J. Michael, J. Pfeiffer, A. Wortmann (Hrsg.): Modellierung 2022 Satellite Events,
190 Digital Library, Gesellschaft für Informatik e.V.

Business Technologies

A Modeling Centered, Application Oriented Course

[1]Heinrich C. Mayr, [2]Volodymyr A. Shekhovtsov

Abstract: In this paper, we present the course "Business Technologies", which we offer at Alpen-Adria-Universität for students of the master's programs in Informatics and Information Systems to introduce them to the exciting world of modeling. It is a combination of lecture and project work that has been offered regularly since 2013, with the content being adapted and updated every year.

We intend this paper to stimulate discussion of modeling as an important component of Informatics teaching. Accordingly, not all our theses are scientifically substantiated; rather, some of them are intentionally formulated in a somewhat pointed way to provoke the discussion.

Keywords: Course content, project work, modeling, metamodeling, ontologies, process, business process, quality

1 Introduction

Since their introduction, the curricula of informatics studies have undergone massive changes: In the beginning the mathematical and telecommunication basics were in the foreground; from the mid-1970s onwards the main areas of software engineering, databases and information systems, operating systems, theoretical computer science, languages and artificial intelligence emerged. Within the framework of a curriculum, students were able at that time to specialize in sub-areas in the sense of majors. With the emergence of new application areas, new studies were developed, such as business informatics, bioinformatics, legal and administrative informatics, etc. A dam burst with the introduction of the Bologna structure: whenever a new buzzword comes up or a new hype emerges, new curricula are promptly invented and set up, differing from each other often only in nuances. For example, the website "studyCHECK.de"[3] currently lists more than 60 study programs with different names in Germany and Austria, which can be attributed to Informatics.

In all this time, models mostly played the role of a Cinderella in informatics teaching, despite their importance as tools for mastering complexity, for understanding complex issues, for specifying processes and systems of all kinds. Usually, the focus is on teaching

[1] Application Engineering, Alpen-Adria-Universität Klagenfurt, Austria heinrich.mayr@aau.at
[2] Information and Communication Systems, Application Engineering, Alpen-Adria-Universität Klagenfurt, Austria volodymyr.shekhovtsov@aau.at
[3] https://www.studycheck.de/studium/informatik-mathematik; visited 23.5.2022

a modeling language (SQL-DDL, UML, BPMN, SySML or a related one), and often this is done incidentally in a course on, for example, database systems, program development, business processes, mechatronic systems, etc. The essence of modeling, the understanding of abstraction and language hierarchies, such as one needs to develop domain-specific modeling languages, fades into the background. We suspect that this is mainly since abstracting and dealing with abstract is more difficult today for both teachers and learners, because the mathematical-algebraic foundations necessary for it have been largely banished from Informatics curricula. But the sometimes-encountered view that modeling is something imprecise and can therefore easily be done on the side also plays its part.

In this paper, we present a course that we offer at Alpen-Adria-Universität for students of the master's programs in Informatics and Information Systems to bring modeling a bit out of its Cinderella niche. The course title is "Business Technologies" and is chosen intentionally: on the one hand to arouse students' curiosity, on the other hand to express that modeling plays a central role in the technical support of entrepreneurial activities. It is a combination of lecture and project work that aims to introduce interested students to the essence of modeling. We have been offering this lecture regularly since 2015, with the content being adapted and updated every year.

The structure of this short paper is as follows: In section 2, we briefly describe what motivated us to set up this course. In section 3 we give an overview of the course content, followed by the supervised project tasks for the students including examples of solutions in section 4. The paper concludes with an evaluation and reflection of this endeavor.

2 Motivation

Already at the beginning of this millennium, modeling had a shadowy existence in many informatics curricula. Therefore, we developed and offered a lecture (with exercises) on the topic of modeling as part of the diploma program in computer science at that time. However, the colleagues in the curriculum committee had agreed to the inclusion of this lecture in the curriculum only if it was held in the 2nd semester, so that the other courses (database systems, software engineering, operating systems, etc.) could build on it. Consequently, the modeling contents from these courses had to be packed into the new modeling lecture. This endeavor failed grandiosely, because the efforts that students of the 2nd semester (who mainly struggle with programming, algorithms and data structures) understand modeling not only as a loose drawing of some graphs or networks, were unsuccessful: this was expressed not least in the fact that the students found the material easy at first, but then were very surprised that the exams had almost the highest failure rates.

After a few years, we abandoned this endeavor and instead developed an (elective) lecture for the now introduced master's and doctoral programs in computer science and information systems - i.e., for students from the 7th semester onwards. These students should be expected to be a bit above the technical stuff and to be able to understand

abstract contexts. As already mentioned in the introduction, we have named this course "Business Technologies", because the modeling of structures and processes, but also the development of modeling languages are crucial for the design and development of information systems for business practice. One - not entirely selfless - goal was to attract students for projects (master's theses and dissertations), but in the foreground was the desire to give modeling a place in our Informatics curricula.

Since the student population at our faculty is very international, the course is taught in English. Its "curricular value" is 4 ECTS. It consists of a teaching part and a supervised project, which groups of students have to choose and work on.

3 Course Contents

Over time, we have repeatedly updated the course content, adjusting its presentation and sequence to reflect experience, and based on student comments. Currently, the course is organized as follows:

1. **Introduction and Motivation**: We derive the importance of modeling in computer science from its explanation as the science and technique of abstracting, analyzing, designing, and executing processes. According to this, models are the key instruments for (1) understanding, (2) analysis and measurement, (3) planning, execution, control, and support of processes by appropriate systems and infrastructure depending on the process' nature and (4) optimization w.r.t. effectiveness, efficiency (vs. resources), cost, time consumption, user satisfaction, quality of results, etc.
2. **Model and Modeling Process**: In this section, basic concepts are introduced and the essential properties of models according to [Ma15] are explained. Special attention is given to the distinction between model object, model (as mental object) and model representation (by symbols/language elements) for the purpose of communication. The conclusion is an explanation of the different types of models with respect to their purpose: from prescriptive or descriptive or explanatory to transient models, from causal to explorative to predictive models, etc. The conclusion is an overview of the "House of Model" [Th14].
3. **Metamodel Hierarchy, MCA and DSML**: Motivated by the paradigm of "Model-Centered Architecture (MCA)" [Ma17] for digital Ecosystems, model hierarchies (such as the classical Information Resource Dictionary System levels and the OMG MetaObject Facility) and the associated language hierarchies are introduced here: Attention is paid to not mixing model aspects and language aspects, as this is also important in the context of Domain Specific Modeling Languages (DSML) and their development, introduced subsequently. This chapter then also discusses the step-by-step development of a DSML according to [MM15] and illustrates it with a number of example projects.

4. **(Business) Process Modeling:** Now the essential concepts of process modeling in general and business process modeling in particular are introduced. The focus is not on teaching a concrete language (even though Event Process Chains (EPC) are sometimes used for illustration) but on the aspects and properties of processes to be modeled, as well as the different types of processes encountered in practice.
5. **BPMN, ADOxx, Adonis and Horus:** In accordance with its title, this chapter is dedicated to concrete and well-known modeling methods and languages; in addition, the metamodeling framework ADOxx®, which is used in the exercises and projects, is also introduced here.
6. **Ontologies:** The semantic foundation of conceptualizations plays a major role in modeling and, of course, especially in the development of domain-specific modeling languages. Therefore, the essence of ontology is considered in more detail here, and the different types of ontologies encountered in computer science are highlighted. To address ontology implementation, OWL (W3C Web Ontology Language) is introduced.
7. **Process Quality, Quality Modeling, Principles of Orderly Modeling:** As the name of this very broad chapter suggests, it deals with the different aspects of quality in the context of modeling: quality models and their underlying "quality ontologies", quality of models, quality of the modeling process, quality awareness in system development.
8. **Aligning Business Models with Business Processes:** This is about the important integration of models of the different facets and levels of a company.
9. **Foundations of Process Modeling**: Here, the theoretical foundations of "Model Checking" and its principles are covered in sections (1) Petri Nets, (2) Finite State Automata, (3) State Charts, and (4) Model Checking.

As one can conclude from this list, it is quite challenging to deal with all these topics in a course in the appropriate depth and with the necessary exactness in such a way that they are also comprehensible to the students. We therefore must admit that the last chapter usually comes off a bit short, also because the mathematical background required here is rather unfamiliar to the students. In view of the fact that our studies are also geared more towards "applied computer science", this is, however, justifiable.

4 Practical Tasks / Projects

As noted in section 2, the course "Business Technologies" consists of a part of frontal teaching and a supervised group work in the form of a project. In these projects, either a comprehensive business process model or a (simple) domain-specific modeling language including a modeling tool has to be developed by each group. Suggestions for topics are given by the course instructors, but students can also suggest topics from their own field of experience. The project work starts from the 4th week of the semester and lasts until

the end of the lecture. During this time, students must repeatedly present interim results (analysis, drafts, etc.) - and receive advice for further work. The final result is the finished model or modeling tool, as well as a report.

Examples of topics from the area of business process modeling

"*You are requested to perform the necessary requirements elicitation and analysis, process model design and implementation for one of the following business processes*:"

- Approval of a building project from the perspective of a municipality
- Purchase and registration of a company car
- Operation of a fast-food restaurant
- Customer acquisition by an electricity supplier (example solution see figure 1)
- Preparing a dissertation at AAU (along the study and examination regulations)
- Preparing and performing a conference participation including travel
- Organizing a scientific conference
- Handling a property damage report – from dealing with insurance to organizing repairs
- Handling bug reports and feature requests by a ticketing system like Atlassian JIRA or Bugzilla.

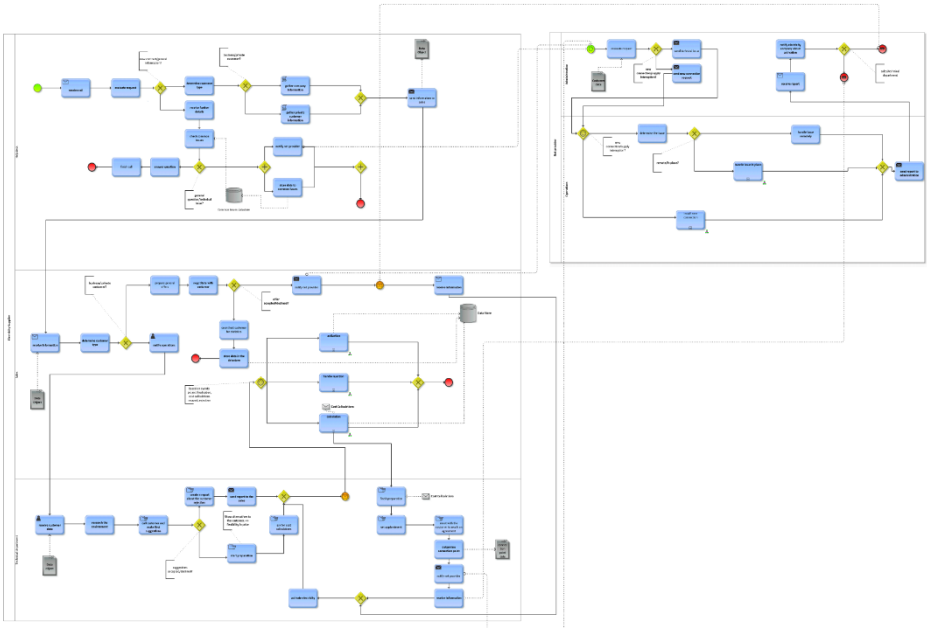

Figure 1: Business process model developed by a student group for the "Customer acquisition by an electricity supplier" assignment, represented using ARIS Express; *Note: this image is intended to give an impression of the complexity of the solution, but not its details*

Examples of topics for designing a DSML and developing a modeling tool.

"*You are requested to perform the process of DSML-development as described in [MM15] for one of the following domains:"*

- Family trees
- Room plans
- Petri Nets
- System Dynamics
- Static and dynamic aspects in medical practices (example solution see figure 2)
- Ambient assistance in the households of the elderly
- Garden planning with 2D elements
- Covid19 Vaccination
- Traffic planning of a city

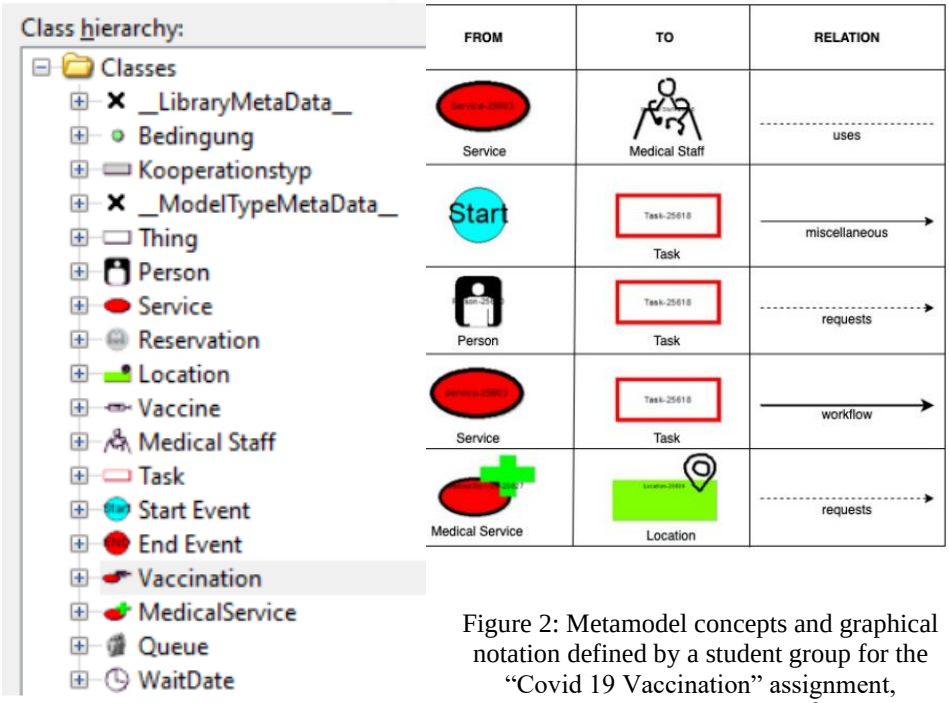

Figure 2: Metamodel concepts and graphical notation defined by a student group for the "Covid 19 Vaccination" assignment, implemented in Adoxx®

5 Evaluation

In times when it is in to look at "artificial intelligences", data analytics, deep learning etc., a course focused on modeling does not find an extremely large number of participants, but very interested and committed ones.

They all performed their respective tasks well to very well, of course under appropriate supervision, and we particularly enjoyed seeing the progress in understanding modeling and thinking at different abstract levels: that models and their representations should be separated, that model and language hierarchies are structured differently, that at each model level (M^0 to M^n in terms of MOF) there must be a semantic foundation in the form of an ontology or encyclopedia so that one can talk about conceptual models, all this the students grasped over time. And they were able, in the context of their project, to define their own modeling language and generate a modeling tool for it or to perform an extensive requirements elicitation and study, to choose a BP modeling tool and to develop an appropriate business process model. In addition, they showed a deeper understanding of what constitutes processes, why parallelism and concurrency are to be distinguished from each other, or why it makes sense to do model checking. According to statements and records of the students, they were able to complete their assignments in the planned time, i.e., in approx. 60 full working hours per person.

The self-serving goal of attracting students for master's theses and dissertations, as stated in the motivation, was achieved: A total of four dissertations and four master's theses have been started by interested students of this course, of which five have been completed and three will be completed soon.

6 Acknowledgement

We thank the unknown reviewers for their constructive and valuable comments.

7 References

Students will, of course, be given extensive references to the individual chapters as part of the course. Within the scope of this short paper, such a list would go too far, so we limit ourselves to the literature references referenced in the text.

[Th14] Thalheim, B.: The Conceptual Model: An Adequate and Dependable Artifact Enhanced by Concepts. Information Modelling and Knowledge Bases, Vol 25, IOS Press, 2014

[Ma15] Mahr, B.: Modelle und ihre Befragbarkeit - Grundlagen einer allgemeinen Modelltheorie. Erwägen-Wissen-Ethik (EWE), Vol. 26, Issue 3, pp. 329-342, 2015.

[Ma17] Mayr, H.C.; Michael, J.; Ranasinghe, S.; Shekhovtsov, V.A.; Steinberger, C.: Model Centered Architecture. In Cabot, J. et als (eds.): Conceptual Modeling Perspectives. Springer Nature, 2017.

[MM15] Michael, J.; Mayr, H.C.: Creating a Domain Specific Modelling Method for Ambient Assistance. In: Proc. Int. Conf. on Advances in ICT for Emerging Regions 2015.