ISTechnology - Technology Based Approach to Information System Development

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Abstract

Information Systems *T*echnology (ISTechnology) – technology-centered and metamodel based approach to Information Systems development is presented. Metamodel, method and tools for defining and enabling organizations technology are main components of ISTechnology. Predefined technological semantics (What?, Who?, When?, Where?, How?) is connected with metamodel entities and relations. *IST*echnology method and tools allow to define the technology model of the organization (according to the metamodel) and enforces people to perform tasks according to this model. This paper mainly describes the ISTechnology metamodel.

1. Introduction

"At the center of every organization is the task it performs and the technology – the work flow, methods, and equipment – used to perform it. The task could be anything – painting toys, processing personnel records, confining prison inmates, manufacturing surfboards, or any of thousands of other activities or combination of activities. But once

the organization commits itself to perform some particular task and applies some particular technology to it, then that technology will affect everything else in the organization" [1].

This paper considers the formal technology definition as backbone for building Information Systems. Metamodel, tools and method for defining organizations technology models was developed. ISTechnology provides the interpreter with standardized user interface, which lets to define and enforce people to perform different tasks within the organization according to the desired technology model. Thus the organization's technology model serves as executable specification and partially bridges the gap between the specification and the implementation of the specification and eliminates problems connected with this gap.

ISTechnology approach can also be called - Information Systems. Holistic approach. The reason is that different well-known techniques and personal experience are combined together using management term technology. The ideas proposed in [2] and [3], the conclusions of [4], successful experience gained by interpreter usage in the MAUS [5] and GRADE MSDOS versions [6, 7] had played a strong impact on the development of ISTechnology framework.

ISTechnology project was implemented mainly in 1996 (January – September) under conditions of very limited financial and human resources. The main reason to undertake this project was lack of cheap and convenient tools for building Information Systems with built-in workflow facilities. All components of ISTechnology were created, tested and improved in the process of building Trade and Treasury Management system for the Bank of Latvia.

In the development of ISTechnology, besides the author of this paper, the following people have made significant contribution: J.Iljins (the University of Latvia), I.Medvedis (the University of Latvia), I.Oditis (the Bank of Latvia), V.Spūlis (the Bank of Latvia), P.Kikusts (the University of Latvia), P.Rucevskis (the University of Latvia), K.Freivalds (the University of Latvia).

2. ISTechnology framework

ISTechnology Framework (ISTF) consists of ISTmetamodel (ISTMM), ISTenvironment (ISTE) and ISTmethod (ISTM). ISTF is used to define Organization's Technology Model (OTM) according to ISTMM. After ISTE interprets OTM and enforces employees to perform the tasks of the organization according to OTM. Employees perform the tasks in the workplaces. See example of ISTE workplace window in Figure 1.

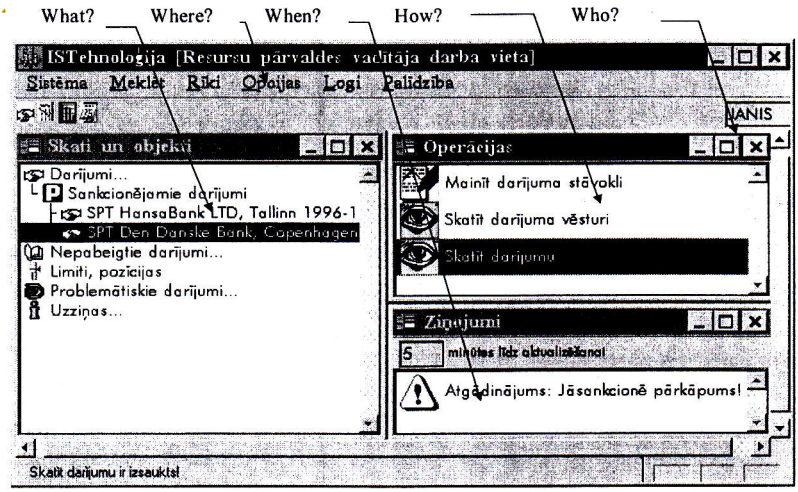

Figure 1: Organization's technological process. Employee's view

ISTE presuposes that workplaces are used only by employees allowed by the OTM. An unlimited number of workplaces of the same type can be used concurrently in the organization. ISTE provides a standartized user interface window for all workplaces. This window mainly consists of three subwindows.

In the window "Views and objects" (What?) employees can access only objects allowed by the OTM. OTM connects a set of views with the workplace. Any view is a set of views or a set of objects from one object class. Thus OTM view notion on the one hand restricts access to objects, but on the other hand helps find objects.

In the window "Operations" (How?) the OTM provides available operations, when the view or object is selected. As a result of the execution of operations new objects can be created, existing objects can be deleted, object attribute values or object relationships can be changed. As a result of these changes the object travels from view to view and from workplace to workplace. Built-in workflow facilities allow, if necessary, to perform only predefined state transitions of objects.

In the window "Messages" (When?) employees receive information, if some object "arrives" in the workplace and technology requires an execution of some predefined operation. Thus ISTE enforces employees to perform tasks of the organization according to some predefined OTM.

3. ISTmetamodel

3.1. ISTmetamodel Structure

ISTmetaModel (ISTMM) consists of seven modules (Figure 2).

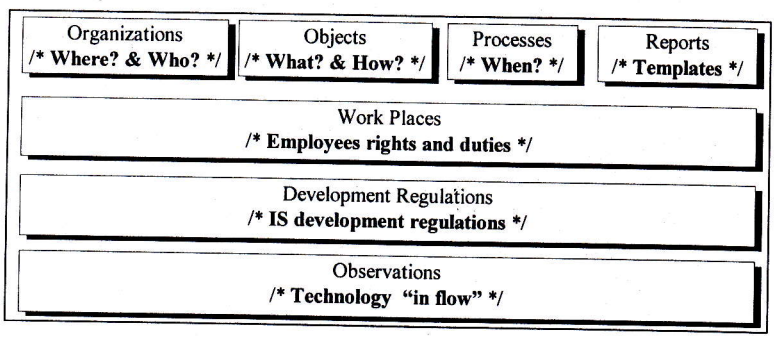

Figure 2: ISTMM components

ISTE allows defining of OTM according to the ISTMM. All ISTMM components (entities, relations, and attributes) have precise formal semantics. This semantics is taken into account, when OTM is being interpreted. Thus, ISTE enforces employees to perform tasks of THE organization according OTM.

In the following paragraphs only the very important entities, relations and attributes of ISTMM will be represented. A slightly modified notation from [2] will be used to define ISTMM. Shadowed rectangles are used to represent object modules, but gray patterned rectangles in the modules will be used to represent the entities defined in other modules.

3.2. The Organizations Module

The organization's task and technology determine the kind of people needed to do the work. Employees (Who?) operate in different positions and in different organizational units (Where?). Thus, as Thoreau wrote people are becoming "tools of their tools". In ISTMM these definitions are done via the Organizations Module (Figure 3).

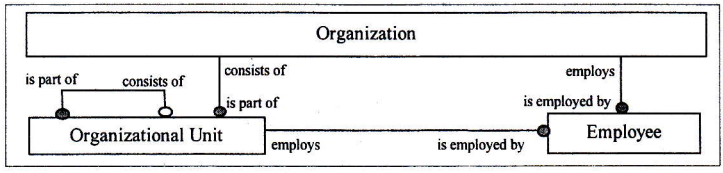

Figure 3: Part of the ISTMM Oganizations Module

The Organizations Module has full command of entities, relations and attributes to give answers to the questions "Who?" and "Where?". Any of the Organizations Module components is used in reports about OTM or audit reports. These reports give possibility to tune the OTM and to follow up the organization's technology "flow". The Employee's attribute password allows controlling ISTE login process.

3.3. *The Objects Module*

To perform tasks, employees carry out various operations (How?) with different types of objects (What?) (Figure 4).

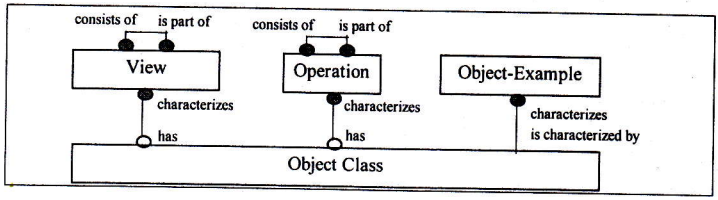

Figure 4: Part of the ISTMM Objects Module

The ISTMM Objects Module provides elements for traditional ER-modeling. It is possible to define ER-model and generate the corresponding CREATE statements. The Object Module allows to define the following important OTM components:

- **View**

  View is defined as a set of views or a set of objects. Thus, classification of objects is depicted as a set of trees built from the abovementioned nodes. The main attributes of the View are the name, the icon representing View, the icon representing objects into the View, and the keyword Self or SELECT statement, if the View contains objects.

  For example,

```
SELECT   INS_ISN, INS_NOSAUK
INTO     :i3, :curtp
FROM     VOP_INS
WHERE    INT_ISN= :isn[1] AND INS_BEIGDAT >= GETDATE()
ORDER    BY INS_BEIGDAT
```

  It is possible to use arbitrary SELECT statements. The only constraint is that SELECT statement must contain INTO section. In WHERE section it is possible to use parameters isn[0],. to identify the context of the View in the tree.

- **Operation**

  Operation is defined as a set of operations or an elementary operation. Thus, classification of the Operations is depicted as a set of trees built from the abovementioned nodes. The main attributes of the Operation are the name, the icon representing the Operation, the name of application, which implements operation (for example, unirep1.exe), statistic and dynamic parameters. Thus, ISTMM provides "plug in" mechanism. Any of programming languages can be used to implement the Operation. ISTechnology framework does not provide special language for the implementation of Operations.

- **Objects-Examples**

  At the beginning of the OTM development there are no real data base tables (specific for Information System). To cope with these situations Objects-Examples are used when there are no real objects and relationships. The main attribute of the Object-Example is the name. The views defined on the Objects-Examples of appropriate Object Class can be used. Step by step replacement of the SELECT attributes in the views can be made after creation of real database tables.

The abovementioned elements are very important components of the ISTE user interface. Employees have access and search objects using different hierarchies of Views. Thus, the View notion is used as an end user notion. The user can execute an appropriate operation, when a View or an object is selected. Objects-Examples are used to create virtual reality before real objects in the database exist.

3.4. The Processes Module

The ISTMM Process Module provides state–transition types definitions of objects and corresponding implementation mechanism for state-transitions (Figure 5).

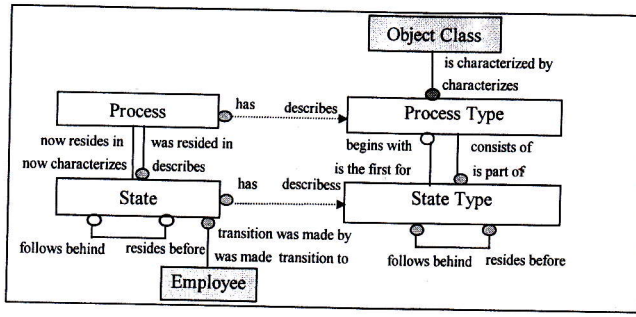

Figure 5: Part of the ISTMM Processes Module

Process type and state type entities, and the corresponding relations allow defining of state-transition process types. Process and state entities, and the corresponding relations allow to execute state transitions for real object according to the appropriate state-transition process type. Process entity, state entity and relations also provide essential audit information, "Who?" and "When?" was made state transition of the concrete object. ISTE provides tools, which allow employees to perform these state-transitions. These tools allow to realize markets style of work allocation. All possible employees are informed to find the one who is acceptable in terms of availability. If one of the employees starts some-state transition process, this state-transition process is locked for the other employees.

3.5. The Reports Module

"Indeed, more than 50 percent of the entire costs of the U.S. military software is devoted to paperwork, while pure coding accounts for less than 20 percent " [3]. Similar situation is in all software projects. Software projects tend to generate an enormous quantity and diversity of paper work. The ISTMM Reports Module tries to cope with this situation (Figure 6).

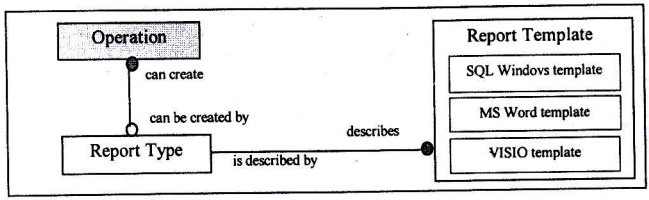

Figure 6: Part of the OTMM Reports Module

It is possible to define different report templates. For example, Microsoft Word template (as *.dot files) can be created using all Word facilities. Some Microsoft Word notions (for example, Bookmark and Field Code) have to play special roles. SQLWord tool, which interprets these templates and creates the corresponding reports, was developed. This tool is designed and implemented for Microsoft Word 95 and for Microsoft Word 97. SQLWord can be used as an Operation performer or as an independent product.

A set of report templates (according the IEEE standards) for project documentation is created. OTM serves as a source for this documentation. Templates and OTM allow receiving "up to date" project documentation with very little paper work. The Reports Module also is used to prepare for end users report templates and the corresponding reports.

3.6. The Workplaces Module

ISTMM Workplaces Module serves as glue to connect together all orthogonal components defined in the previous sections (Figure 7).

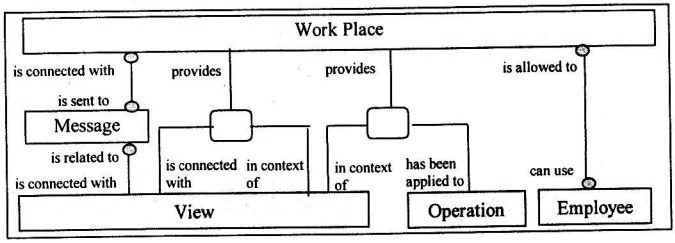

Figure 7: Part of the ISTMM Workplaces Module

The notion of the Workplace is used to define the employee's rights and duties. More formally, the ISTMM Workplace Module defines

- **Workplace**

  The Workplace entity attributes are the name and the comment. This entity is used as a placeholder to define the employees' rights and duties.

- **Message**

  The Message entity main attributes are the text (for instance, Warning: FX deals are waiting confirmation!), the icon representing message and SELECT statement. It is possible to use arbitrary SELECT statements with a set of predefined variables. ISTE executes this statement after defined time intervals. The message text appears, if SELECT statement, when executed, find some object.

- **Set of technological relations**
  - the relation between the Employee and the Workplace entities allows employees to participate in the organization's technological process with a predefined set of rights, which will be defined below;
  - the relation between the View and the Workplace entities allows the employee who works in a particular Workplace to get access only to predefined sets of Views and Objects;
  - the relation between the View, the Operation and the Workplace entities allows the employee to execute a predefined set of Operations with Views and objects in a particular Workplace;

The relation between the Message and the Workplace entities allows the employee to receive Messages about predefined events, which is connected with the Workplace. Usually these messages are related to a necessity to process some object which "arrives" in the Workplace in some View. The relation between the Message and the View entities allows the employee to find those objects easily.

ISTE interprets these technological relationships and thus enforce employees to perform the organization's tasks according to predefined OTM (Figure 1).

3.7. The Development Regulations Module

"Since software is highly labor-intensive, the communication and coordination functions span a rattier board bandwidth. Obviously, single-user tools are not sufficient for large team projects. The lack of reusable components has been a weak link in the chain of software engineering technology since the software industry began 50 year ago" [3]. The ISTMM Development Regulation Module allows to define some elementary organization's Information Systems development rules (Figure 8)

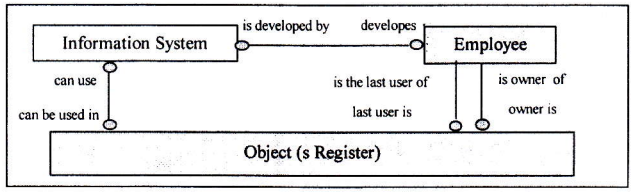

Figure 8: Part of the ISTMM Development Regulations module

The main player of the abovementioned module is the entity Information System (IS) and corresponding technological relations. The entity Information Systems defines organizations IS. The relation between the IS and the Employee allows to give the Employee a possibility to participate in the IS development. All OTM objects which are created during the IS development are registered in the Object register. The owner of the object is the Employee who creates the object. Only the owner's rights allow to edit or delete the object. The employees "non-owners" can only view objects or set relationships between "non-owned" objects. It is possible to change an owner of the object. Technological object can be automatically used in the development of IS for which it is created. It is possible to allow to reuse the object in the others organization's IS of the organization.

3.8. The Observations Module

The Observations Module provides the organization's technological process audit facilities (Figure 9).

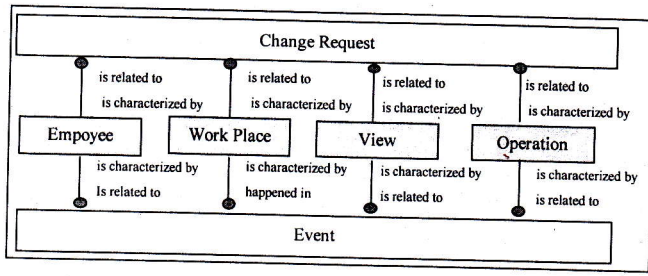

Figure 9: Part of the OTMM Observations Module

More formally, the ISTMM Observations Module allows to capture information about

- **Change Requests** (CR)

  CR has such attributes as CR call text, time of CR, and reference to the technology objects – the View, the Operation, the Workplace and the Employee. The employees can call CR. ISTE provides special tools for CR calls. In reality, the Employee has to write only CR text, all other attributes are added automatically.

- **Event log** (EL)

  Time and references to the technology object (the Employee, the Workplace, the View, the Operation, and etc) characterize technological events. Information in the EL is written when predefined technological events have happened. For example, start-up of operation, login to the ISTE and etc.

ISTE allows to get a wide range of reports about CR and EL. Thus organizations technologist can follow up the technological process and. if necessary, tune OTM.

4. ISTenviroment

ISTechnology framework was developed in the time period from June 1995 until September 1996 under conditions of very limited financial and human resources. The ISTmetamodel and ISTmethod were developed mainly in 1995, but ISTenvironment in 1996. ISTenvironment is a client-server type application. Gupta SQLWindows was used

as a development environment. Some of operations were developed using Microsoft Visual Basic. ISTenvironment can be used under Windows 95 or Windows NT operating systems. Microsoft SQLServer is used as a server engine. Currently ISTenvironment versions for Sybase and Oracle servers exist, too.

ISTehnology was implemented using ISTehnology itself. For OTM development two types of work places – the Administrator's Workplace and the Technologist's Workplace – are defined.

The Administrator's Workplace functionality allows to define the rights of the employee to use workplaces, participate in particular information system development, owner rights for technology object and rights to reuse the existing technology objects (see Sections 3.2, 3.7, 3.8).

The Technologist's Workplace allows according to ISTMM to define others OTM fragments (see Sections 3.3, 3.4, 3,5, 3.6, 3.8).

A set of parameterized standard model development operations are implemented – binary and ternary relationship editor, object destructor, simple report generators, etc. SQLWord allows to prepare Microsoft Word 95 and Microsoft Word 97 reports.

5. Experience

ISTechnology currently is used in the Bank of Latvia as standard framework for building Information Systems. Besides the Bank of Latvia during 1996 and 1997 ISTechnology framework was used in two other organizations to build and maintain complex Information Systems (Figure 10).

Information System	Organization
ISTechnology (as described in this paper)	Computer and Software Engineering Institute Ltd.
Salaries Management IS	Bank of Latvia
Employees Management IS	Bank of Latvia
Commercial Banks Management IS	Bank of Latvia
Trade and Treasury Management IS for Central Bank	Bank of Latvia

Information System	Organization
Trade and Treasury Management IS for Commercial Bank	Unibank of Latvia
Patient Register IS	Health Department of Riga Municipality

Figure 10: Examples of ISTechnology usage

6. Conclusions

ISTechnology framework – ISTmetamodel, ISTenvironment and ISTmethod - for technology-centered and metamodel based development of Information Systems was presented. This framework was verified in real life by building different types of Information Systems. The experience of the ISTechnology usage shows that the proposed framework could be successfully used in complex Information Systems development and maintenance projects.

ISTechnology framework helps quite well in the "fight" with the problems mentioned in [3]:

- Client or user requirements for software tend to be extremely volatile;
- Software tend to be extremely complex and highly error-phone;
- Software projects tend to generate an enormous quantity and diversity of paper-work;
- Since software is highly labor-intensive, the communication and coordination functions span a rather broad bandwidth;
- The lack of reusable components have been a weak link in the chain of software engineering technology;
- Software does not age gracefully. The steady accumulation of an additional 5-7 percent new functionality each year is typical for software.

Future development directions of ISTechnology framework are now being investigated. Currently ISTechnology provides very "Puritanical" framework. The reason is that experience shows - framework has to be simple in order to be used by

users. This means that any extension of ISTechnology framework must be well motivated and consequences must be carefully analyzed.

7. References

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