Let's Modularize the Data Model Specifications of the ObjectLens in VisualWorks/Smalltalk

Dr. Michael Prasse

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1. Introduction

Aims of the presentation

- ObjectLens Database Access Layer
- declarative definitions, design patterns, refactoring, product families
- monolithic ⇔ modular design
- adaptation of system components of VisualWorks

2. Context

Collogia Unternehmensberatung AG

- management consulting and software development
- > 50 employees
- 3 business fields: SAP consulting, project services, pension management

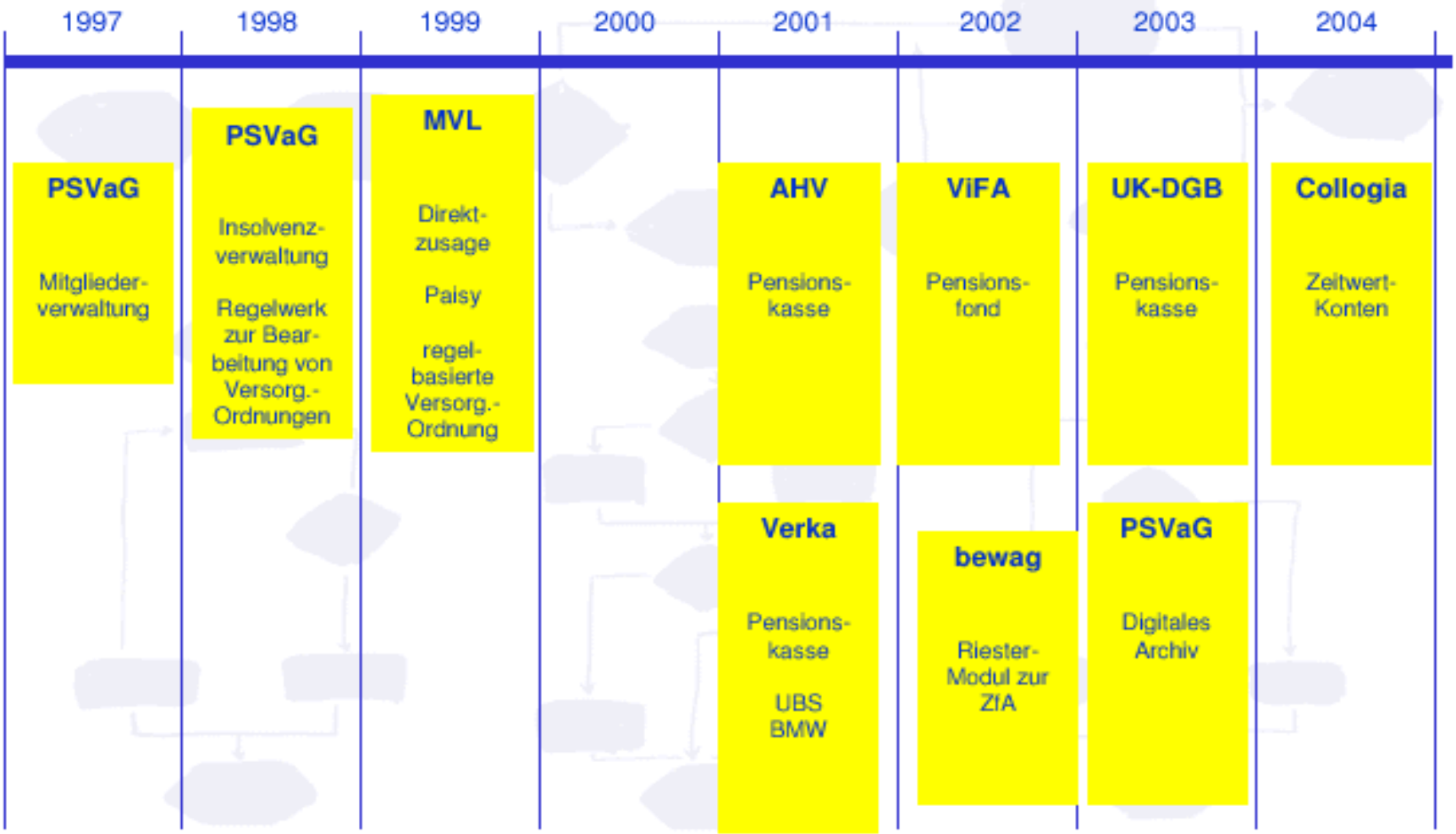
Pension Management

- VisualWorks since 1997
- Collphir Product Family: application software in the domain of pension schemes
- over 100 man years (including analysis, design, testing, maintenance)

We are not:

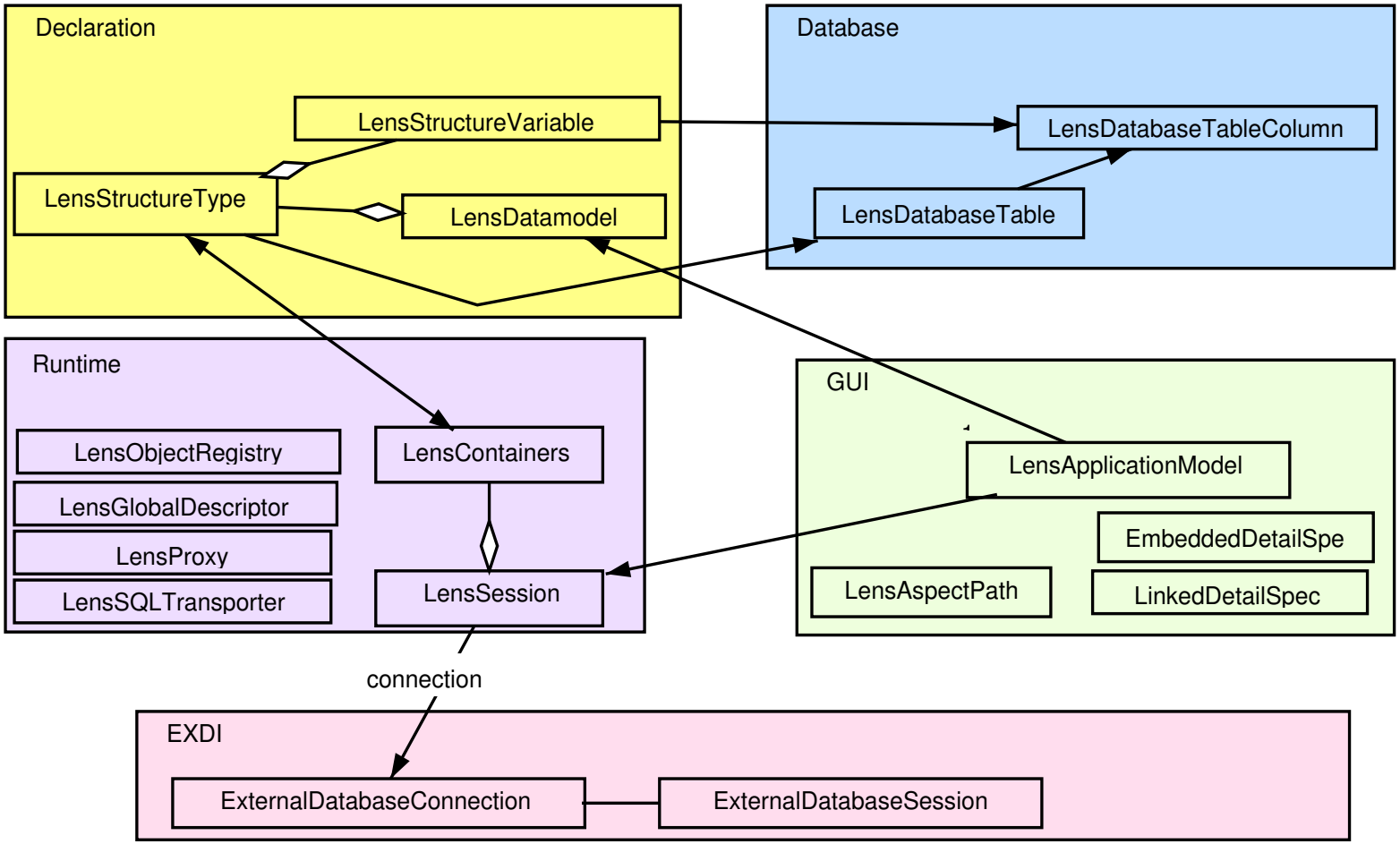
- a research organisation
- a framework or software tools vendor

Collphir - Software-Standard of management of pension schemes



3. ObjectLens

Architecture



Conceptual Mapping from Classes to Tables

Mapping Support	Concept	Mapping
	calculus level	Φ: object calculus $\rightarrow$ relational calculus (static semantics)
directly	class level	$\Phi_{classes}$: classes $\rightarrow$ tables Each class is unambiguously mapped to one table. You can't store objects of different subclasses in the same table.
directly	instance variable level	$\Phi_{instance\ variables}$: variables $\rightarrow$ columns
	simple data types	are mapped directly to one column
	object references (1:1 relationship)	are realized as a foreign key relationship
indirectly	1:n and n:m relationships	additional tables and select-statements (association classes)
no support	inheritance	A table contains all instance variables of the class including inherited variables.
no support	polymorphism	own support for untyped object references foreign key = (classID, objectID).

Programming Metaphor

programmer

- explicit persistence
- The ObjectLens is interpreted as a persistent collection.
  - to make an object persistent: *aLensSession add: anObject*
  - to remove an object from the database: *aLensSession remove: anObject*
- Database queries can be written in Smalltalk (select:).

internal

- automatic „isDirty“ detection of all persistent objects in the Lens
- flat transactions (begin, rollback, commit)
- proxy objects

➡ Smalltalk syntax can be used for persistent objects.

➡ This reduces the impedance mismatch.

4. DataModelSpec

Conception

- declarative description of a LensDataModel
- LiteralArray (Array of Arrays)
- encoding:

  LensDataModel>>literalArrayEncoding
- decoding:

  LensDataModel>>fromLiteralArrayEncoding:anArray

- using the methods *literalArrayEncoding* and *fromLiteralArrayEncoding:* then you can switch between the data model level and the data model specification level.

➡ You can choose the language level for the specification.

☛ windowSpec of the GUI-Framework

Example

```
literal array
      ^#(<Class>
            <aspect> <value> ...)

lens literal array
^#(#{Lens.LensDataModel}
            #setDatabaseContext: #(...)
            #structureTypes: #(
                        #(#{Lens.LensStructureType}
                                    #memberClass: <memberClass>
                                    #setVariables: #(
                                          #(#{Lens.LensStructureVariable}
                                                #name: 'angelegtAm'
                                                #column:    <Database Column>
                                                #privateIsMapped: true )
                                          ...)
                                    #table:  <Database Table> )
                              ...)
            #lensPolicyName: #Mixed
            #lensTransactionPolicyName: #PessimisticRR
            #validity: #installed )
```

Properties

- One monolithic *datamodelSpec* describes the data model of an application.
- The data model has to contain all entity classes of the application.
- The lens structure type of a class defines all instance variables of a class including inherited variables.
- Instance variables of a class can be mapped (persistent) or unmapped (transient).

Maintenance Problems

Class hierarchy problems

An instance variable is specified in each LensStructureType of a subclass.

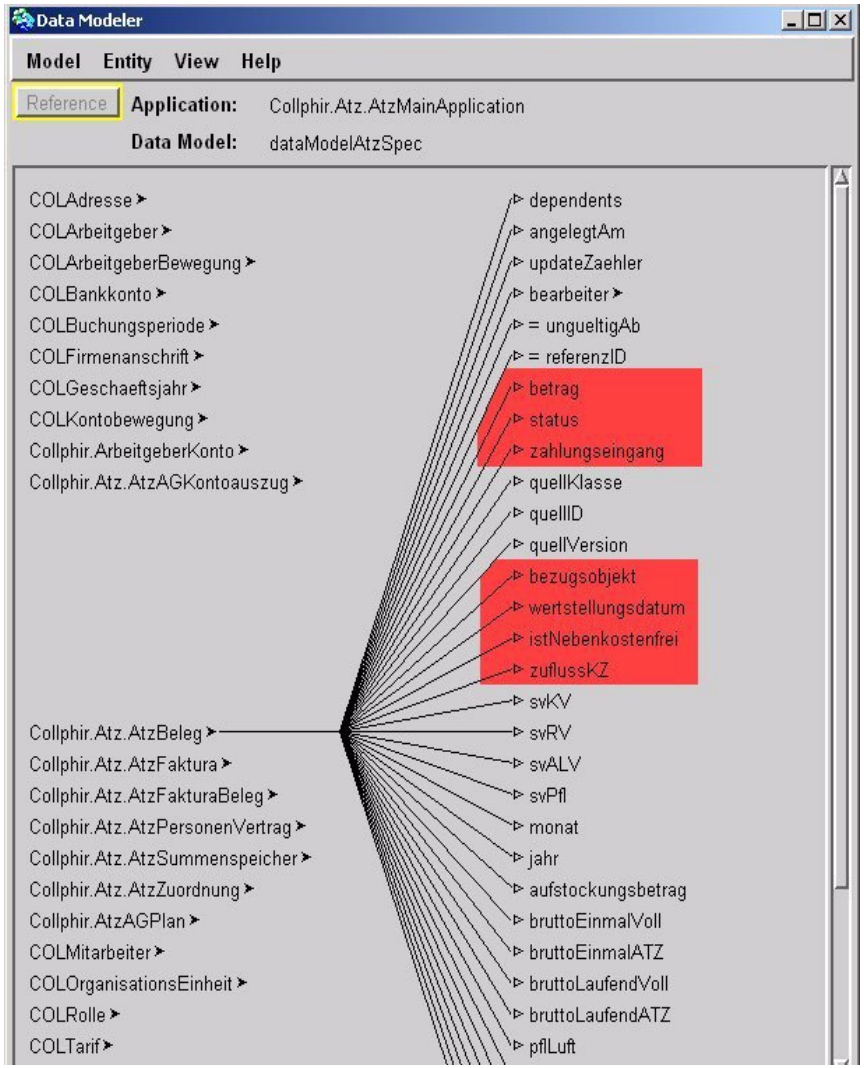
You have to adapt all LensStructureTypes of subclasses:

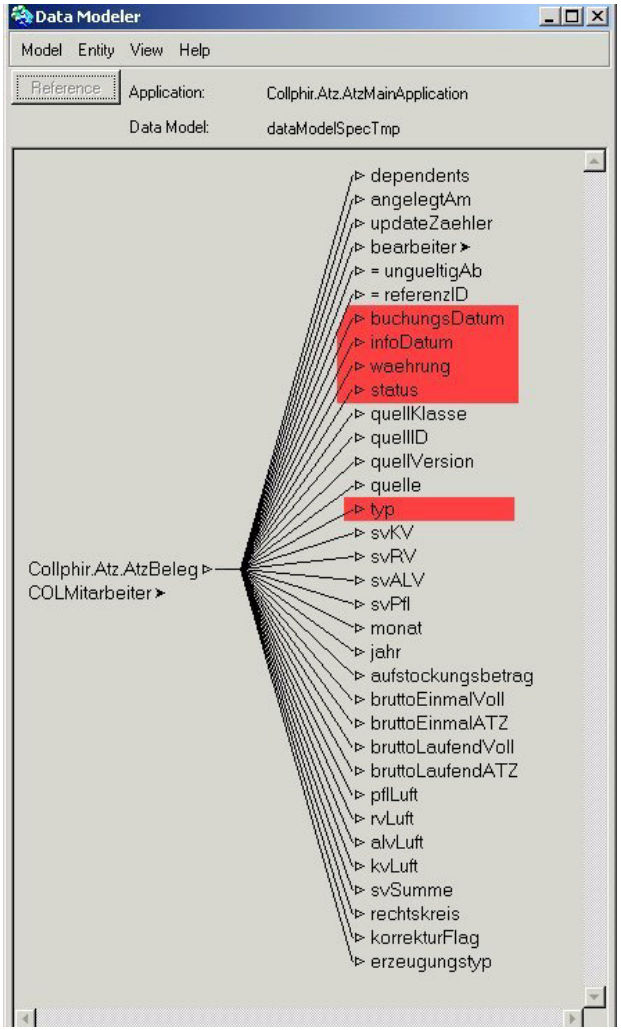
- ➡ when you define a new instance variable of a super class.
- ➡ when you change the specification of an instance variable of a super class
- ➡ when you rename an instance variable of a superclass
- ➡ when you change the class hierarchy

An instance variable can be specified differently in several subclasses.

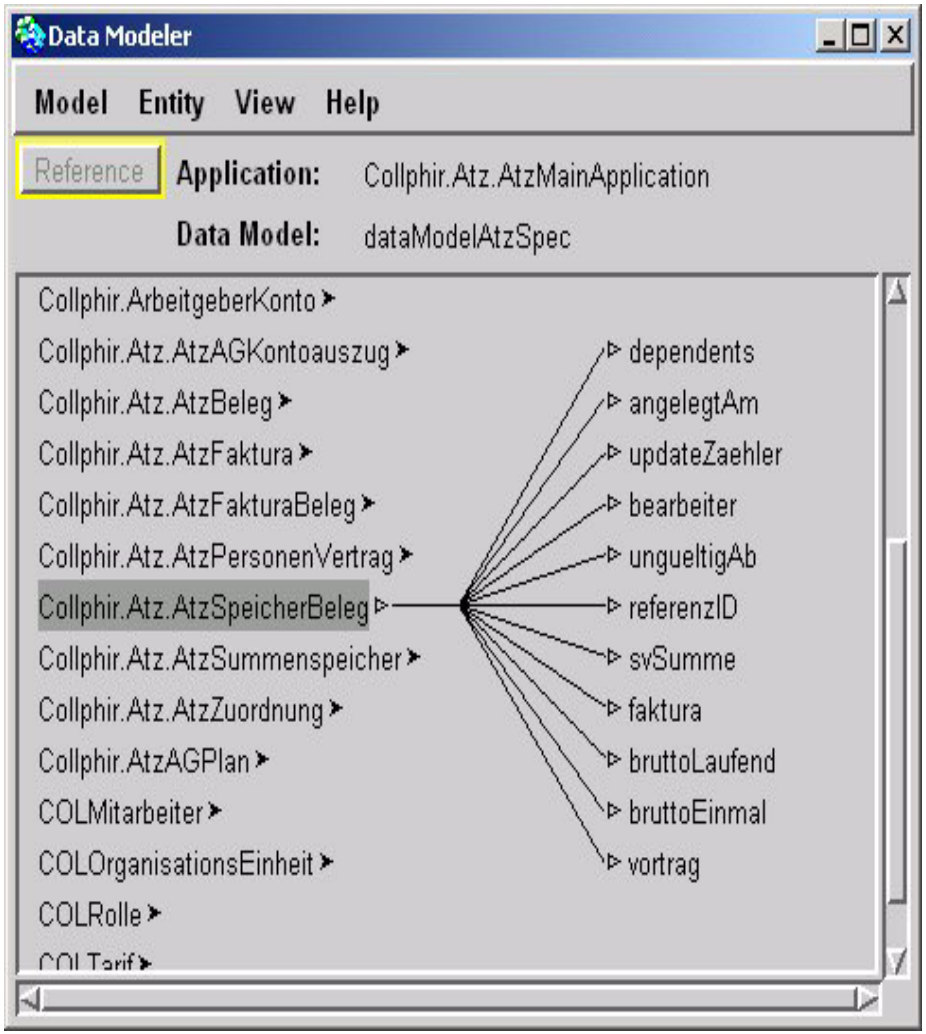
- geschlecht (engl. gender) : Boolean
- geschlecht (engl. gender) : {'m', 'w'}

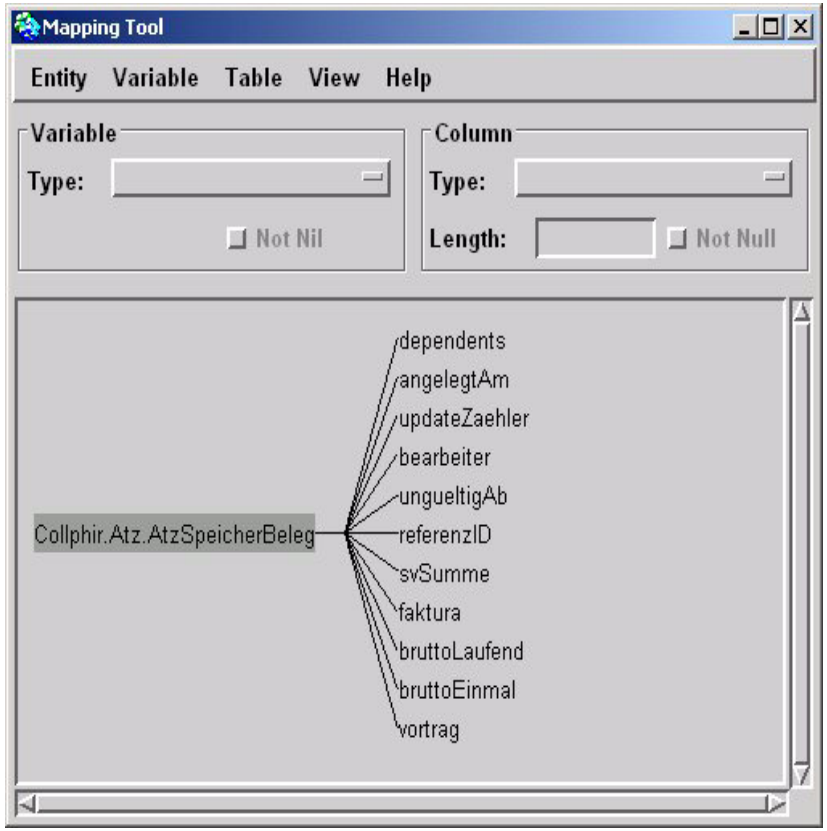
Example: Changing the class hierarchy





Example: Definition of a new class





Multiple datamodelSpec Problems

- One monolithic *dataModelSpec* is used to describe the data model of an application.
- Collphir:
  - begin: one application ➡ one dataModelSpec
  - today: a product family with common core ➡ multiple dataModelSpecs
  - copy & paste an existing *dataModelSpec* and adapt this to the new require-ments.
  - overlapping parts in all dataModelSpecs concerning the common data basis
  - synchronizing several dataModelSpecs

➡ The origin of all these problems is the redundant specification of instance variable mappings in subclasses and *datamodelSpecs*.

➡ There is no single source principle for specifications of the ObjectLens.

5. Modularization of the ObjectLens

General Ideas

- general aspects: modularization and the use of inheritance
- The *datamodelSpec* is one aspect of the class and is organized by the class itself.
  - We break up the monolithic specification in several pieces.
  - Each piece describes the mapping of one class without inherited variables.
- The single class data specifications are the pieces from which the whole data model specification is constructed.
- Instead of changing a central monolithic definition, we change only the modular definitions of the concerned classes.

➡ The result is a normal but generated monolithic data model specification.

➡ We change only the definition and construction process.

➡ All other aspects of the ObjectLens are unchanged.

Solution

a). We store the mappings in the domain classes.

b). We construct the *datamodelSpec* from these mapping fragments.

c). We support the common development tools.

d). We support the migration of our existing data model specifications.

Data Model Mappings of Classes

dataModelDefinitionSpec

```
" You should not override this message. "
^ self dataModelDefinition literalArrayEncoding
```

dataModelDefinition

```
" You should not override this message. You can adapt primDataModelDefinition"
| type |
type := self primDataModelDefinition.
self primLocalDataModelDefinitionChanges: type.
type variables: (List withAll: type variables ).
type resolveStandalone.
^type
```

- The method *primDataModelDefinition* provides the standard implementation. It will usually be automatically generated.
- The method *primLocalDataModelDefinitionChanges*: gives each class the opportunity to override the inherited definitions. It is created by hand and describes changes, which should not be overridden by further generation steps.

COLPersistentModel>>primDataModelDefinition

```
| type |
type := LensStructureType new.
type memberClass: self.
type table: ((Oracle7Table new) name: self name; owner: 'COLBAV').
type idGeneratorType: #userDefinedId.
^type
```

primDataModelDefinition

```
| type |
type := super primDataModelDefinition.
type variables add: #(#{Lens.LensStructureVariable} #name: 'name' #setValueType: #String #fieldType: #String #column: #(#{Oracle7TableColumn} #name: 'name' #dataType: 'varchar2' #maxColumnConstraint: 100) #generatesAccessor: false #generatesMutator: false #privateIsMapped: true) decodeAsLiteralArray.
self addSummenspeicherVariableIn: type.
type table name: 'kontoZuordnung' .
^type
```

primLocalDataModelDefinitionChanges:type

```
| var |
super primLocalDataModelDefinitionChanges:type.
(type variableNamed: 'speicherBeleg') setValueType: #AtzSummenspeicherBeleg.
```

LensApplication datamodelSpec

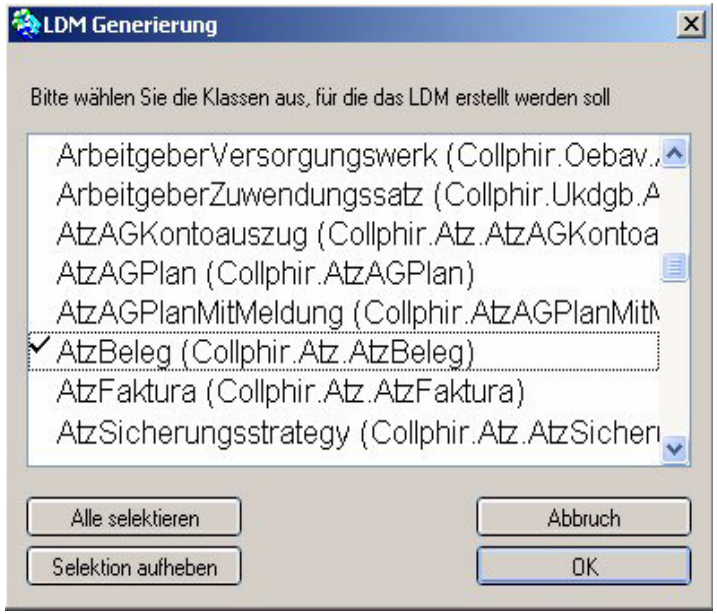
```
dataModelSpecGenerated
    | ldm |
    (ldm := LensDataModel new)
        application: self;
        fromLiteralArrayEncoding: (self dataModelSpecForStructureTypeSpecs:
                                                    self dataModelStructureTypeSpecs).
    self adaptDataModel: ldm.
    ldm compile.
    ^ldm literalArrayEncoding
```

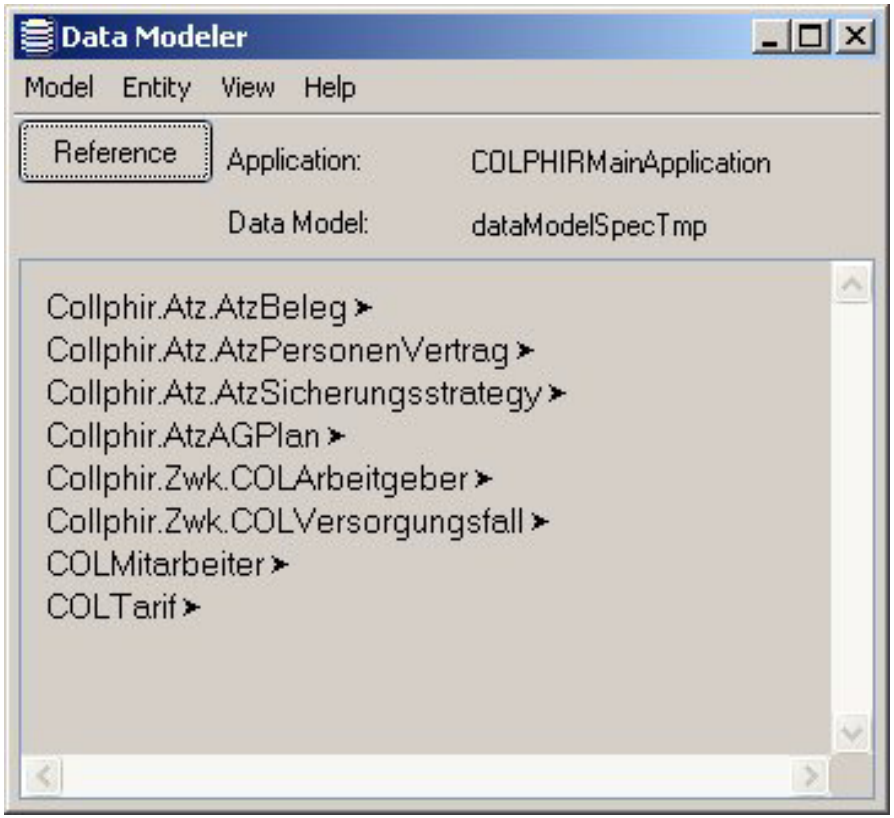
- The *LensDataModel* is created by *"self dataModelSpecForStructureTypeSpecs: self dataModelStructureTypeSpecs"*.
- The method *adaptDataModel* permits adaptations, which are only valid for this special application.

```
dataModelStructureTypeSpecs
    ^ self dataModelStructureTypeSpecsFor: self dataModelClasses

 dataModelStructureTypeSpecsFor: classColl
    ^ (classColl collect:[ :cl | cl dataModelDefinitionSpec]) asArray

dataModelClasses
    „Returns a set of all classes which contain to the data model“

dataModelSpecForStructureTypeSpecs: aColl
    | res |
    res := self dataModelTemplate copy.
    res at: 5 put: aColl.
    ^res

dataModelTemplate
    ^#(#{Lens.LensDataModel}
        #setDatabaseContext:
        #(#{Oracle7Context} ... )
        #structureTypes: #()
        #lensPolicyName: #Mixed
        #lensTransactionPolicyName: #PessimisticRR
        #validity: #installed )
```

Integration into the Lens Modeling Tools

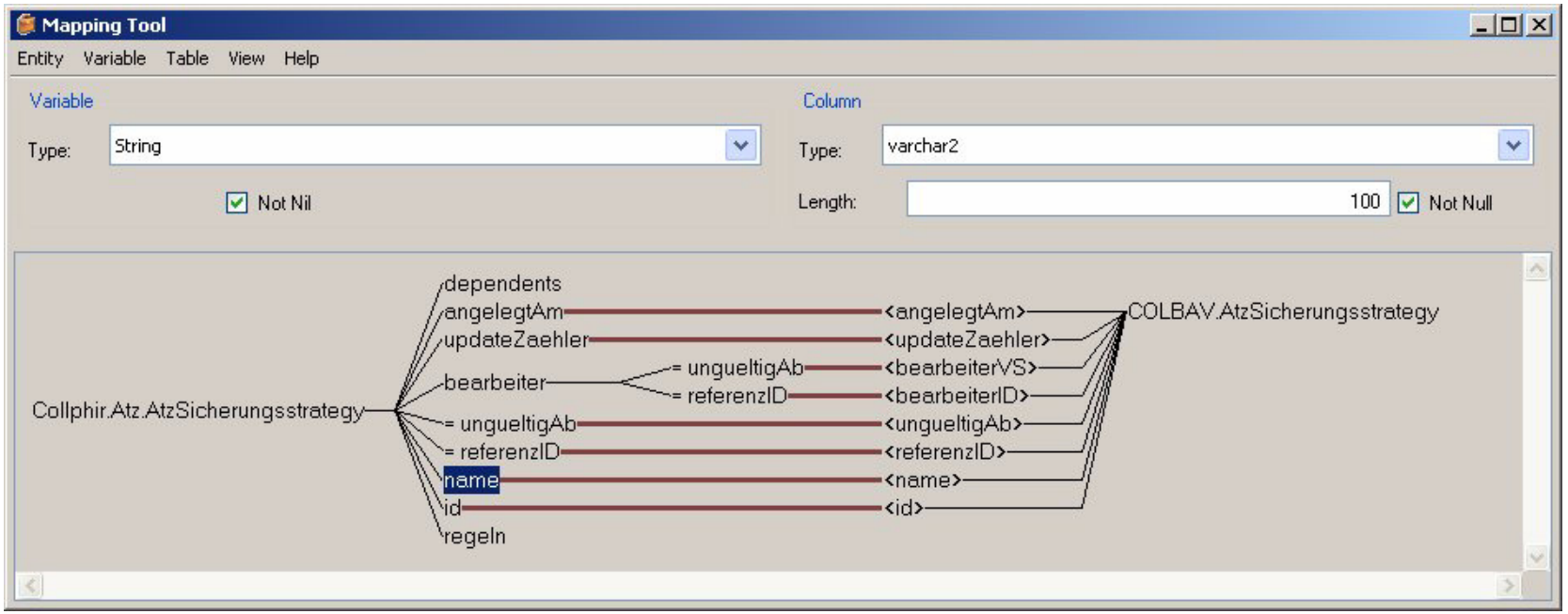
LensEditor for Class Data Models

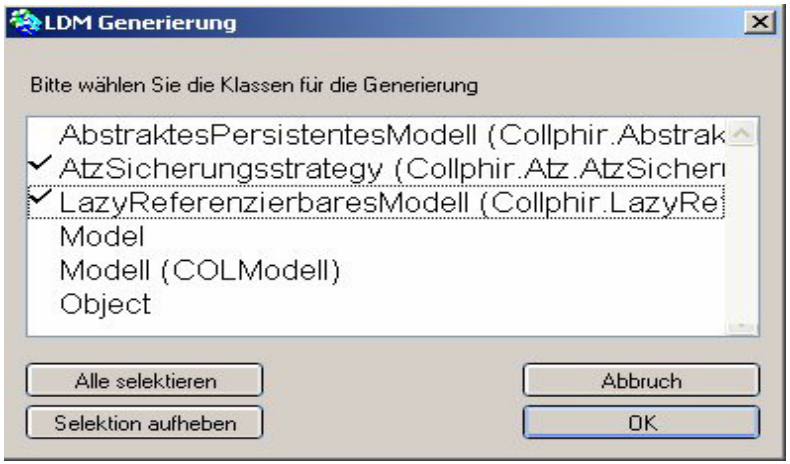





```
LensMainApplication
    openLensEditorFor:CollphirMainApplication
    with: (Set new add: AtzBeleg; yourself)
```

Lens Mapping Tool for Class Data Models






```
DataModelDefinitionGenerator new
        generateLensSpecsFrom: self ldm
        for: selectedClasses
```

Migration Process

I). transformation T

```
generator := DataModelDefinitionGenerator new
    add: AtzMainApplication dataSpec: #dataModelSpec;
    add: ZwkMainApplication dataSpec: #dataModelSpec;
    yourself.
```

II). conflict reports

```
generator report
```

III). data model classes

```
generator
    generateDataModelClassesFor: AtzMainApplication dataSpec: #dataModelSpec .
```

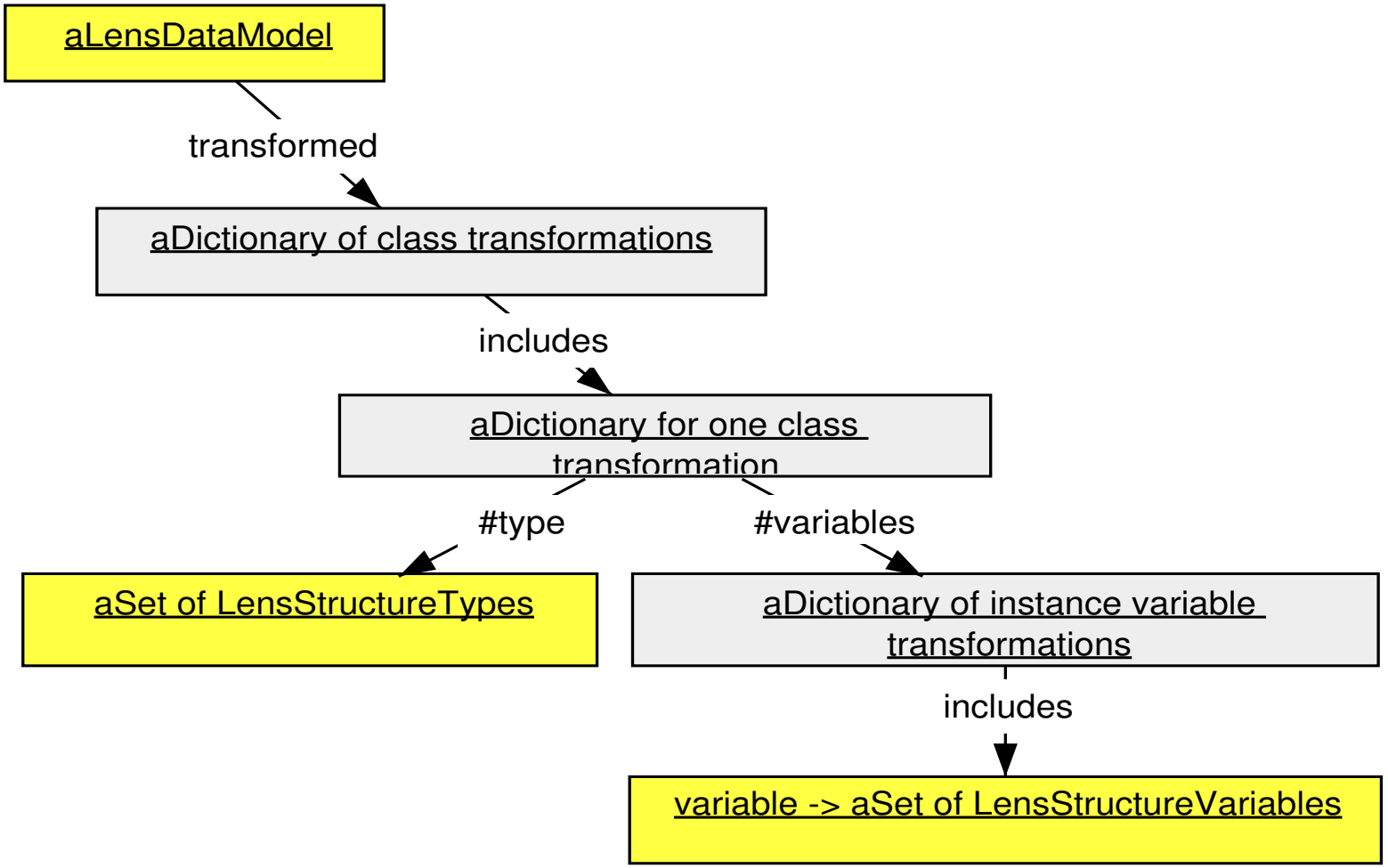
IV). generating of all classes

```
generator generate
```

generating of a subset of classes

```
generator generateLensSpecsFrom: ldm
                for: (Set new add: COLRente;add: COLAZ03 ;add: COLAZRR ;yourself)
```

Dictionary structure of transformation T



DataModelDefinitionGenerator - Generation and Migration

- migration of old monolithic *dataModelSpecs*
- generating class data models in the mapping tool

Data Model Spec Migration

- Computing the conflicts between different definitions of an entity (transformation T).
- conflict solving: two-step strategy
  - trivial cases: different max column constraints ➡ weakest condition.
  - complicated cases: pair reviews, which mapping should be become the standard.

Support of different mappings by using the methods *primLocalDataModelDefinitionChanges* and *adaptDataModel*.

Code Generation

- Generation of method *dataModelClasses* for the application
- Generation of method *primDataModelDefinition* from the corresponding *classDict*.
  - Simple data mappings are inlined.
  - Complicated mappings for foreign key relationships are extracted in separate methods.
- Code generation uses common Smalltalk techniques.
- Methods:
  - for invariant code fragments.
  - which provides a string representation for related parts of the mapping like table name, primary key, or variables.
- a stream to merge this fragments.
- Result: a source string of a Smalltalk method that we compile in the metaclass of the considered class in the protocol *'lens data model specs'*.

Testing and V&V

Generation of dataModelSpecs

- simple test data for old dataModelSpecs
- simple test data for modular dataModelSpecs (same data)
- comparison of the datamodels

Migration

- reviews (code and dataModel)
- application test
- stepwise introduction

Editing

- development use