Fostering Collaboration and Communication between University and Industry through Partnering

Case Study: Centre for Object Technology Applications and Research

COTAR

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ABSTRACT

This paper discusses various aspects of the collaboration between University and Industry which has occurred as a result of setting up the Centre for Object Technology, Applications, and Research, COTAR is a centre of excellence based at the University of Technology, Sydney, and is focussed on applications of Object Technology (a technology which provides a new approach to the development of high-quality software) in industry and commerce. COTAR collaborates with industry in a number of ways; provision of facilities, technology transfer projects, research, financial support, etc. This collaboration benefits both the industrial partners, as well as the academic members of COTAR, though often in different, yet complimentary ways. This paper looks at these collaborations, what benefits they provide, and other associated issues.

*Joint undertakings stand a better chance
When they benefit both sides*

Euripides, *Iphigenia in Tauris* (c 414-412 B.C.)
1. INTRODUCTION

During 1993, The Centre for Object Technology Applications and Research was established at the University of Technology, Sydney. This centre focuses on applications of Object Technology (a technology which provides a new approach to the development of high-quality software) in industry and commerce. COTAR has both academic members and industrial partners. Collaboration is actively encouraged between these participants in a number of ways. Industry supports COTAR through a variety of mechanisms - research funding, postgraduate student funding, other forms of funding, provision of hardware, software or other resources, collaborative grant proposals, provision of industrially focussed data, provision of test-bed environments, secondment of personnel, seminar sponsorships, joint undertaking of suitable projects, etc. COTAR in turn provides a series of benefits to industry, access to experts in relevant fields, advice, networking to other companies, priority access to professional development courses, access to a wide-range of evaluation tools, access to results of research projects, access to research students providing collaborative input to appropriate projects, etc.

This paper aims to discuss COTAR, and its collaboration with industry. Section 2 of this paper will begin with a brief overview of COTAR, its mission statement, objectives and structure. This will provide a foundation for understanding the relationship which exists between COTAR and its industrial partners. This is discussed in more detail in section 3, where the methods by which industry participates in COTAR are considered. Section 4 looks at the benefits which each participant can expect, and shows that although academic members and industrial partners have different agendas, both parties can obtain significant benefits from the collaboration.

The paper finishes with a look at a specific example of the collaboration which has occurred - a joint venture between COTAR and Class Technology P/L, to develop a suite of integrated professional development courses aimed at industry. Prior to the collaboration, both partners had a number of industry courses, and differing reasons for providing these courses. The problems encountered in setting up the partnership, and the benefits obtained, are considered.

Object Technology: What is it?

Object technology, OT (also known as object-oriented technology) is a new paradigm for the development of high-quality software. Traditionally software has been predominantly developed using the structured paradigm. In this approach, the software system under development is modelled as a process which is transforming data. The process is progressively decomposed until each component is simple enough to be easily specified. These subprocesses are then mapped into the modules which are to be implemented. This process has long been known to result in some significant problems. In particular, it often results in software which is difficult to maintain, and has low potential for reusability - both increasingly important as the quantity of software increases.

Object technology views software systems differently - as a collection of interacting objects. Each object encapsulates both data and operations, and different objects communicate by sending messages to each other. These messages can be requests to perform some action, or a request to supply some information. It is not feasible to delve into the detailed concepts of OT here (encapsulation, abstraction, inheritance, polymorphism, etc). Nevertheless we can still state that the synergism of these concepts is a high quality, robustness, and greater reuse potential.

Object technology evolved out of concepts which originated in the Simula programming language, more than 25 years ago. Although programming languages which support OT concepts have been existence for more than 2 decades, acceptance of OT has only started to widen during the last 5 years. This is a result of the recent development of suitable development methodologies, tools, project management and other associated components of the overall development process. It is worthwhile keeping in mind that the technology itself is still evolving, though it is widely accepted that it has now reached a level of maturity where it can be successfully applied to a broad range of application domains.
**COTAR Mission Statement**

In line with UTS’s mission statement committing the University to close interaction with Industry, COTAR’s mission is

- To foster collaboration and communication between universities and industry in order to accelerate the practical development of object technologies
- To provide an Australian research centre in object technology
- To provide quality professional development courses in object-oriented software engineering
- To provide an Australian focus for the dissemination to industry of leading-edge knowledge on object technology

**COTAR Objectives**

The focus of COTAR is object technology: research issues and technology transfer. The Centre’s objectives, which are in line with UTS’s organisational objectives, are:

1) To promote and conduct research in object-oriented software engineering, object-oriented information systems and object-oriented computing.

2) To provide a research training environment for postgraduate research studies and create new courses at the Masters level.

3) To provide a vehicle and focal point for collaborative work with industry

4) To collect, collate and disseminate to industry the growing body of knowledge on theoretical and practical aspects of object technology and its use in application-domain, industrial software development

5) To assist companies in their transition to object technology.

6) To provide professional development education of a quality endorsable by the Australian Computer Society in their Practising Computer Professional (PCP) scheme.

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**2. WHAT IS COTAR ?**

COTAR - The Centre for Object Technology Applications and Research - is a centre set up at the University of Technology, Sydney to provide an Australian focus for research into Object Technology and the rapid transfer of this technology to local industry (for a description of Object Technology and its implications, see the associated panel - “Object Technology: What is it?”).

The centre was originally conceived by Professor Brian Henderson-Sellers - an internationally recognised and widely published expert in the field of OT. It was founded as a cross-disciplinary centre, and although centred on UTS, has academic members from at least 8 other Universities - with a total of more than 2 dozen academic members. The centre has a director (Professor Henderson-Sellers) and co-directors, along with an advisory committee. The status of the centre is reflected in the membership of the advisory committee, which includes some of the best known local names in the computing profession, as well as a number of international experts. The Centre is funded entirely through its industry participation, though support is also sought from appropriate research granting bodies.

The academic members of COTAR are typically involved in research in a broad variety of areas related to object technology: software development methodologies, languages, project management, software reuse, software tools, databases, OT education, real-time systems, testing and metrics, etc. Object technology is the unifying thread running through these topics.
The industrial partners of COTAR are typically companies involved in software development in one form or another. Examples include software development houses, consulting firms, financial and insurance institutions, and software product vendors. These companies have varying levels of expertise with object technology - varying from just beginning to investigate its relevance, to significant experience with practical systems.

The centre aims to focus on applications of Object Technology in industry and commerce. This is strongly reflected in COTAR’s mission statement and objectives (refer to the attached panel). COTAR aims to not be just a pure research centre, but wishes to have its focus solidly on collaboration and communication with industry.

3. HOW DOES COTAR SUPPORT COLLABORATION BETWEEN INDUSTRY AND ACADEMIA, AND WHAT BENEFITS ARE GAINED?

We have stated previously, and it is made explicit in the COTAR mission statement, that COTAR aims to foster collaboration between industry and academia. Quite obviously the various participants in COTAR have different agendas, different requirements, different skills, different organisational structures, different goals, etc. The participants in COTAR are going to therefore contribute to COTAR in different ways. These contributions can nevertheless be compatible and complementary. If managed correctly, the academic contributions can benefit industry, and the industry contributions can benefit academia.

How does industry contribute?

As will be shown shortly, COTAR’s industry partners can benefit considerably through their participation. For COTAR to achieve its stated objectives, it needs to obtain support from these partners in return for the benefits which they obtain. Investment can (and already has) take a number of forms. These include:

- Provision of funds for PhD scholarships (for example, $25,000 p.a. for three years)
- Provision of funds for MSc scholarships (for example, $25,000 p.a. for two years)
- Provision of top-up funding for an existing government (APA) scholarship (for example, $5,000-$10,000 p.a. for two to three years)
- Sponsoring of a specific research project or researcher
- Sponsoring of a post-doctoral position
- Higher level funding to permit a flexible research and technology transfer environment (> $100,000)
- Collaborative grant proposals to government (e.g. GIRD grants, collaborative ARC grants)
- Provision of software or hardware
- Provision of industry focussed data for use in research projects
- Provision of industry test-bed environments for ideas generated by COTAR researchers
- Provision of travel funding to allow young researchers to attend national and international conferences ($500-$5,000, one off, or annually)
- Sponsoring of seminars or seminar series
- Secondment of personnel to COTAR to undertake joint research projects and teaching ventures
- Willingness to act as an “expert” on some aspect of OT, to whom specific enquiries can be channelled by the staff of COTAR

It is recognised that different organisations have differing abilities, and will wish to contribute in differing ways. As such, COTAR does not require a specific form of contribution, but is willing to negotiate an appropriate contribution, taking into account the organisation’s size, business, level of OT expertise, etc. It would naturally be expected that the level of contribution by a given organisation would be commensurate with the benefits which they hope to gain from COTAR.
In addition, all support provided to COTAR is fully acknowledged. The name of the sponsoring organisation appears in all research publications and presentations arising from the sponsorship and full details appear in the Annual Report of the Centre which is circulated widely nationally and internationally.

What are the benefits to industry?

It is quite obvious from the above that the industrial partners of COTAR make a financial commitment of one form or another (in terms of funding, personnel, or resources). It is to be expected they receive in return some form of commensurate benefit. These benefits can take a number of forms:

- Access to state-of-the-art expertise on software development
- Advice on many aspects of Object Technology, including migration to this new technology, language and methodology choice, tools, etc.
- Networking to other companies adopting OT for similar projects
- Priority access to in-house and public professional development courses
- Access to a wide range of object-oriented CASE (Computer Assisted Software Engineering) tools, languages, and support tools for evaluation.
- Access to researchers and students providing collaborative input to appropriate projects.

In addition there is the more long-term issue of the general health of the industry. The nature of OT is such that the greater the level of activity, the greater the benefits which can be obtained - both in direct terms of software reuse, and more generally in the expanded skills base which becomes available.

It is these benefits which ensure the success of COTAR. If the industry partners cannot see the benefits of supporting COTAR then they will not participate. Many of these benefits are related to assistance in adopting OT and ensuring that it fulfils its potential. The software industry is in a stage where an increasingly large number of organisations are beginning to adopt this new technology. It is this state of flux, as much as anything, which contributes to the need for a centre such as COTAR.

How does academia contribute?

As was listed above, industry partners of COTAR obtain a series of benefits through their participation. These benefits need to be supported. This can occur partly through the involvement of other industrial partners (e.g. networking to other organisations adopting OT for similar projects). Many of these benefits however arise out of the involvement of the academic members of COTAR.

Academics contribute to COTAR predominantly through research, post-graduate supervision, and various methods of sharing their knowledge and expertise. Most academics spend a considerable proportion of their time undertaking research. It is an accepted (or rather, an expected) part of their professional activities. As a result of the nature of academia, and the freedom which it offers, this research is almost entirely self-directed (at least within broad bounds set by available funding and access to appropriate support). The research tends to be in specific areas which combine both the individual’s area of expertise, and their area(s) of interest. Each academic is therefore likely to be working in their own specific area. However, for the research to be as productive as possible, the researcher needs to communicate and collaborate with others working in similar areas - hence the existence of research teams, research centres and other mechanisms for providing a forum for this collaboration amongst researchers. COTAR provides a mechanism whereby researchers working in Object Technology can come together to form a synergistic relationship. Formal mechanisms for assisting with this are being developed within COTAR in the form of a newsletter, seminar sessions, etc. In response, research results (typically in the form of published papers) will acknowledge the support of COTAR.

The academic members of COTAR also invariably supervise postgraduate research students. Again, COTAR provides an avenue for providing these students with a broader resource base (especially in the form of a much broader expertise base). These research students will eventually feed into industry, and so academia is effectively assisting in the development of a skills pools in this area.
Finally, the academic members of COTAR have a considerable body of expertise in the area. They contribute to COTAR by sharing this expertise in various ways: the development and presentation of professional development courses, providing advice on the adoption and use of object technologies, providing a research resource where appropriate, etc.

**What are the benefits to academia?**

Finally we need to consider the benefits which academics obtain from their involvement in COTAR. The most obvious of these benefits is financial - it enables them to obtain funding (in various guises) for their research. This funding can support post-graduate students working with the various academics, post-doctoral researchers, pay for travel to appropriate national and international conferences, and pay for necessary equipment and other resources. Although funding is available from other sources (such as government granting bodies - e.g. the ARC) this funding is highly competitive, and other sources of funding are actively sought.

Practical support for research can also occur in other forms. These include many of the direct contributions from industry listed previously, such as provision of test-bed environments and commercially-focussed data. These forms of support are invaluable to research which has such an immediate industrial relevance.

Other benefits which academics gain form their involvement are more abstract, but nonetheless important. An important contributing factor to the quality of research which is undertaken in academia is the support environment which is available. This includes many factors which are difficult to quantify, but add up to the general research ethos of a department, centre, university, or group of researchers. One factor which has a strong impact on this is reaching a critical mass of individuals. Another is access to individuals who have first-hand commercial experience and an understanding of real-world issues and problems. COTAR provides a mechanism for achieving both of these.

Finally, one factor which is often overlooked (or ignored) is simply the enhancement of prestige or reputation which occurs through involvement with a high-quality research centre such as COTAR. This is especially true in a University such as UTS, which prides itself on, and actively encourages, involvement with industry.

**4. RISKS AND DIFFICULTIES IN THE COLLABORATION - HOW SUCCESS WAS ACHIEVED!**

**Differences between Academia and Industry**

It is worthwhile considering the risks and difficulties associated with setting up a centre such as COTAR, and how these issues were addressed (or not addressed as the case may be). Firstly we need to look at the differences between a university and commercial organisations. This covers a plethora of issues which include:

- **Organisational structures.** The organisational structure of a University is typically quite different from that of most other organisations. As a general rule there is reasonably tight control over any major initiatives, such as COTAR (typically requiring suitable approval from the Vice Chancellor). However once these initiatives are set up, their operation tends to be highly autonomous. Unlike most organisations, the instigation for initiatives such as COTAR tends to come from an individual or small group of individuals within the academic community, rather than from the ‘management’. Another aspect of the organisational structure is that the individuals responsible for the centre tend to be involved in a broader range of activities. The stratification of academic structures tends to be vertical rather than horizontal. For example, the director of COTAR is actively involved in the management of COTAR, applied research, running professional courses, as well as normal academic teaching and administration duties. Although this can occur in small companies, it is less likely in organisations the size of a University. More generally, the hierarchy of responsibility is much looser in Universities. This will be discussed further shortly.

- **Working structure.** The working environment, conditions and general structure of academia tends to differ significantly from most commercial organisations. An academic work pattern tends to be both more and less flexible than elsewhere. Academics tend to have regular commitments which cannot be modified (it is
difficult to reschedule a teaching ‘appointment’ with 200 students!). Outside of these teaching commitments however, academics tend to have considerably more flexibility. Many often work from home, tend to undertake self-directed research and consulting, and in general have much more professional freedom in terms of their method of working than is usual in companies.

- **Agendas and Priorities.** Probably the most significant different in the cultures of academia and industry is in the priorities and agendas which are considered important. Commercial organisations naturally tend to place importance on commercial success and factors which will assist them achieve this. The predominant reason for participating in COTAR is that it will help them adopt and utilise object technology, which will in turn help them develop more competitive software systems in one form or another. This is obviously not a major priority for academia. The priorities here tend to be more varied and subtle. Examples of academic priorities include a desire to undertake world-class research, develop marketable skills (both for oneself and for ones students), and improve the reputation and resources of the University. The priorities of commercial organisations (and the individuals within these) tend to be based on commercial considerations. The priorities of academics tend to be based much more on individual considerations.

### Handling these differences

Although there is significant differences between academic institutions and commercial organisations, this by no means prohibits them from working together. Although the expectations and priorities of the participants in COTAR are considerably different, this does not necessarily imply conflict. One of the most important considerations is that each participant needed to be aware of the differing priorities of the other participants.

The various participants in COTAR were all well aware that the other participants expected different benefits and would be making different contributions. One major factor which contributed to the success of COTAR was that these benefits and contributions were made very explicit. At all times, the expectations placed on the various participants was well delineated. The industrial partners were made well aware of the ways in which they could contribute and the potential benefits which they could expect to gain. They were also well aware of the possible contributions made by academic members and the benefits they wished to gain.

### Other factors assisting the success of COTAR

A number of other factors contributed significantly to the success of COTAR. Some of these are relevant to other collaborations between industry and academia, some are not.

- The academic members of COTAR are proficient and experienced researchers in the area of OT. In particular the director - Professor Brian Henderson-Sellers - is very well known and respected in the field of Object Technology, both within Australia and internationally. He has had considerable interaction with many of the best known names locally in the computing profession - through consulting, training courses, and professional societies. This has tended to instil a sense of confidence in his ability and integrity amongst the possible industrial partners.

- Object technology is currently a relatively new technology, which promises much. As a result it is just beginning to be more widely investigated and adopted. There are many organisations who wish to investigate this ‘new’ technology and its applicability, but do not have the skills or resources to undertake this in isolation.

- The computing profession is, compared to most other professions, relatively young. There is still a large gap between the demand for specific skills, and the supply of these skills. Additionally, much of the knowledge base and many of the techniques used in the industry are not yet settled or refined - the industry is continuing to evolve rapidly. The industry subsequently has a strong record of support for any initiative which might help to address these issues. In addition UTS has a strong record of active involvement with industry. Both these factors tend to help in setting up a centre such as COTAR.

- One effect which was not intentional (but which could easily be foreseen), and has contributed to some of the industry participation is what I would call the “club membership” effect. In a number of cases, especially where there were a number of organisations in similar areas, once one organisation has
committed themselves to participation in COTAR, a number of others immediately followed. The cynical point of view may be that they wanted to ensure that the commercial playing field stayed level!

5. EXAMPLE: THE COTAR/CLASS TECHNOLOGY TRAINING COURSES

As an example of the type of collaboration which COTAR encourages, the development of a joint program between COTAR and Class Technology Pty Ltd will be considered. This program aims to develop a cohesive suite of professional development courses on various aspects of Object Technology.

Prior to the formation of COTAR, the academic members of COTAR had developed and presented various industry, undergraduate and postgraduate courses on many aspects of OT. These courses tended to be run as isolated courses, rather as a cohesive part of a larger OT program. Similarly, many organisations had courses on specific aspects of OT. Many product vendors ran courses aimed at developing knowledge or skills in their products or related areas. Various consulting companies ran OT courses, often promoting their specific solutions or methodologies. Universities often ran CPE (Continuing Professional Education) courses on aspects of OT. The major problem with these courses, from COTAR’s perspective, was that they did not form an integrated package which provided organisations with a solid path into OT - many organisations found themselves sending employees on courses from a variety of sources which were poorly integrated and often leaving gaps or duplicating material.

One of the major goals listed in COTAR’s mission statement was to address this problem by providing “quality professional development courses in object-oriented software engineering”. This implied the development and offering of a large number of integrated courses. Although COTAR academic members had in existence a number of courses, and the skills to further develop others, they did not have sufficient resources (in particular time) to dedicate to this project.

As a result of the above considerations, COTAR and Class Technology Pty Ltd - one of the leading OT consulting firms in Australia - formed a joint venture to look at developing, administering, and presenting a suitable suite of OT professional courses. At this stage both COTAR academic members, and Class Technology representatives were presenting specific OT courses.

During the initial discussions, COTAR saw the benefit of the active involvement of an organisation who had constant exposure to commercial systems, problems, issues and requirements. Class Technology could more readily ensure that the courses maintained their commercial relevance. Additionally, Class Technology would be able to provide industry contacts and exposure, as well as commercial credibility to the courses, both of which would be difficult for a University. Class Technology saw that their involvement with a University based centre such as COTAR would provide the courses with a degree of educational credibility to the market. Additionally it would ensure that there was a stronger and broader base of expertise for the courses. It would also ensure that the University facilities (rooms, computing facilities, etc) would be available. In short, both partners saw considerable benefits arising from the proposal.

During the ongoing development of the project, various difficulties arose and had to be resolved. As an example, this project was the first major collaboration with an external commercial organisation on the development and presentation of professional courses. The University has strict guidelines for the development and approval of professional courses (as a method for protecting its reputation against the offering of inferior quality courses). Thus all courses (whether developed by COTAR or Class Technology) had to be approved by the University, if they were to offered as part of a program involving the University. Similarly, the University had certain requirements pertaining to the financial aspects of the courses which caused difficulty. These problems essentially arose from the University’s rigid organisational structure, whereas the much smaller Class Technology had much more flexibility.

Another issue which needed to be resolved was the financial aspects of the courses. COTAR was involved in the program partly as a method of facilitating the commercial acceptance of OT, and partly to raise funding to be used in the various research projects. Class Technology was naturally involved in the project as a
commercial venture. They obviously hoped to gain the normal commercial benefits from their involvement - both financial benefits and commercial contacts (extremely important for a company heavily involved in consulting). An arrangement which was considered satisfactory to both partners was developed.

The program which was developed encompassed in excess of a dozen different courses (ranging from 1/2 day courses to full-week courses). The total number of courses running each month will typically average 8 or more. For each course there will be a number of presenters who have been trained to ensure availability. These trainers are drawn from COTAR academic members, Class Technology staff, and where appropriate external presenters who are suitably qualified.

The program appears to be a considerable success (though it is still evolving). This is mainly because both parties have recognised the benefits to be gained from their active involvement with the other partner, whilst still being prepared to contribute in a constructive fashion. Undoubtedly, the University’s requirements for financial and educational accountability presented the greatest difficulty - not in the requirements themselves, but in the need to adhere to certain administrative mechanisms.

6. CONCLUSIONS

During 1994 UTS created the Centre for Object Technology Applications and Research with Professor Brian-Henderson-Sellers as the director. This centre was intended to act as a non-profit making organisation committed to research excellence and technology transfer to industry. As such, it aimed to maximise its collaboration and communication with industry. The response from potential industrial partners has been excellent and reflected on the need for a centre such as COTAR.

The success of COTAR, and in particular the high level of industry involvement, can be attributed to a number of factors. These include

• The current state of evolution of object technology within the computing industry means that many industries are just now at the stage of beginning to investigate the adoption of this technology and yet lack sufficient expertise or skills. They are therefore willing to participate in any venture which may improve their chances to successfully adopt OT.
• The proven willingness of the computing profession to support ventures such as COTAR
• The high-level of industrial experience and the immediate commercial relevance of the areas of expertise of many of the academic members of COTAR.
• The high profile, experience and expertise of the first director - Professor Brian Henderson-Sellers.

Many of these factors are particular to the establishment of COTAR, and may not hold for other centres - particularly the first of the above points.

7. ACKNOWLEDGMENTS

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