Collaborative Duet of Friction and Traction: When the Academia Rubber Hits the Industrial Road

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Abstract

There is no argument that theoretical reasoning, as captured in scientific papers, may be of great value for industry. Typical examples in our field include refactoring methods, software engineering process methods, Object Oriented Design techniques and patterns and much more. However, industrial development teams focused on the delivery of tactical short-term solutions feel they cannot afford to be delayed by such strategic thinking without industrial, evidence-based success. This is not to mean development teams are unaware of the value of the research-first approach. Still, they are occupied by their daily struggle in creating a simplified architecture, one resilient to change, which would preserve their critical intellectual property.

Bridging the gap between visionary strategic and tactical implementation teams is not trivial due to the inherited timeframes.

This paper discusses the type of collaborative duet performed by CA Labs and our university partners. The authors, collaborating on one of the projects, reflect on the gained experience, strengths and challenges, representing both sides. The paper discusses the desired characteristics of collaboration projects for producing theoretically based, down-to-earth practical value.

General Terms: Management

Keywords Architecture Centric Evolution

1. Introduction

Academia and industrial collaboration has always been a difficult task, although many times successful. Typical examples in our field include refactoring methods [Brown 1998][Hadar 2006][Mens 2004], software engineering process methods [Beck 1999][Summerville 2006], Object Oriented Design techniques and patterns [Booch 2002][Gamma 1995] and much more.

The theoretical work of software engineering and computer science may be compared with the engine of a vehicle; it is supposed to generate the rotation energy for moving the technological car, constructed for real world businesses and consumers. However, movement can only be generated where there are accurate levels of friction between the road(map) of software companies and the spinning wheels.

In order to maintain a gradual and accurate knowledge transfer, the vehicle requires a transmission gear that will decuple and maintain a sensible momentum ratio between engine and wheels, as well as matching the best wheels for a given R&D terrain.

In the next sections, we reflect on our gained experience, representing the long-term strategic thinking engine of academia, and the tactical domain of the R&D road, facilitated by the CA Labs [CA] transmission gear. We present a duet of opinions. Each side will discuss its view on the underlying forces, the strengths and challenges of such collaboration, concluded with CA's approach for handling collaborative opportunity.

2. The Industrial Perspective - Background and Driving Forces

Financial considerations are the fundamental forces driving a commercial company. Beyond the need to increase income, reduce costs, and increase market share, companies are exploring new market opportunities and means to improve customers' satisfaction. Thus, product lines are required to maintain the existing customer-base by modifying the existing technology and adding features. Even more, they are required to perform evolutionary steps that will attract new-contract-value (NCV) and increase the market share. In addition, they are required to do so within the boundaries of tight competition affected by a combination of features value and pricing.

In mature companies, software and architectural evolution determines the company's "Darwinistic" survival. Vertical market expansion sustains existing customers and creates new ones for the existing business. Cost reduction needs are met by better technology and improved operations efficiency. Finally, horizontal expansion enables new markets.

Consequently, external forces affect the type and nature of the required software evolution that can provide tangible results within a certain timeframe. Vertical markets are constrained by the next immediate release cycle due date. Costs reduction and operational efficiency do not have external time limits, and thus it is an internal decision. Horizontal markets do not have tangible timeframes during the strategic phase, but when moved into the first proof of concept, the time constraints resemble those of start-ups.

Given these considerations, we aim for a solid and proven solution that will provide a competitive edge, implemented immediately and with minimal costs.

Utopia, is it not?

2.1 The Challenges

If we minimize the above requirements, what is actually needed is a practical solution for a given problem with minimal technological risks. Some may claim that an unproven theoretical algorithm should always be treated as one with high risk. Validation of the theoretical algorithm by using university students (as done by many researchers) as well as providing glamorous statistics performed in laboratory conditions will be disregarded due to the impracticality of such a solution. It is regarded as "academic work done for academia". Many engineers feel that a work provided by knowledgeable theoretical people, who did not fight with them in trenches, is detached from reality. Simply put, it is the "not-invented-here" concept, but targeted towards the "ivory tower" of academia.

Is it us versus them? Is it a prestige competition? After all, the current graduate students are the future employees of the software industry, so where is the dichotomy?

It is our view that the heart of the matter is comprised of trust, technological proficiency, and terminology. Development teams are aware of the value of the research-first approach. In many cases, they simply do not have the time to spend on translating the language and interpreting the results into something that is tangible. Our subjective experience revealed that most of the industrial engineers are expanding their knowledge from books or from technical websites, rather than from scientific journals. Trying to understand why our best engineers are not looking at these structured results revealed reasonable causes.

Our engineers claimed that there are simply too many journal papers, conference proceedings, and workshop articles. "We are overwhelmed by this information overload. Within this information we often find different, and sometimes even contradicting, opinions. It is simpler to construct our own solution rather than judging and choosing from the vast possibilities that the literature has to offer". One should wonder if this is the root cause, or is it a matter of taxonomy, aggregation of information, and other cultural differences. After all, scientific journals are written for academia, and magazine papers are written for the industry. Thus, engineers should read magazines more than journals. Presenting this claim to our engineers resulted in a simple answer that they do not distinguish between journals and magazine.

R&D state of mind is driven by notions such as "use cases", "bottom line", "client needs", and "market opportunity". They cannot waste cycles on "theoretical research" without practical implications related to the current and next phases. They are energized and motivated by "quick wins", "end result", and "time to market" driving forces. Academia research is considered riskier than the value proposition the company's own strategic leaders, such as the Office Of the Chief Technology Officer (OOCTO), Product Management and the Business Strategists Office provide.

Pure research, detached from commercial pressures, is more likely to provide unbiased solutions. With timeframes much less stressing than in the industrial world, researchers can afford not to compromise on quality and keep on optimizing the results in successive publications.

When suggesting academic solutions based on theoretical reports to the engineering team, most of the responses started with comments such as: "I am not sure I get it", or "Where does it fit with our next release?" We also got comments such as "What's in it for me and how much effort does it require?" These skepticisms exposed question marks on the nature of the solution as well as indicated reluctance to accept a third-party solution. Even more, the engineers requested the paper's authors' proven experience. Others just trusted us for having already scrutinized their professionalism. Passing that hazard area we faced more difficult questions, such as "When can I have this? Can I just install it in my product?" and the worst: "OK, but I need something a little different. Could they provide the additional work within 6 months?" The final one was "This is truly great, when the students can come and work with us, we need 4 developers and one team lead…"

Meaning we were challenged with trust, schedule, resources, and budget.

3. Bridging the Gaps

Naturally, bridging the gap between the visionary strategic teams and tactical implementation ones is not trivial due to the inherited timeframes, but it is not impractical. The industry is more focused on the Pareto rule of 80/20 [Koch 2007], which means that we are willing to compromise in order to maximize the value. The Pareto rule is also about constant prioritization of tasks and reasonable shifting of resources.

The industry considers itself as academia's audience; thus, it is very important for the research outcomes to be presented and delivered in an industrial language. We would understand better if it is presented using our own domain and best practices taxonomy, exemplifying the outcomes in a use case. Slicing the results into tangible components that can be used separately is crucial as well, as opposed to convincing us in yet another new holistic magic bullet. Using reasoning and claims that are based on other theoretical references of yet more research does not advance us.

It is all about communication skills for presenting, aggregating, and summarizing the research for us. We look for our academia partners to make sense of it all and organize these numerous reference into a set of concrete statuses and conclusions.

We are aware of how academic research is structured, and we are more than willing to assist in providing all the test cases, environment setting, data access and much more. However, it is important to keep it simple and provide us with the bottom-line. We are driven by the end-results. The journey itself, even if providing interesting observations, is not as crucial to industry as it is to academia.

Like in any good partnership, compromise may be required even if a certain research roadmap has already been structured, due to market changes, organizational changes, and product changes. Cyclic, iterative development is part of our way of evolution, and we are beholden to environmental constraints that mutate our solutions. Thus, any supporting research partners need to be aware of these constraints, and evolve and adapt with us. We cannot lose market focus, even when providing something astonishing and new. We will always tend to evaluate something based on its financial value.

4. CA Labs Approach for Bridging the Gaps

The previous sections focused on difficulties in collaboration between academia and industry. CA Labs team members mitigate these risks enabling the propagation of valuable research into industrial products by acting as the transmission gear between the university and engineering teams.

We act as facilitators, negotiators, language translators, and research project managers, ensuring that both parties can achieve their goals, whether these are product releases or scientific papers. We are familiar with the inner needs of the product lines, the challenges they are facing, and the environment constraints. We navigate our way in the organization, making sure that when a research project will be pursued, logistics, technical and personal constraints will be relatively easily mitigated. Simply put, we are paving the way for the research team.

One collaboration scenario is when a CA Labs Research Staff Member (RSM) detects an interesting and prospective new direction. The first step is to interpret the theoretical language into industrial language. Working together with academia researchers, we construct a tangible, practical research justification, reviewed and approved by the research recipients, answering the “I am not sure I get it” and “Where does it fit with our next releases?” questions.

In order to build the technological trust, we are conducting several presentations magnifying the researchers’ knowledge and experience in the domain, translated into practical terms. We start with a small audience that assists the researchers to transform their strategic thinking into practical use-case examples. It is followed by several additional presentations with larger audiences in order to select the best research recipients. In academic terms, it might be considered as invited talks or short tutorials.

After the appropriate audience is identified, we need to set sensible scheduling and time constraints on the project. Any research project in the university is milestone-based as well; it is simply a matter of marketing the research interim results. The academic *literature survey* is simply *state of the art and technology scan*. *Workshop* papers and participation are a result of a small *proof-of-concept* and internal presentations. *Interviews and surveys* can be done during a *practical internship*, and *research structure and methods* are considered to be *requirements and design specs*. It is all a matter of taxonomy. Structuring the research timeline to use this terminology assists in answering the most difficult question of “What’s in it for me?” and “When can I have this?”

Structuring the research proposal, or as we call it, *product release specification*, enables us to answer the “what, why, when, and who”, leaving the “how” as the research question. During this time, the industrial peers are requested to define specifically who will work on the project collaboratively with the research team. Naturally, since engineers are dynamically changing positions, roles, and assignments, it is defined abstractly. It is the responsibility of the CA Labs’ RSM to handle the risk in case of a change.

Since a research project can last from several months to a full three years PhD research, the form and structure of the projects differ. It can be practical testing of existing research within the last period of the academic research, focusing on knowledge transfer. Alternatively, it might be the conducting of a brand new process analysis that is specifically tuned to the industry needs, serving as a methodological sandbox for academia and a solution for industry.

5. Defining and Conducting the Research - The Academic Perspective

5.1 The challenges

Conducting empirical studies in our line of research has always been a grave challenge. Researchers often face the dilemma of whether to run experiments on students or to study "real people". The advantages of each possibility are obvious. Students are available, usually in statistics-enabling numbers. However, we are more interested in "real people", namely the professionals working in industry. Moreover, the industrial environment is our true research field, not university classroom or computer lab. Unfortunately, the field and its professionals are usually unavailable for us. It is extremely difficult to find firms and individual professionals that are willing to invest their time and effort, not to mention overcoming non-disclosure issues, for an academic research.

In order to make industry accessible, we need to find a way for both sides to be interested in the research and its results. But note, here we face our biggest danger. Industry, interested in concrete, ready for implementation results, may understand such collaboration as a turnkey project with the academic research team serving as a subcontractor. Such collaboration is doomed for disappointment for both sides: The researchers will find themselves occupied with an opportunistic rather than scientifically driven research, while their industrial partners will be frustrated by the strategic (rather than tactic) and abstract (rather than concrete) results and different timeframes than they are used to. Thus, successful collaboration requires that research objectives and questions, methodology and conduct, and finally personnel and roles of both sides, will be predetermined explicitly, taking into account the driving forces and relative advantages of each party.

Many different types and form of academia-industry collaborations exist that are potentially successful. In what follows we shortly describe our experience of an ongoing project employing this collaboration, according to the CA collaboration approach, and discuss its characteristics.

5.2 Collaborative Duet – A Case Study

The case study we present here is a reflection of our experience with an ongoing collaborative project of knowledge management research. It is aimed at evolving exiting knowledge management processes and systems within CA. The specific details of this project are beyond the scope of this paper; however, the interested reader may view the description and results of the first phase of this project in [Levi 2008].

CA Labs triggered this project by identifying the potential of employing new and improved principles of knowledge management within CA miscellaneous knowledge processes and systems. Understanding that currently much of the intellectual property with regard to this evolving field of knowledge management circulates within the academic world, CA Labs has decided to approach potential partners in academia for promoting this initiative.

As the academic research team started to assemble, according to the members' backgrounds, interests and potential contributions, a research team from within CA started to be formed as well. Finally, the academic team included three members: two researchers (principle and secondary) and a PhD student. CA's team included two CA Lab Research Staff Members and, as the research progressed, participants from the divisions relevant to the different phases of the project. The latter were expected to contribute in two main areas. The first was to evangelize the project within the different departments and pave the way to extensive data collection. The second was to form an implementation team that will act upon the research recommendations, enabling follow-up validation of the research results.

One of the guiding principles in forming the research staff was viewing the team as a single interwoven one, including members from both university and CA, working side by side. The research team as a whole was responsible for planning as well as executing the research project. This fundamental element mitigated our biggest collaboration risk. Rather than acting as customer and sub-contractor, the cohesive team collaboratively worked in achieving mutual goals.

The next step was formulating the research questions. While the general objectives were defined by CA, the more elaborated research questions had to reflect both the academic researchers' scientific interests and CA's concrete ones. The research questions were formulated in two layers: (1) practical, concrete questions regarding the evolution of CA's processes and systems, and (2) theoretical questions structuring a generic framework based on the practical case studies preformed in CA.

The research methodology and scope need to be much more flexible and adaptive in such a project than they usually are in academic studies. While a pure academic research can accurately execute a predetermined research plan, including scope, data sources, data collection, analysis methods, and accurate time plan, the work in industry has to be managed differently. Even with full industrial collaboration and working with motivated and enthusiastic professionals there are risks. When pressed with deadline or unpredicted crises, a strategic long-term research is the first one to be abandoned or at least postponed. Foreseeing this phenomenon makes it crucial to define the research scope, questions and methodology to be agile and adaptive to changes.

In our case study, one of the three departments allocated to this research in the beginning of the project started to "fade out" during the first phase of the study because of internal pressures and priorities. The alertness of the CA Lab's research team caught this trend early and enabled to immediately search and find a replacement for that department. The adaptive nature of the predetermined characteristics of the project, enabled to make this large change of scope with almost no overhead of effort and time.

Finally, the research project provides additional outcomes, that when leveraged, may contribute just as much as the original research. Combining the data-rich industrial environment with the academic systematic data-collection and analysis methods provides a comprehensive database packed with opportunities for additional examinations. Examining this database in light of different interests of the participating researchers may lead to new, at times unexpected, insights and revelations as well as trigger future research projects.

6. Conclusions

Bridging the gaps requires a bridge. Otherwise, both sides need to handle huge risks that usually generate burden and potentially jeopardize the relationship, taking away all of the fun.

We've presented our experience in collaborative research as manifested at CA Labs. To continue with the car analogy mentioned in the introduction, constant goal alignment maintains the accurate speed to movement ratio between the researchers' engine and the product-lines' road constraints. Terminology translations, schedule alignment, and sets of tangible deliverables couple the teams as a gearbox should, providing value for both sides. Adapting to the research recipient constraints is equivalent to replacing the wheels' rubber in order to maintain maximum friction efficiency. Thus, we can shift gears as well as replace the type of road, and still generate great movement. These actions by CA Labs, and many more, are fostering productive research and tangible down-to-earth results between CA and its academic partners.

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