OMiLAB - An Open Innovation Community for Modeling Method Engineering

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OMiLAB - An Open Innovation Community for Modeling Method Engineering

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Abstract: *The Open Models Laboratory (OMiLAB) provides an open innovation environment for modeling method engineering. Innovation within OMiLAB relates to the engineering of new domain-specific modelling methods. The created modeling methods are shared in a world-wide open and collaborative community. OMiLAB enables prototyping and experimentation in heterogeneous research areas. The backbone of the OMiLAB ecosystem is openness on multiple layers: content, methodology, and technology. Content refers to the sharing of research results, methodology refers to the application domain of modeling methods, and technology refers to the provision and use of open technologies. This paper introduces OMiLAB briefly focusing on the different evolved communities that constitute the OMiLAB ecosystem as it exists today.*

Keywords: *open models; modeling method engineering; domain-specific conceptual modeling; open innovation*

INTRODUCTION

Digital transformation and emerging technologies like Internet of Things (IoT), Cyber-physical Systems, or Industry 4.0 enable innovative product service systems that will change the way humans use, interact, and employ information technology. These changes also come with novel requirements when thinking of the design and development of information and communication systems. Conventional and de-facto industry standard modeling languages like UML or BPMN cannot cover all these specific requirements adequately. It is therefore one recent focus of information science research to explore novel domain-specific conceptual modeling methods and to develop modeling tools [1] that enable efficient application of these methods [2]. Simultaneously, an increasing amount of interest is put on openness and information technology - and in particular on applying openness in research [3].

Following these directions, the Open Models Laboratory (OMiLAB) works at establishing an environment for an open community that enables prototyping, experimentation, and practice-oriented information science research related to modeling method engineering. OMiLAB targets modeling enthusiasts independent of their domain focus, aiming to address upcoming needs by designing domain-specific conceptual modeling methods. The goal is to act as a facilitator similarly to Wikipedia [4] for common knowledge creation or platforms like Apple iOS and Google Android for application development (cf. [5]). The community shares experiences, discusses ideas, proposes approaches, and realizes prototypical solutions related to current and emerging challenges. This vision becomes manifest in the three pillars the OMiLAB builds upon: the *Innovation Environment*, the *Collaborative Environment*, and the *Technological Environment*.

The paper at hand introduces the OMiLAB and exemplifies current endeavors. The goal is to foster a common understanding on the need of a condensed and open community for collaborative practice-oriented information science research. The paper is structured as follows: Section 2 provides an overview of the OMiLAB by detailing the three OMiLAB pillars. Thereafter, Section 3 discusses the multiple levels of openness and relates the correspondingly evolved communities. Practical relevance and possibilities of deployment are evaluated in Section 4. A discussion and some open issues conclude this paper in Section 5.

THE OMiLAB

Information science researchers used the OMiLAB facilities for design and develop domain-specific prototypes for a variety of domains like enterprise modeling [6, 7], data science [8], business engineering [9], or health care [10] (see [11] and www.omilab.org for an overview of the covered domains and available tools). Up to now, the OMiLAB community has continuously grown to over 40 projects which span 4 continents and more than 25 countries.

What makes OMiLAB unique is the diversified set of services it offers to the community, like: (1) *Conceptualization*: where OMiLAB provides expert knowledge in the conceptualization of modeling methods. New members can benefit from existing expertise and contribute their specific requirements and solutions to further extend the knowledge base. (2) *Cooperation*: OMiLAB to be an open community of modeling enthusiasts. Consequently, an open communication and collaboration environment has been established. New members may introduce themselves to the community and identify

collaboration partners. (3) *Evaluation*: Modeling experts from a large set of domains contribute to OMiLAB. These experts can engage in evaluating a novel modeling method. (4) *Dissemination*: The web-based OMiLAB portal is useful for searching for domain-specific modeling methods that are comprised by freely available modeling tools. Hence, contributing to the OMiLAB enables new members to benefit from a) the broad audience of OMiLAB portal visitors, and b) the participation in OMiLAB events and projects. (5) *Education*: Recently, OMiLAB also started to educate young scientists, interested in conceptual modeling and the area of Internet of Things. Moreover, OMiLAB tools like Bee-Up[1] are attracting attention at multiple universities, where they use the tool and the provided materials in their teaching activities. As a consequence, OMiLAB community members are asked to provide not only their modeling tool but also training material on a free basis. This enables the tools to be tested and used by a broader audience, addressing also non-experts of the specific domain, or the usage within university teaching.

2.1 Collaborative Environment

Collaboration of practice-oriented IS researchers and practitioners within the OMiLAB can be triggered by a plethora of activities like scientific workshops (e.g., [12]) and tutorials (e.g., [13]) at national and international conferences, or by trainings in modeling method engineering and tool development. Moreover, currently two physical OMiLABs exist that ensure local collaboration facilities. One is located at the University of Vienna, Austria[2], the other at the University of Chonbuk, Korea[3]. Both labs aim at becoming the primary address for method engineers and tool developers in their respective region. They employ the methodologies and approaches introduced in the Innovation Environment as well as the tools and platforms provided by the Technological Environment.

The OMiLAB's collaborative environment is intended to grow further as such distributed facilities enable local bonding whilst ensuring international collaboration and visibility. Organizers of an OMiLAB can utilize local contacts, address colleagues in an appropriate tone and even with the same language. This fosters collaboration and bridges entry barriers. OMiLAB community results as well as the international distribution of its collaborators are documented in a wide variety of free available modeling tools and models created with them. A major pillar of the collaborative environment is the Next-generation Enterprise Modeling Summer School (NEMO), which will be detailed in the following.

2.1.1 Next-generation Enterprise Modeling Summer School (NEMO)

The annual NEMO Summer School[4], funded through the Erasmus+ Strategic Partnership Project OMI-KA2, is one recent endeavor within the OMiLAB collaborative environment. Table 1 lists the professors and students of the last four NEMO editions. Figure 1 moreover illustrates the worldwide distribution of the NEMO students. The NEMO program comprises theoretical lectures and practical exercise sessions. The exercises enable the transfer of theoretical knowledge towards practical application in novel domains like Smart Cities [14, 15] or the application of the theory with an open modeling tool provided by the OMiLAB. NEMO enhances the community with the next-generation of practice-oriented research and initiates new collaborations, ultimately leading to the creation of new open content and open modeling tools.

NEMO enables the community, albeit being distributed around the world, to physically interact, share experiences, and discuss future collaboration possibilities. For the students, NEMO is a unique opportunity to interact with other students coming from completely different cultural and educational backgrounds. In the two-week program, the students have the possibility to listen to distinguished professors and leading scientists, enabling them to broaden the spectrum and reflecting on different views on certain topics which would not be possible at regular university curricula.

Table 1: Summer School students' statistics of the years 2014 to 2017

	Lecturers	Students	Lecturers	Students	Lecturers	Students	Lecturers	Students
Year	2014		2015		2016		2017	
# of Participants	36	50	32	50	45	67	45	67
# of Countries	14	18	14	21	19	27	18	25
# of Continents	2	3	4	2	5	4	3	4

[1] BEE-UP Modeling Tool [online], http://austria.omilab.org/psm/content/bee-up/info
[2] OMiLAB Austria [online], http://austria.omilab.org
[3] OMiLAB Korea [online], http://asia.omilab.org
[4] NEMO Summer School [online], http://nemo.omilab.org

Figure 1: Origin countries of the NEMO Summer School students (in dark grey and the listing) of the years 2014 to 2017

2.1.2 OMiLAB Training

OMiLAB provides currently two types of trainings: *one for method engineers and one for tool developers*. The first type of training provides theoretical foundations and practical examples of how to conceptualize a new domain-specific modeling method. This includes aspects on the modeling language, e.g., how to design meaningful and intuitive graphical visualizations (cf. [16, 17]), how to specify type and inherent semantics [18], or how to specify mechanisms & algorithms that process the knowledge codified in the models.

The second type of training provides a training concept and supporting material for tool developers. This comprises information on how to realize the theoretic specification of a modeling method with a given meta modeling platform (cf. [19]). The experience gained through conducting multiple physical trainings in the OMiLAB Vienna is used to continuously improve the quality of the trainings in order to enable people to study without any physical interaction.

2.2 Innovation Environment

Within the context of the OMiLAB Innovation Environment, innovation relates to the design and development of novel modeling methods and the provision of corresponding modeling tools. Both are knowledge-intensive tasks requiring a rich set of skills and expertise. To help novel method engineers coping with this complexity, OMiLAB provides methodological support built upon experience and best practices (see [20] for a detailed description): (1) *Agile Modeling Method Engineering (AMME)*: AMME provides guidance in defining domain requirements and designing a modeling method in an agile manner. (2) *AMME Lifecycle*: The AMME conceptualization lifecycle provides guidance by introducing a procedural approach starting from the specification of a modeling method and targeting the development and deployment of a corresponding modeling tool.

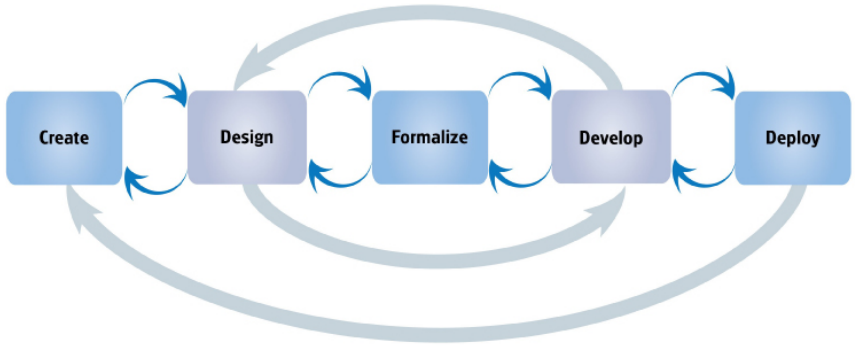

Figure 2: The AMME Lifecycle [20]

The AMME lifecycle visualized in Figure 2 comprises the phases *create*, *design*, *formalize*, *develop*, *deploy*. Each phase is supported by specific methodologies, tools, and best practices. All mentioned aspects target knowledge sharing and helping novices in designing and developing modeling tools in the OMiLAB. Methodological agility is enabled by an iterative *Produce-Use* cycle, with two phases per iteration: (i) the Produce step will capture domain knowledge (*models of concepts*), formalize it and deploy it in a modeling tool; (ii) the Use step employs this modeling tool to capture case knowledge that instantiates the domain concepts (*models using concepts*) while also evaluating acceptance and various quality criteria to feed back in the next iteration of the Produce step.

The AMME lifecycle comprises the following steps and associated tasks [20]:

- *Create*: a mix of knowledge acquisition and requirements elicitation techniques;
- *Design*: practices for designing the modeling method building blocks as introduced in [21], i.e., modeling language, modeling procedure, and mechanisms & algorithms;
- *Formalize*: refinements of the method design in terms of appropriate formalisms, to supporting implementations across various platforms by removing ambiguities from the method design specification (cf. [22]);
- *Develop*: the modeling tool development phase, typically benefiting from rapid prototyping environments;
- *Deploy/Validate*: the packaging and deployment of the tool with improved user experience and an evaluation protocol that feeds back into the Create step of the next iteration.

Feedback loops occur both internally, between subsequent phases, and for the overall cycle, as each deployment collects change requests for the next method increments.

2.3 Technology Environment

The aim of the technological environment is to support method engineers with open tools and technologies fostering design and development of modeling methods, and with a platform to exploit the modeling tools by open source technological means.

2.3.1 The ADOxx Meta Modeling Platform

The ADOxx meta modeling platform[5] has been successfully used in a multitude of industrial and research projects. The aim of the platform is to raise the abstraction level of modeling tool development to a more adequate level - enabling engineers with low programming experience to realize their modeling tools. ADOxx takes care of all the domain-independent and non-functional requirements like model management, user management, storage, visualization, and user interaction. What is left to the tool engineer is to (cf. [6]): 1) configure the specific modeling language by referring its concepts to the meta concepts of the platform; 2) provide a proper visualization for the concepts and combine concepts into logical clusters, i.e., ADOxx model types; and 3) realize tool functions and other functionality like model transformations, model queries, or simulations.

When the development is finished, all relevant information can be packaged and sent to an openly available deployment service[6]. Within a couple of days, users receive a download link with a complete Windows installer package for their modeling tool.

2.3.2 The OMiLAB Portal

The OMiLAB Portal is the central space for all activities and materials of OMiLAB. It is a responsive web application available at *www.omilab.org* for the presentation of modeling projects, OMiLAB Collaborative Environment events, services and tools of the OMiLAB Technology Environment. Each OMiLAB project can use the portal functionality to provide the interested visitor with information regarding the application domain requirements, use cases, tutorials, training materials, a wiki, and a download for a modeling tool for his/her modeling method. The portal is realized with a state-of-the-art technology stack on top of a microservice architecture. This architecture enables easy extension of its functionality as well as the integration with existing third-party services. All microservices are well documented and comprised by a user manual and a developer manual. The whole technology stack is based on open source and open use platforms and technology enabling the creation of a developer community and the efficient extension of the portal with other platforms and tools.

[5] ADOxx meta modeling platform [online], http://www.adoxx.org
[6] ADOxx Deployment Service [online], https://www.adoxx.org/live/adoxx-development-tools

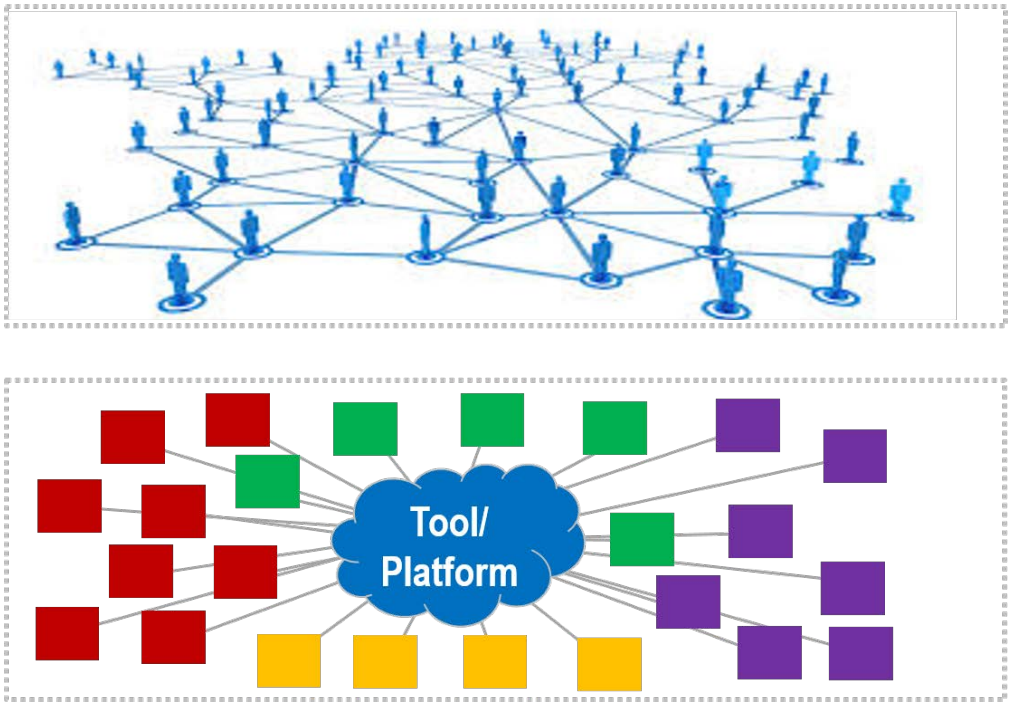

Figure 3: The OMiLAB Research Community (top) and the tool-centered Developer Community (Bottom)

OPENNESS & OPEN COMMUNITIES IN OMiLAB

OMiLAB was inspired by the open source movement in the software domain and motivated by the belief that the conceptual modeling community was yet to harness the innovation potential lying in using similar concepts and tools. The same importance for OMiLAB's inception had the observation, that successful communities tend to center around a technological platform, which enables the collective and individuals to contribute their ideas and work. The idea of the OMiLAB is therefore to foster individual ad-hoc networking between researchers sharing similar research interests (see Figure 3 top) while at the same time providing a common technological backbone based on open technology and an open platform (see Figure 3 bottom). Lastly, results of the OMiLAB shall be provided as open content in order to share knowledge and disseminate research results. Consequently, openness on multiple levels is vital for the Open Models Laboratory. In the last decade of operation, several communities have established themselves, benefitting from the openness of the OMiLAB as shown in Figure 4.

On the bottom of Figure 4, the technological backbone as described in Section 2.3 is given. Here, a developer community has been established, positioned around the ADOxx meta modeling platform with www.adoxx.org as a central knowledge and community base. As of May 2017, the developer community has grown to more than 1.700 developers distributed among 44 countries on six continents. 12 laboratory installations and 16 partner universities and research groups exist that operate and use ADOxx in their research and education.

Using the technological foundation, a research community has been established that creates domain-specific modeling methods and tools. Besides its utilization by researchers, ADOxx was also successfully used in more than 26 EU-funded projects. Hence, technology-driven innovation is documented in the high number of acquired funding and the dissemination of the results. A recent book by Karagiannis et al. [11] documents first results of the divers domain-specific modeling methods conceptualized within the OMiLAB. The methodological diversity is documented by over 40 different domain-specific modeling methods and corresponding tools already realized and available within the OMiLAB. The research community comprises scientists coming from all continents of the world, realizing their very own domain-specific methodologies to address domain-specific and/or regional challenges. In the last four years, only the lecturers of the NEMO Summer School add up to 158, not counting PhD students. In addition, several international collaborations have been established, e.g. to the University Technology, Sydney, to the Instituto Tecnológico Autónomo de México, and to the University of Pretoria.

Finally, OMiLAB research results are used and shared in an educational community, interested in learning cutting edge conceptual modeling research and applying open tools in educational scenarios. Here is where open OMiLAB content is

used in e.g., the trainings and the NEMO Summer School series, continuously educating the next generation of OMiLAB contributors. All results produced by the research and developer communities are openly accessible through the OMiLAB portal[7].

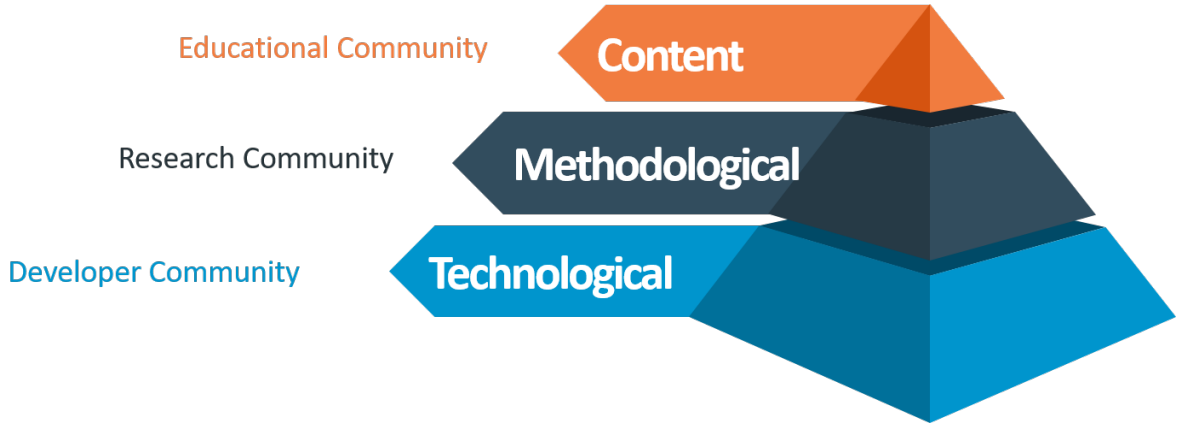

Figure 4: Different Levels of Openness with corresponding Open Communities in OMiLAB

EVALUATION

The evaluation of the OMiLAB is not an easy endeavor as it comprises a multitude of tools, services, methodologies and best practices. In the following, the evaluation therefore regards OMiLAB's performance by focusing on: i) the educational impact of the NEMO Summer School; ii) the practical relevance; and iii) deployment possibilities.

4.1 Educational Impact

Since 2014, the NEMO Summer School featured 158 lecturers educating a total number of 234 students. The positive feedback from both sides, lecturers and students, is manifest in the high degree of recommendations and oral advertisement we observe. Due to the fact, that the Summer School is currently funded by an Erasmus+ program of the European Commission and that the students are asked to take part in an examination after the program, students are even able to integrate their Summer School into their curriculum. A detailed qualitative evaluation of the exercise sessions of the 2016 edition of the Summer School can be found in [14].

4.2 Practical Relevance

Practical relevance of the OMiLAB is reflected in the high number of international contributors and over 40 open modeling tools with models. IS researchers of varying domains successfully utilized the OMiLAB to design and develop domain-specific solutions (cf. [11]). In this regard, the OMiLAB contributes to the need of encouraging collective intelligence for the common good (cf. [23]).

The tools created within the OMiLAB enable practitioners and students to practically apply conceptual modeling in diverse domains. One recent OMiLAB project with contributors from industry resulted in a domain-specific modeling method for product service systems in the context of Internet of Things - the ComVantage method [24]. ComVantage was developed following the AMME approach and the OMiLAB lifecycle. It features modeling of complex mobile maintenance processes and model processing using Linked Open Data technologies [25, 26]. A different project is concentrated on improving enterprise architecture management with ArchiMate by proposing domain-specific adaptations of the standard [27].

4.3 Deployment

All materials and all implemented tools and services of the OMiLAB are openly available. OMiLAB aims to distribute the idea of open modeling all over the world. Researchers interested in establishing an OMiLAB in their region are encouraged to use and extend existing materials in order to benefit from existing works.

Since autumn 2015, a second physical OMiLAB is successfully in operation. It is located at the Chonbuk University in Korea and aims at supporting the Asian region with knowledge and tools on the conceptualization of domain-specific conceptual modeling. In this regard, OMiLAB had a first successful inauguration of its ecosystem on a different continent.

[7] The OMiLAB Portal [online], www.omilab.org

Moreover, feasibility is demonstrated and maturity is increased by this process. A further OMiLAB in Europe is already in the concrete planning phase.

We hope to motivate further researchers to collaborate with the OMiLAB and to deploy and operate more OMiLABs. Having more local laboratories significantly increases the productivity of the whole community. The power of the community moreover increases with any new member and OMiLAB.

DISCUSSION & OPEN ISSUES

The paper at hand introduced the Open Models Laboratory (OMiLAB) by focusing on the three building blocks, i.e., the Community Environment, the Innovation Environment, and the Technology Environment. Moreover, the different communities – evolved around the three levels of openness have been introduced.

To the best of our knowledge there is no similar initiative as the OMiLAB. The amount of open services, tools and platforms as well as the focus on domain-specific conceptual modeling make the OMiLAB interesting for researchers and practitioners worldwide. The OMiLAB has been successfully utilized in numerous modeling method engineering projects coming from a rich set of different domains. However, lots of work is still left to be done and the possibilities for collaboration and extension of the OMiLAB are infinite.

Future extensions of the OMiLAB Portal will incorporate the possibility to design domain ontologies, and the possibility to collaboratively discuss published models. The idea is to have all information at one place and to enable direct feedback and exchange of opinions in an open environment. This will also bridge the different OMiLAB communities (see Section 3). One last endeavor is to strengthen the communities by investigating existing research on the roles and partners inevitable for the establishment of a successful and lasting online community as proposed by e.g., [28, 29].

Future work will also focus on transporting the OMiLAB and its ideas to regions and disciplines not yet addressed, e.g., Latin America and North America in the former and e.g., mechanical/electrical engineering, social sciences, and more industry-focused domains in the latter. Moreover, we aim at continuing to support modeling method engineers with meaningful tools and knowledge. We will continue organizing the yearly NEMO Summer School to establish an annual meeting point for all OMiLAB community members and modeling method engineers from all over the world.

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