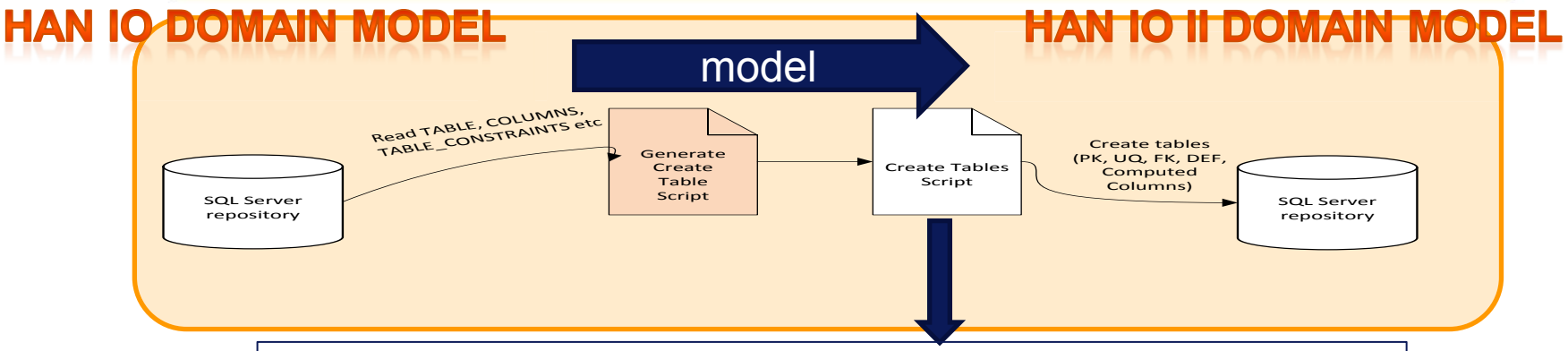
HAN
MASTERS PROGRAMMES

Development of the transformations




```
/*****************************************************************************
 Table :        ADRESCODE
 ColumnPrefix : adc
*****************************************************************************/
CREATE TABLE [dbo].[ADRESCODE]
(
  [LAND] VARCHAR(10) NOT NULL
, [ADRESCODE] VARCHAR(8) NOT NULL
, [HUISNRVANAF] VARCHAR(8) NOT NULL
, [HUISNRTOT] VARCHAR(8) NOT NULL
, [POSTCODE] VARCHAR(8) NOT NULL
, [STRAATNAAM] VARCHAR(60) NOT NULL
, [PLAATS] VARCHAR(50) NOT NULL
, [CODEPROVINCIE] VARCHAR(10) NULL
, [CODECEBUCO] VARCHAR(10) NULL
, [INDEVENONEVEN] INT NULL
, [ID] INT IDENTITY NOT NULL
, [ADRES]  AS  ([POSTCODE] + '
' + [STRAATNAAM] + '
' + [PLAATS]) -- calculated column
, [HUISNRRANGE]  AS  ([HUISNRVANAF] + '-' + [HUISNRTOT]) -- calculated column
, CONSTRAINT [PK_ADRESCODE] PRIMARY KEY ([LAND] , [ADRESCODE] , [HUISNRVANAF] )
)
GO
```

Development of the transformations




```
/*****************************************************************************
 REFERENCES
*****************************************************************************/
ALTER TABLE [ADRESCODE] ADD CONSTRAINT [FK_ADRESCODE_LAND] FOREIGN KEY ([LAND])
  REFERENCES [LAND]( [CODELAND]) ON UPDATE NO ACTION ON DELETE NO ACTION
```

```
ALTER TABLE [ADRESTYPE] ADD CONSTRAINT [U1_ADRESTYPE] UNIQUE ([OMSTYPEADRES])
```

```
ALTER TABLE [INSCHRIJVING] ADD CONSTRAINT [CHK_PersoonOrganisatieFactuur] CHECK
(([persoonFactuur] is not null and [persoonAdresTypeFactuur] is not null and
([organisatieFactuur] is null and [organisatieAdresTypeFactuur] is null) or
[persoonFactuur] is null and [persoonAdresTypeFactuur] is null and
([organisatieFactuur] is not null and [organisatieAdresTypeFactuur] is not
null)))
```

```
ALTER TABLE [dbo].ARTIKEL ADD CONSTRAINT [DEF_ARTIKEL_INVOERDATUM] DEFAULT
((getdate())) FOR INVOERDATUM
```

Project results

A web based HAN Individueel Onderwijs system implemented for CPM department in March 2013

Formulieren ▸ Inschrijving (2/23)

Start ▸ Inschrijving

NAVIGATIE

Toevoegen | Bewerken | Verwijderen | Zoeken | nabben | Tabel-weergave | Exporteren | Inschrijven voor complete opleiding

Inschrijving

Reg nr	Status inschrijving	Opzegtermijn	Begeleiding	Wijzigdatum
701284-Nabben-MTJO-Misja	AS-Actief studerend	3	S-Schriftelijk	
Inschrijfnummer	Bewijs van inschrijving?	Betaalwijze	Notities	
201296	J-Ja	MI_AC-Module inceins mbv factuur		
Woonadres	Inschrijfgeld?	Gebruiker begeleider	Invoerdatum	
PAST STRYKERSSTR 7 , 5809 BG LEU	J-Ja	158-Cecilia Gerritsen	woensdag 6 februari 2013	

Onderbreking, Beeindiging

Afbreekreden	Afbreekdatum

Organisatie

Reg nr organisatie	Adressering	Studierapportage?
		N-Nee

STRUCTUUR

Factuur naar, Verzenden naar

Factuurnaar	Verzendennaar
PERSOON	PERSOON

Factuur naar persoon

Reg nr factuur persoon	Adrestype factuur persoon	Persoon factuuradres
701284-Nabben-MTJO-Misja	P-POSTADRES	PAST STRYKERSSTR 7 , 5809 BG LEU

Verzending naar persoon

Reg nr verzending persoon	Adrestype verzending persoon	Persoon verzendadres
701284-Nabben-MTJO-Misja	P-POSTADRES	PAST STRYKERSSTR 7 , 5809 BG LEU

Gewijzigd 56 dagen geleden vanaf:::1 door:grscv , aangemaakt 56 dagen geleden vanaf:::1 door:grscv

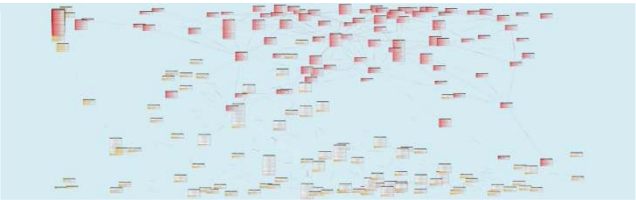
Samenstelling studieprogramma (4)

Toevoegen | Opties

Opleiding	Module	Volgnr. studie	Indicator vrijstelling	Status V/D	Afspraakstatus	Zenddatum	Reg nr docent
AL15-Voorbereidend Jaar Technische HBO	7004-Voorbereidende Wiskunde HBO	1.00	N-Nee	D-definitief	EC-Cursist die de cursus regulier beeindigd	6-2-2013	241428-Schaaf-J.-
	6121-Natuurkunde: toelating HTO	2.00	N-Nee	D-definitief	EC-Cursist die de cursus regulier beeindigd	6-2-2013	241428-Schaaf-J.-
	6122-Scheikunde: toelating HTO	3.00	N-Nee	D-definitief	EC-Cursist die de cursus regulier beeindigd	6-2-2013	-
	6081-Rapporteren	4.00	N-Nee	V-Voorlopig	-	7-5-2013	248178-Lockefeer-E.L.R.M.-

Conclusions

- **Development is based on (meta-)data transformations instead of programming.**
- **More declarative rules instead of procedural code**
- **Testing is primarily based on testing the existence of (meta-)data in the new environment.**



Errors arise in procedural code not in declarative rules

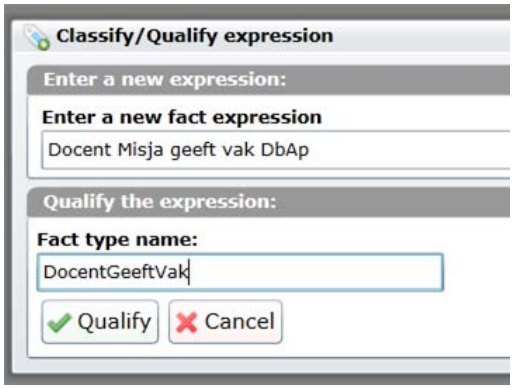
- **Project cost of HAN IO II was < 10% of the original costs of HAN IO I.**

Input for future research and improvements regarding application generation for us and bachelor / master students

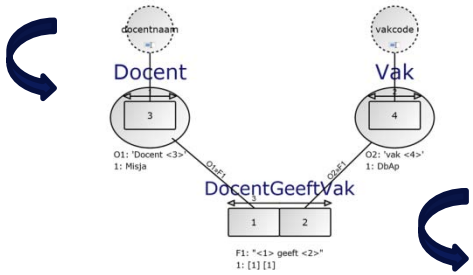
- Improving default heuristics.
- Improving subtype support
- Improving foreign key titles
- Improving the visualization of child records
- Improving the user interface controls to support high volume domain tables
- Adding the verbalized fact type expression to the user interface

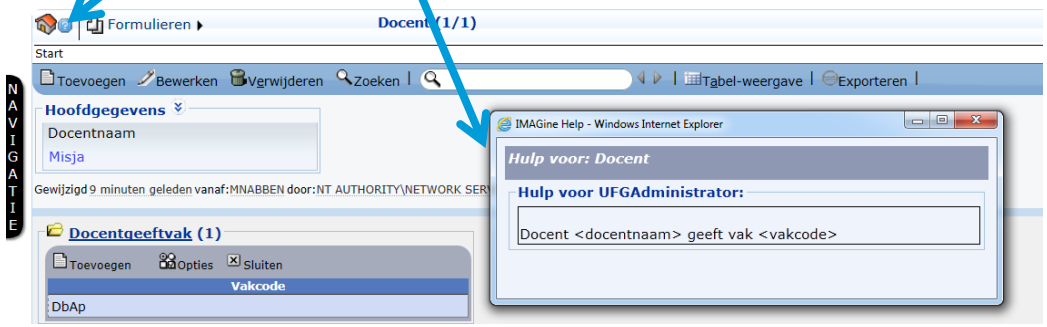
Future research and improvements regarding application generation

- **Adding the verbalized fact type expression to the user interface**




```
INSERT INTO dbo.tblUFGHelpText
        (uhe_TableName,uhe_Rolename,uhe_Language,uhe_HelpText)
SELECT  utb_TableName,'UFGAdministrator','Nederlands',
    ISNULL(CAST((SELECT Expressions.Expression AS span
    FROM tblUFGColumns
        OUTER APPLY
            (SELECT CHAR(10) + CHAR(13) + Expressions.Expression AS Expression
            FROM FCOIMDemo.dbo.tblFCO_OTFT
                INNER JOIN FCOIMDemo.dbo.tblFCO_Roles
                    ON otf_Modelname = rol_PlayedModelname
                    AND otf_ModelType = rol_PlayedModeltype
                    AND otf_OTFTName = rol_PlayedBy_OTFT
                CROSS APPLY FCOIMDemo.dbo.fn_AllRegExpression(
                    otf_Modelname,otf_ModelType,rol_PartOf_OTFT) AS Expressions
            WHERE otf_Modelname = 'OIS'
            AND otf_ModelType = 'EL-IGD'
            AND otf_OTFTName = ucl_TableName
            ) AS Expressions
    WHERE ucl_TableName = utb_TableName
    AND Expressions.Expression LIKE '%<' + ucl_ColumnName + '>%'
    FOR XML PATH('br'),ROOT('ROOT'),TYPE) AS VARCHAR(MAX)),'-')
FROM tblUFGTables
```





concept

Thank you for your attention

More info at:

Lectoraat Model-based Information Systems - HAN.nl

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