Synergia – A Software Engineering Laboratory to Bridge the Gap Between University and Industry

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ABSTRACT
This paper describes a case of cooperation between university and industry in which a software and systems engineering laboratory housed in a public university acts as a technology solution provider to several public agencies in Brazil. This is an interesting cooperation model for the Brazilian scenario, where the best universities are almost fully dependent on federal government funding – which is usually scarce – and the software community in general still lacks the desired capability maturity.

Although this laboratory, named Synergia, is internally organized as a traditional software development company, it also retains important academic characteristics. Such model provides both unique cooperation opportunities and significant management challenges, as will be discussed throughout the text.

Categories and Subject Descriptors
K.3.2 [Computers and Education]: Computer and Information Science Education – computer science education, information systems education.

General Terms
Management, Performance, Economics, Reliability, Human Factors, Legal Aspects.

Keywords
University-industry interaction, software and systems engineering.

1. INTRODUCTION
In this paper we present a case study of interaction between university and industry in the field of software engineering. This shows a cooperation model where a federal university laboratory provides software, systems, training and consulting solutions for Brazilian public agencies and private companies. The university gains important professional experience and financial resources, while it provides effective, professional-level services.

The interaction model presented was applied in the Synergia\textsuperscript{1} laboratory, located in the Department of Computer Science (DCC) of the Federal University of Minas Gerais (UFMG), Brazil. It is important to notice that Brazil has a complex educational system, where the best universities are public, supported mainly by government funding. Such funding is usually scarce, and there is frequent public debate as to whether or not the university should seek alternative funding support. It is also fair to say that in Brazil the best professionals often come from public universities, and that the best undergraduate students often come from private high schools. This scenario illustrates the importance of well-established cooperation projects between university and industry, where significant social, economical and cultural development can be achieved by both parties.

2. MODEL DESCRIPTION
Synergia is a laboratory for software and systems engineering, having its origins in a cooperation contract, established in 1993 between DCC and one of the largest Brazilian telecommunications company, for the development of engineering applications. The complexity of the development activities motivated the development of a software development process, named Praxis\textsuperscript{2}[1]. This process is used in several computer science and information systems undergraduate and graduate courses throughout Brazil and, although an educational process, may be fully customized to be applied in professional organizations.

Synergia has currently 55 people in its staff – 15 undergraduate students, 13 graduate students and 27 non-student graduates (10 with an M.Sc. degree), most with a computer science background. The laboratory is organized as a project-oriented company, with four business units: Products, Processes, Marketing and Management.

Professors of the computer science department staff the senior management board, which defines organization strategies and advise the activities of intermediate level managers. These manage day-to-day activities and discuss strategic matters with the board – this organization relieves the professors from operational tasks that could compromise their academic activities. The Syner-
Synergia staff is organized in multi-functional project teams, with specific profiles for requirement and analysis, design and implementation, testing and quality control, usability, process engineering and project management.

3. EXPERIENCE

3.1 Portfolio
Since 2000, Synergia has focused its activities in software and systems engineering, training and consulting, providing services mainly to Brazilian public agencies. Recent significant cooperation projects had the following organizations as customers: a state financial auditing agency, a state planning and management agency and a municipal legislative body. Typical projects deliver information processing and retrieval systems, ranging from 800 to 3000 function points in size. The usual project duration ranges between 7 and 14 months. Depending on customer needs, the scope of those projects usually comprehends one or more of the following approaches:

- Business Modeling: providing a comprehensive view of the business process of an organization, and proposing possible software products to be developed;
- System Specification: eliciting the requirements of a software-based system, providing a conceptual model of the problem, and studying the feasibility of proposed solution approaches;
- System Development: implementing, testing and deploying a software system, to meet the needs of the users and business processes;
- Training, both system-specific – to end users of the developed software products – and company-specific – to meet technology and process training needs of an organization;
- Consulting on systems and software engineering, as well as other computer science and information technology subjects, often supported by laboratories with which Synergia has a solid partnership;
- Research on specific systems and software engineering problems identified by the industry.

3.2 Interaction appraisal
There are several interesting aspects to be considered, regarding Synergia’s cooperation model. This section describes the most relevant ones, discussing both their positive and negative aspects.

3.2.1 Human resources development
One of the most important features of Synergia is its thorough integration in the academic environment. Synergia establishes an effective environment for practical education, where both undergraduate and graduate students work with up-to-date software development methodologies and technologies, driven by current market demands. Synergia thus fulfills a main university goal: the development of technically proficient human resources.

Since Synergia has no government subsidies and has to be self-sustained, it operates like a real-world company in the market. This leads to the creation of a healthy environment for stimulating competitiveness, which is favorable for the formation of human resources and for the development of technology and process solutions towards improving productivity.

Undergraduate students working in Synergia receive a scholarship to support their expenses, and are allowed to arrange their schedules, to meet both work and course demands. Their activities are planned and supervised in order to achieve a nice balance of their education and the laboratory’s interests. Graduate students, in addition, receive a scholarship supplement, very attractive when compared to scholarships granted by public research agencies. The graduate students can also acquire other competencies, besides research, and are encouraged to align their research interests with Synergia’s technology and project demands. Also, both undergraduate and graduate students can be fully employed in Synergia, after completion of their studies.

Considering this environment and also the skills of the students of federal universities, in our country, Synergia has no difficulties in staffing capable and experienced teams. Often, a good staff percentage has an M.Sc. degree. Even when a project team is composed mostly by inexperienced people, these often have a strong learning potential. When working in an open, informal environment, the teams often contribute significant ideas to the improvement of the processes and technologies applied on the software projects.

Managing a high-potential staff also presents some drawbacks – of which a high turnover rate is probably the most critical one. Since Synergia’s staff proficiencies are well known in the local technology market, it is very common for private companies – and sometimes, even Synergia’s clients – to try to recruit Synergia’s professionals. Thus, key people may be lost to competition during critical phases of a project. Another important aspect is that, since that kind of people demands to be constantly challenged, it may be difficult to allocate staff to routine project tasks and medium-complexity projects. Also, although technically mature, Synergia currently does not possess mature human resources policies; hence the staff does not always perceive a long-term career opportunity, and is usually seduced by traditional, formal corporate environments.

3.2.2 Strategy and internal organization
While having a relatively well organized project structure, Synergia still lacks important strategic definitions concerning both business and academic postures. It is rather complicated to align academic and business strategies, especially in a public university, where there is a constant debate as to whether or not the university should pursue alternative funding support, coming from industry, public organizations or other sources.

Synergia’s marketing strategy must be driven by both business and academic objectives and, moreover, it is restricted by regulations and policies common to public universities. In this sense, the local information technology community (e.g. possible private customers or competitors) does not always see Synergia as a real-life professional-level organization, but rather as an academic, idealistic one. This can be explained by the lack of mature development processes of most regional IT suppliers, who often regard Synergia’s higher costs as a consequence of the software processes it applies. Oddly enough, many of former Synergia’s collaborators who have been hired by competitors were recruited to help establishing quality and process cultures, which they often successfully did. The competitors’ view, however, does not agree
with the understanding of Synergia’s top clients, who usually consider that Synergia provides solutions with a much higher quality level. Recent Synergia’s project results show minimal schedule and cost overruns, compared to local market practice.

Although academic objectives such as practical education and research must be accomplished, the rules of the game establish that the laboratory must be self-sufficient. Its long-term survival depends not only on being able to constantly obtain new development contracts, but also to keep a solid group of senior engineers and managers, committed to long-term goals. Therefore, the marketing strategy and the human resources policies must be coordinated, in order to attain the laboratory’s strategic objectives.

3.2.3 Service performance and client relationship
Synergia has currently a firm relationship with many public agencies within the federal, state and municipal levels. Synergia’s housing in one of the top computer science departments, located in one of the largest universities of Brazil, is seen by many customers as a strong endorsement of its technical capability.

With the experience of the Praxis software process (see Section 3.2.5) and recent improvements in project management procedures, Synergia has been able to deliver products and services with high quality levels – around 0.018 defects per function point – and very small schedule and cost overruns. Such performance levels are not usually found in the local information technology community, and Synergia’s clients are now realizing the good cost-benefit ratio of their interaction with the laboratory.

Public agencies in Brazil are subjected to strict and rather inflexible acquisition regulations, which do not adequately fit the dynamics of information technology needs. In general, legal procedures for procuring, acquiring and supporting products and services from private third-parties are extremely bureaucratic, and often slow. A typical procedure involves many steps – defining the acquisition object, establishing a market research and potential suppliers, publishing the request for proposals, analyzing technically and financially the bids, resolving legal conflicts, establishing the contract – and usually takes at least a couple of months to complete. When considering IT products and services, the situation is complicated by factors such as: lack of specialized professionals in the public agencies, able to provide consistent evaluations of the technical proposals; a consequent lack of a documented acquisition process and acquisition history to support legal, financial and technical evaluations; and a rather unstable market where long-term commitments from IT suppliers cannot always be attained due to short lives of many private companies.

One alternative that public agencies usually take to avoid those drawbacks is to look for suppliers that may be exempted from standard acquisition regulations. Some public IT companies fit the requested supplier features, but these are often overwhelmed by the high demand levels, and may also lack the technical capability to deliver the desired solutions. Another more viable alternative is the establishment of agreements between public agencies and Brazilian non-profit institutions dedicated to education, research and development, of which public universities and research foundations are usually viewed as the best choices.

The above scenario motivates public agencies to acquire software products and services from Synergia, since the desired results can be obtained in a more feasible schedule. There is, however, an obstacle related to the higher prices established by Synergia. Besides practicing product and process quality levels above market average, which tends to elevate production costs, the laboratory has to pay stiff university and department fees, which range from 40 to 50% of its gross income. However, Synergia’s clients, who consider the guarantee of delivery within cost and especially schedule agreements as a fundamental criterion, usually perceive a good cost-benefit ratio. In other words, cost is not perceived as high when considered a comprehensive view that includes development, timing, deployment, end-user training, and maintenance, among others.

It is important to mention that one of the current projects comprises the definition of an acquisition model, which is expected to improve procurement, management and project performance of information technology projects conducted by state public agencies. The scope of this project includes an evaluation of the current capability of local IT companies to develop and deliver high-quality software products, as well as an evaluation of the acquisition processes of the public agencies, concerning the issues discussed above. The results of this evaluation will be organized into a comprehensive model [2].

3.2.4 Relationship with the university
The Federal University of Minas Gerais (UFMG) is one of the largest public universities in Brazil, currently with more than 30,000 students in 61 graduate courses, with a budget of approximately US$ 300M – 96% of which from government funding. Its Computer Science Department (DCC) is one of the top computer science departments in Brazil, with a high-level scientific production, and many research and development partnerships with private companies and public agencies.

Synergia takes advantage of this structure by partnering with other laboratories and research groups in this university, in order to meet technology needs of both research and development projects. These partnerships are usually motivated by specific expertise demands in some information systems and consultancy projects, or information systems demands in infrastructure projects. Negotiations of partnerships between Synergia and other department laboratories can sometimes be complicated by conflicts of interest and political issues. Recent project feasibility studies have also involved laboratories from the Information Science School and Electrical Engineering Department. It is interesting to notice that the project coordinators from these laboratories often experiment the same political difficulties in their own departments.

Usually, when a laboratory is able to attain expressive amounts of financial resources, involve many students, and also use a significant portion of infrastructure, some concerns arise in the department board. In a public university, this matter is complicated by the coexistence of rather different views and political and ideological opinions, regarding university stand on interaction with the industry. Synergia must also cope with such political and organizational scenario. It must invest part of its resources in keeping a significant academic production and communicating its
achieved achievements to the outside public, alongside the necessary investment in people, process and technology.

Another important aspect of the relationship between Synergia, the department, and the university, concerns the bureaucracy involved in establishing agreements and contracts, and management procedures. There are several hierarchical levels involved in negotiating and especially approving financial resource usage. This imposes significant constraints on Synergia’s agility to make and enforce management decisions. Also, all the contracts must be signed by an university associated foundation, which manages finances for all research, education or development projects between the university and industry. Legal procedures are often lengthy, and must be taken into account when negotiating project schedule. This complicated structure is yet aggravated by stiff university and department fees, as discussed before.

Maybe the most critical issue of the relationship between Synergia and the university is Synergia’s dependence on the physical infrastructure of its parent department. Such dependence imposes detrimental constraints, not only on Synergia’s day-to-day activities, but also on strategical and tactical decisions. In this sense, Synergia is subject to the physical and security regulations of its parent department, thus being unable to freely invest on infrastructure improvements. Depending on the amount of resources demanded by new projects, Synergia’s current available infrastructure, although relatively large when compared to other laboratories, may be easily overwhelmed. Strategic decisions regarding whether or not to establish new offices elsewhere in the department, university, or even external areas, must be carefully discussed between Synergia’s board and the department board.

3.2.5 The Praxis-Synergia software process
Praxis is a software development process, designed to support the education and training in software engineering. It has been applied in undergraduate and graduate courses and industrial training programs ([3], [4]). Praxis is currently in version 2.1 [5]. It has also been used in real-life organizations, sometimes as an initial process in software improvement efforts, or in a tailored industrial version.

This last approach has also been adopted by Synergia. Since 2000, the laboratory has applied its practical experience to tailoring and enhancing its own version of Praxis – the Praxis-Synergia software process. This process is almost fully aligned with the standard Praxis, but with some differences in the techniques, procedures and patterns used by project teams.

The tailoring effort, however, has been significant and has been driven, primarily, by technology aspects of Synergia’s software development projects. Firstly, the demand for higher productivity showed the need to implement more process automation tools, which in turn required more stable artifacts and procedures. Secondly, recent development projects of web-based software products, for instance, have demanded fine-tuning of design, implementation, testing and deployment procedures, as well as quality management. The enhancements were based on previous experience, literature and also on available support tools. Procedures are currently better adjusted to project technology features, but there are yet several improvements to be done.

After having established relatively stable technical processes, another major improvement focused on the project management discipline. Although standard Praxis defines project management procedures and artifacts, Synergia’s projects often present a more challenging managerial scenario, where complex software products with larger scopes are developed by larger teams, within tighter cost and schedule constraints. Recent enhancements were based on PMBoK methodology, focusing primarily on scope, time and cost management techniques.

It is important to point out that, although Synergia is located in an academic environment, there are still several challenges when trying to adapt an educational software process to the needs of a real-life organization. Staff resistance on changing processes, patterns and procedures can still be a concern, since people must be convinced of the expected benefits. In Synergia, the staff is usually more receptive to process improvement, especially considering that most enhancements are proposed by the engineers themselves. This is made even easier by the academic culture and the skill of project teams.

4. DISCUSSION
This paper presented a case study of interaction between university and industry in the field of software engineering, represented by the Synergia laboratory. Synergia participates in education, research and development activities, favoring the relationship between academia and local information technology community.

Interesting gains can thus be obtained by all parties involved: the university – which not only earns important financial resources to support and develop its infrastructure, but also provides high-quality professional education for undergraduate and graduate students; the government clients – which are provided with high-quality IT solutions through a transparent, mature development process, besides being educated in solid, transparent software acquisition procedures; and the Brazilian software community, which gains the influx of highly capable and educated professionals, facilitating the assimilation of software engineering best practices, as well as quality assurance and process improvement cultures.

5. REFERENCES