The 4+1 View Model of Industri–Academia Collaboration

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Abstract

Industry–academia projects exist in complex contexts of various stakeholders, time perspectives, and goals. In order to analyze projects and communicate about them, we have defined an "architectural" model for industry–academia collaboration, inspired by Kruchten's software architecture model. The model has four views of i) time, ii) space, iii) activity and iv) domain, corresponding to the questions: when, where, how and what. The +1 view is the scenario, binding the other four together. We illustrate the model by applying it to the Industrial Excellence Center EASE and the Sigrun Software Innovation and Engineering Institute. The model helps analyzing industry–academia collaboration projects, to find gaps and reduce redundant work.

1 Introduction

When defining industry–academia collaboration projects, there is often an urgent need to communicate not only what topics to be worked on, but also how, in which time frame, and by whom. Further, whether a project should be funded or not is not only a matter of topic, but also how it may be complementary to existing projects and how it enables collaboration between new stakeholders. In order to support this communication and assessment of ongoing collaboration projects, we have defined *the 4+1 view model of industry–academia collaboration*. The model is based on experiences from more than a decade of collaboration between industry and academia in different projects, and is of course inspired by Kruchten's 4+1 View Model of Architecture [5]. More specifically, this work is based on experiences from the Industrial Excellence Center for Embedded Applications Software Engineering (EASE)[1] and our forming of the Sigrun Software Innovation and Engineering Institute[2].

Previously presented models for industry–academia collaboration focus on *activities*, as proposed by Gorschek *et al.*[4], or *relations*, as proposed by Sandberg *et al.* [8]. Other work includes *experience reports* on specific projects [7] and summaries of *challenges* for the industry–academia collaboration [9]. The model proposed in this paper addresses the "architecture" of industry–academia collaboration, i.e. the "components" and their structural relationships.

We present the model in section 2, and introduce each of the 4+1 views in subsections 2.1 to 2.5, elaborate an example from EASE and Sigrun in section 3, while section 4 concludes the paper.

2 4+1 View Model Overview

The proposed *the 4+1 view model of industry–academia collaboration* consists of four views,

[1] http://ease.cs.lth.se

[2] http://www.sigrun.se. The organizational host for Sigrun is currently under investigation, but for simplicity, we refer to it as a separate unit here as it has been up till now.

according to the traditional *when, where, what* and *how* questions. The +1 view, is like in Kruchten's model, the scenario instantiation, which binds them all together.

1. Time view (when)
2. Space view (where)
3. Activity view (how)
4. Domain view (what)
5. + Scenario view

The model is graphically represented in Figure 2, and is elaborated below.

2.1 Time View – When?

In the forming of any project, the time constraints are by definition important, since a project can be defined as "a temporary endeavor undertaken to create a unique product, service, or result" [1]. This is of course applicable for an industry–academia project as well. However, here we refer to *target time* for the joint project. Is the project aiming at addressing current problems, next product generation problems, or a future problem, which we only see at the horizon from an industrial point of view? We therefore define the time view in terms increasing time to when the research is expected to be practiced:

- Now – best current practice
- Soon – next practice
- 3–5 years – applied research
- 5+ years – basic or fundamental research

Now, there are best software engineering practices in industry, which most probably can be shared between industry partners. Academia may have a catalyst role is this peer-to-peer exchange, but more often, this is the role taken by consultancy companies. Next is about practices at the door-step, for example practices developed and evaluated in pilot projects. The industry–academia collaboration may here involve scaling up the application of the practices, but gradually, industry or industry consultants take the responsibility for the roll-out. The 3–5 years perspective is fruitful for industry–academia collaboration, where the slower, more thoughtful pace of academia processes may complement the industry higher speed pace. Industry relevant, long-term challenges may be addressed, still with continuous interaction between industry and academia, and incremental delivery of results. Finally, basic research on software engineering should also be driven by industry relevance, however, not for the current industrial state, but for a future situation. Continuous interaction with industry is important also in basic research, but the time to perspective to expected application is much longer – and thus more risky.

2.2 Space View – Where?

Any type of industry–academia collaboration requires continuous interaction. Software engineering researchers need influence from industry practice to ensure relevance, and industry practitioners need to adopt new influxes from research to improve the practice. Even though electronic communication means also support the industry–academia communication, the face-to-face meeting is crucial in this kind of collaboration, since the communication is about getting to know each others perspectives, trying out novel ideas, and also build up trust. Therefore, the spatial view is important, i.e. where the researchers and the industry practitioners are located plays a significant role in how tight the industry–academia collaboration may become. This issue very much boils down to how much extra time either party has to spend on traveling for a meeting, which becomes an overhead cost. We therefore distinguish between four grades of spatial vicinity:

- Local – almost no traveling time

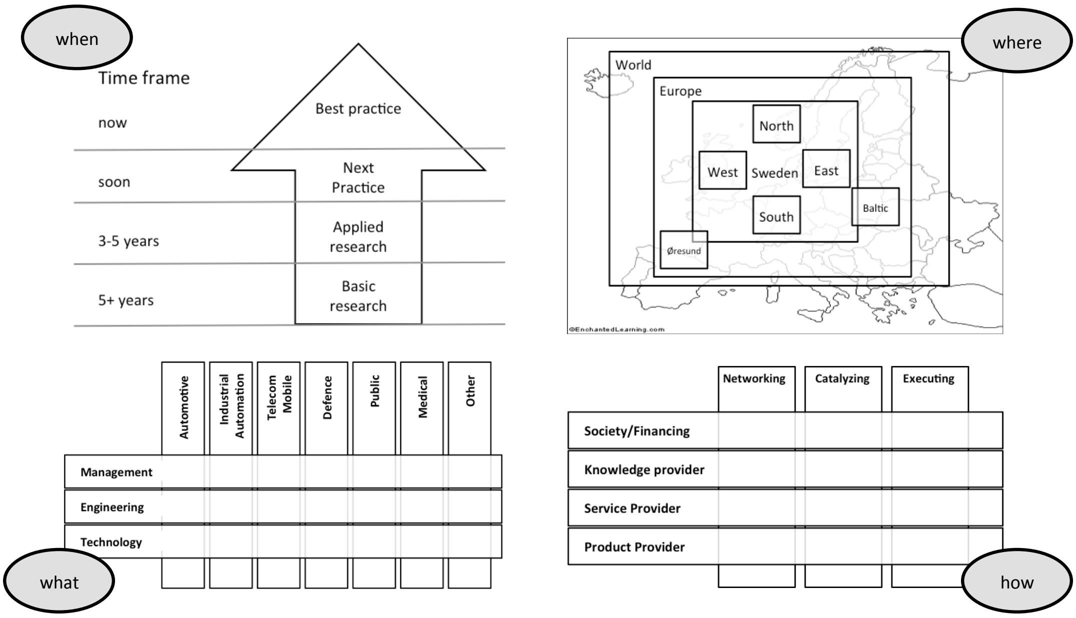

Figure 1: Overview of the 4+1 view model.

- Regional – traveling time of 1-2 hours, i.e. a meeting takes at least half a day
- National – traveling of 2+ hours, i.e. any meeting takes a full day
- International – traveling takes more than one day

How far these zones reach depend on where they are located. For a research center in Luxembourg, for example, the whole country can be defined as local, while in a US context, the *national* level would rather be referred to as the *state* level. In our specific context, as shown in Figure 2(top-right), local is the cities of Lund and Malmö, regional is the southern Sweden, national is Sweden, and international is Europe and beyond.

2.3 Activity View – How?

The activities undertaken in industry–academia collaboration may take many different forms. All collaboration projects must not have the goal of finding the "software engineering silver bullet" – in fact not one should have – but project may have three principal goals:

- Networking – create contacts between actors
- Catalyzing – initiate activities
- Executing – running joint research and improvement activities with specific goals

We have identified four principal types of actors, which are involved in these kinds of collaboration projects, below presented with examples.

- Financing – science or innovation funding agency, companies, or independent funds
- Knowledge provider – university, research institute, or company
- Service provider – consultancy company, which transfers knowledge and experience
- Product provider – software development company, that ultimately wants the knowledge

A networking activity may be an industry seminar, where product providers and knowledge providers meet and start talking to each other. From these, knowledge exchange projects or internal improvement projects may be catalyzed. What we normally refer to as "research projects" fall in the executing category. The need for financing is very small for networking and catalyzing activities, while the execution of larger projects require external funding, or co-funding.

2.4 Domain View – What?

Finally, we zoom in on *what* to do within an industry–academia project. First, we find it fruitful to distinguish between three categories of topic areas related to software engineering:

- Technology – the software technology in itself; languages, tools, frameworks
- Engineering – the systematic approach to develop and evolve software systems
- Management – the management of software engineering projects, products and services; the business aspects

Research on, for example, software regression testing, may address technical issues of how to identify regression test cases from code changes (technology)[3], may be about which visualization approach is feasible for test managers (engineering)[2], or may be about the economics of various regression test strategies (management).

Another dimension of the What? question is the industry domain, in which the research takes place. Software engineering has the unique characteristics of being cross-domain, to a large extent. Many software engineering challenges are the same or similar across industry domains, as for example a survey of four safety-critical domains show (robotics, transportation, automation, and aerospace) [6]. The challenges may come in different flavors, and at different points in time, but there is definitely a potential to learn across industry domains. Therefore, we characterize the research with respect to the industry branch(es) in which it is conducted.

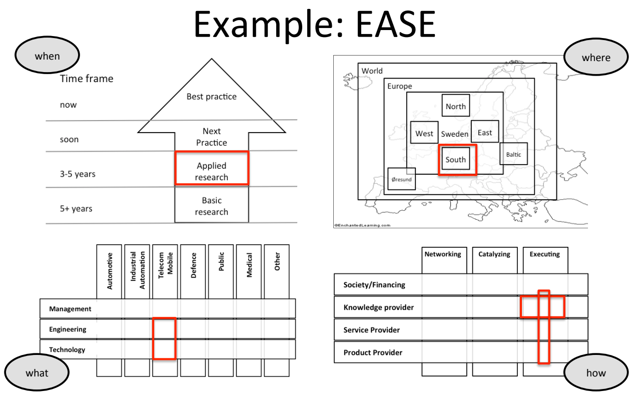

Figure 2: Scenario of the 4+1 view model for the EASE Industrial Excellence Center.

2.5 Scenario View

The +1 view basically connects the other four, into one instance for each industry-academia collaboration project. The dimensions of the model are not completely orthogonal (it may, for example, be hard to think of a basic research project, based on networking only) but they are sufficiently independent to provide key characteristics to be used when defining and communicating industry–academia collaboration projects. Next section presents the EASE Industrial Excellence Center and the Sigrun Software Innovation and Engineering Institute as examples.

3 Example

The EASE Industrial Excellence Center, as presented in Figure 2, is a ten year program to execute *applied research* projects in the field of embedded applications software engineering, which now has endured for five years. EASE is based on the long term collaboration between *knowledge providers* Lund University (LU) and Blekinge Institute of Technology (BTH) as well as four software-intensive companies with offices in *southern Sweden*: *product providers*: Sony Mobile, Ericsson, Axis, and *service provider*: Softhouse, all in the *telecom and mobile domain*. The center operates in the industry–academia ecosystem in south-

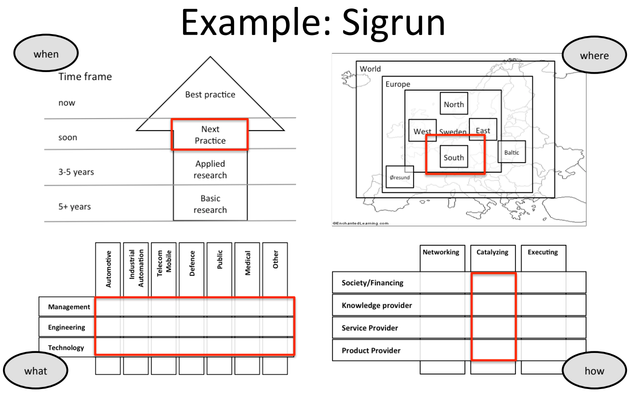

Figure 3: Scenario of the 4+1 view model for the Sigrun Software Innovation and Engineering Institute.

ern Sweden. It is mostly *funded* by companies (1/2), academia (1/3) and Vinnova[3] (1/6). Since some of the company funds come in terms on industrial PhD students, and other in-kind support, parts of the execution takes place in the product and service provider companies.

The research agenda that has been and is continuously developed in collaboration with the industrial partners and has been focussed on two main areas and four themes: *1. Engineering*: i) analysis and assessment of agile and open source software engineering practices, and ii) models and tools to bridge gaps between information artifacts for requirements and testing. *2. Technology*: i) tools for ubiquitous interaction and configuration, and ii) implementation of speculative parallelization in web browsers.

Based on the 4+1 view model of EASE, we can see that the center only operates in one branch of industry, and that there is a missing link from applied research to next practice. In order to bridge this gap, Sigrun was founded in 2010 to constitute a bridge between applied software research and industrial practice. Sigrun promotes openness by creating a forum for open collaboration and exchange of software, development and business experience, and software innovations. Research and innovations are brought to practical use mainly through running innovation projects including participants from academia, product companies, consultant companies, and public organizations. The goal of innovation projects is to try out new technology, processes, or services in practice in an industrial setting. Sigrun is open to membership for large companies, small and medium-sized enterprises, startups, and public organizations.

By starting Sigrun, more light-weight projects may be launched, with short-term commitments. That has enabled us to include new actors, specifically small and medium-sized enterprises (SME), and to expand into other industry domains. The 4+1 model in Figure 3 show that Sigrun is a complementary actor to EASE.

On the other end of the time view, basic research is funded by other kinds of projects, e.g. the Synergies ICT Framework program on Software Engineering for Open Innovation[4]. This is a long-term basic research project, funded by the Swedish National Science Foundation. In the project proposal, the project was positioned using the time view of the 4+1 model, see Figure 4, where Sigrun and EASE are mentioned alongside other projects, thereby helping the project funders to assess whether the project is complementary to or overlapping existing projects. Further, we here added the education dimension, to illustrate how the research project contributes to education, which has both long term and near practice components.

4 Conclusions

Industry–academia collaboration projects may be defined along many different perspective, with respect to what to study, which time horizon, and which actors are involved. In order to support communication and analysis of collaboration projects and activities, we have defined

[3] http://www.vinnova.se, The Swedish Governmental Agency for Innovation Systems

[4] http://serg.cs.lth.se/projects/synergies/

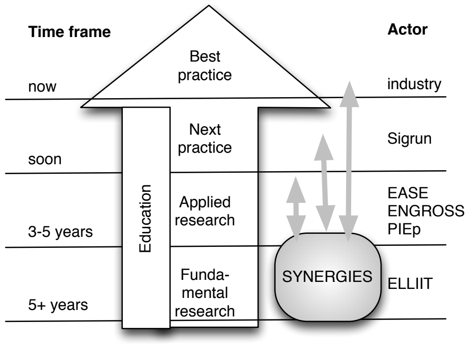

Figure 4: Overview of Synergies project time view, from the project application.

the 4+1 view model of industry–academia collaboration. We demonstrate by example, that the model is useful in analyzing gaps in the industry–academia ecosystem, and communicating goals when proposing new projects. In our context, the model has been useful to analyze and communicate industry–academia collaboration, and we think the model may be useful for other industry–academia ecosystems as well.

5 Acknowledgments

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