

Leading edge technology in advanced manufacturing: Supporting the needs of industry

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This paper aims to discuss the first trial of the Applied Technology Framework and an innovative approach to enterprise consulting within a medium sized company specializing in precision machining. It reports on both what happened and the enhanced understandings, which have flowed from this process. It begins with a brief outline of the Applied Technology Framework (ATF) and its aims and builds on a paper presented at the Post Compulsory Education and Training conference in December 2003 (Martin, 2003). This paper has been written through collaboration with other project team members involved: Catherine M. Down, Projects Director, Educational Development and John Pittman, Strategic Consultant, Office of the Director TAFE.

The purpose of this paper is to outline the convergence of new ways of working as they come together in a continuing training, consultancy and research project provided by RMIT in partnership with a medium sized precision machining company, the Office of Tertiary Training and Education (OTTE) and the Department of Innovation, Industry, and Regional Development (DIIRD). Funding is from government programs managed by these departments and designed to target critical industry needs.

These partnerships are built on the basis of relationships. Buchanan et al (2002) in reporting to the Victorian Learning and Employment Skills Commission (VLESC) identified the three most important pre-conditions to renewing capacity for skills formation in Victorian manufacturing industry as:

1. The recruitment of Champions to develop new institutional forms;
2. Brokering dialogues between Business and educators, and;
3. Developing a “‘relationships’ as opposed to a ‘programs’ mindset. It appears that a key operational principle of this group is to build networks and relationships between employers before putting the ‘hard word’ on them to adopt a new approach or participate in a new training initiative. ... It is also a quite different approach to the now fashionable ‘purchaser-provider’ model of program delivery. Relationships cannot be bought and sold. They need to be cultivated before changes in behaviour are achieved.” (pp. 49-50).

This project satisfies these three conditions.

The three new ways of working are:

1. The development of the Applied Technology Framework (ATF), which provides a flexible framework for the provision and recognition of workplace training for post-trades level workers; especially those who have skill gaps because of the emergence of new technologies and/or the continuing development of new technologies in the workplace. It allows competencies from any Training Package or accredited VET program to be combined as required by industry in a specific setting, and it also enables customisation where determined as necessary by industry clients to meet their productivity needs. Where skills are identified which are not yet part of National outcomes specifications, these can be documented and recognised under the umbrella of

the Applied Technology Framework. This provides industry and the Australian National Training System the opportunity to address competency gaps.

The Applied Technology Framework is a post-trade framework of accredited programs, which is being developed to meet the needs, identified by industry, in particular, those small to medium enterprises working in areas of rapid technological change and/or emerging industries. It has been designed as a framework for the recognition and support of work-based learning to allow mixes of competencies to be, tailored for individual employees within an enterprise context and recognized through the Victorian Qualifications Framework.

2. The development of a new way of conceiving the relationship between the university and its business partners, whereby the relationship is not the preserve of one part of the University but between the entire University community and the client partner. This means that a holistic production of solutions service, continuing skills need identification, and training with consultancy in both technical and business issues, and desktop and applied research, can be provided. The University community is viewed in a broader way with other TAFE Institutes, Universities, research centres, client suppliers and other enterprises seen as constituents under appropriate partnering relationships and arrangements. Those possessing relevant expertise are all potential partners in productivity problem solving arrangements.
3. RMIT University's strategic direction, aimed at *Dissolving the Boundaries* both within the University (between departments and between its VET and higher Education sectors) and between the University and government and business partners.

The Context: Advanced Manufacturing

The model is being implemented within a number of groups in the Advanced Manufacturing sector as well as the Plumbing and Waste Management. There is room in this paper to only discuss one of these and this is the work currently being undertaken with an advanced manufacturing enterprise. Precision engineering and machining companies make die-cast tools for the manufacturing industries. These are the metal moulds that are used to shape materials such as plastics, metals and new composite materials into objects such as car components, bodywork and interior fittings, plastic lunch boxes, coinage, wheelbarrows, compost bin, wheelie rubbish bin, surgical instruments, medical and scientific equipment, chairs and plastic packaging. A tool can weigh from several kilos up to several tonnes.

The precision engineering and tooling industry underpins the capability within the advanced manufacturing sector of our economy and is, therefore, a key industry sector with respect to economic growth. It is thus currently being given priority by government instrumentalities with respect to training. In discussions with RMIT University staff, the precision machining company identified skill gaps as one of its current issues, especially those arising from the introduction of new technology, which requires all operators to undertake skilled functions that have previously been the domain of one or two technical experts.

The project

RMIT University has developed a program for this medium sized company to address training needs that have arisen from the emergence of new technologies and competition in a global market in the Precision Engineering and Tooling industry and for the addressing of those issues

identified above. The program enabled a trial of the Applied Technology and consultancy model.

Understanding the Problem

In order to remain competitive in a global economy, management recognised the need to invest in state-of the art technology. In order to get the maximum value from this technology it will be necessary to align the skills of their production team with the requirements of the new technology. These skills are understood by management to be across three key areas; machine dynamics, controller technology and cutter technology. A team of up to sixteen manufacturing staff and six administration and management staff need to be part of a process to optimize manufacturing process technology and the underlying systems design to enhance the productivity in order to remain competitive in the global market. The principal measure of success of this project is the ratio of unattended to attended hours. At the start of the project the ratio was 1:1. The companies' goal is to ultimately achieve a 3:1 ratio. The demands of production and the nature and the range of skills involved required the project to be delivered on site. More importantly, occurring in the context of the workplace would enhance that learning.

Problem Solving Approach

Taking a problem solving approach involved asking, and then entering into a dialogue with the client, as to what help they wanted with solving their productivity problems. Establishing this dialogue was a catalyst in dissolving industry perceptions that there are impermeable boundaries between themselves and the education sector. Early discussions clearly demonstrated that our potential manufacturing partners shared the perception identified in *Renewing The Capacity for Skills formation: The Challenge for Victorian Manufacturing* (Buchanan et al, 2002), that the current education and training system is rigid, autocratic and out of touch with rapidly changed up-skilling and new skill formation issues in industry particularly small to medium enterprise. To earn the trust of the company's personnel, RMIT had to show itself as flexible and supportive able to respect the ability of the client to identify and resolve its problems (albeit with facilitation from RMIT staff).

An RMIT team of three that included an Industry Liaison Officer, lead TAFE teacher (with expertise in computer numeric control (CNC) and computer aided drafting and machining (CAD/CAM)) and a Strategic Consultant from the Office of the Director TAFE met with the management of on site. They listened to the issues, teased them out, and toured the production areas to start to get a picture of the workplace and the issues sitting within it. The next step was to formulate a proposal for a productivity improvement project that RMIT could deliver that met the range of needs and constraints of the client.

Goal of the Training

The goal of the project was to contribute to the building of an effective work team with a skill base that would include CNC operation, specific skills in Machine Dynamics, Controller Technology and Cutter Technology; improved understanding of systems design; and team communication skills and strategies to maximise efficiency in the use of newly acquired technology. Although not a requirement of the project, it was planned to provide the participants with recognition of competence as a natural part of this process of capability development. We recommend this as it provides national recognition of the skills that the employees will be developing.

As the designer of the Applied Technology Framework wrote:

Finding solutions to workplace problems involves a process of learning. This learning is generally unstructured and involves the construction of new knowledge about the

workplace, its processes and its practices. The Applied Technology Framework project seeks to establish a framework which allows learning related to the resolution of workplace problems like those related to the introduction and use of new technologies to be supported and, where possible, recognised in terms of industry competency standards and vocational qualifications.

However, the framework is more than just a set of nested qualifications. It represents a distinct, yet very flexible, approach to the enhancement and recognition of workplace learning through problem solving and or investigative projects. The approach is focused on learning from work and learning from and with others. However, it also uses structured reflection to ensure that the tacit understandings, which enhance our work performance, are explored and made explicit.

One way of visualising the Applied Technology Framework is as a kind of Rubik's Cube. Whilst each workplace will have a different configuration of needs and skills, there will be a core mechanism that enables these needs and skills to be configured and applied to form the unique pattern which is necessary for effective workplace practice for that enterprise.

(Down, 2003)

Implications of using the Applied Technology Framework and consulting model, mixing VET, Higher education and research.

The client, management and staff

For management there was the discovery that staff had a better understanding of productivity improvements than management had expected. Not only did the staff have knowledge of problems that were impacting on productivity for the company but they also had solutions. The first activity undertaken was an interactive whole of company workshop assessment of managements understanding of the problems and proposed solution, understood to be the need for increased technical skills. This unearthed not only the staff's sophisticated understanding of the issues and knowledge of the practices of the company but that there was a rich and diverse consideration of possible solutions that could be trailed by the company.

Key issues identified by the staff were: inadequate communications in all dimensions of the company, inadequate structures to manage and support information flow and sharing, the hierarchical structure within the company was not supporting productivity.

As a result, management recognised that the project with RMIT University would need to address a broader range of needs than just the technical skills, that a shift of culture to one of the whole company working together in a problem solving approach was likely to bring greater success in addressing their productivity issues, that the companies way of operating was going to need to change. Underpinning skills and knowledge that would be needed were communications, planning and risk analysis, design of systems and processes, research and internet use.

For staff this was the experience of a sea change. Many had had previous learning experiences in their lives that had been negative. There was also a negative history of attempts to fix things that had built up within this company. Most staff had worked on problem identification and solution recommendation in the past had passed this on into the management hierarchy and that had been the last they had seen or heard. The problems had continued, management had not followed through the solutions, and no feedback around these issues had ever been offered.

The first workshop included an undertaking by the management group to listen, to participate, to act, and to communicate with the staff. That this was to become a whole of company problem solving activity. The structure of the workshop made explicit a belief and recognition of the existence, importance and role of the workers existing knowledge and skills. It supported and validated individuals ability to identify, share, and problem solve.

The setting of the problem within the context of a productivity issue has been a critical factor in providing a focus for all concerned with the project. Productivity measurement provides a tool for observing the effectiveness of this program for the company, the workers, RMIT University, DIIRD, OTTE, suppliers, consultants and industry.

Technical experts/industry consultants/suppliers

A core concept underpinning the Applied Technology Framework is that there is a diversity of resources available to learners learning in the context of the workplace. These include fellow workers; suppliers; industry consultants; research centres; workers in other similar companies; the internet; and manuals, both printed and electronic. Several suppliers of tools, materials and software were involved in the project as were two research centres, and a number of industry experts in software use, CNC machining, and cutter path design.

A key issue that emerged was an awareness of a subtle boundary between a supplier's dual and interconnected roles of both seller of their product, or service, and provider of knowledge essential to their industry that sits under a product or skill. This needed to be made explicit, discussed and managed in the workplace. The project provided experiences for the workers of workshops with technical experts who were suppliers of component tools used in the precision engineering manufacturing processes. These activities were to support the development of increased capability within the workers established and consolidated practices that would support learning about new technologies as an ongoing activity within the company.

During regular team meetings many staff revealed that in one particular supplier workshop that they felt they were receiving information biased toward that particular suppliers product lines. The issue was that the duality within a supplier needed to be made explicit and that the workers had to address strategies for managing such situations in ways that would ensure that they could manage the information obtained from a supplier. This involved developing strategies for questioning a supplier, seeking alternative views from a range of sources, testing information, and making judgements.

To suppliers that participate in providing knowledge to their clients makes good business sense. It brings them closer understanding their clients business needs and productivity issues and so more able to add to their resolution. If a clients business and the industry grow as a consequence then so will that of the suppliers.

Teaching and learning professionals

TAFE

There are machining experts working in industry as consultants who are able to provide relevant and up-to-date technical knowledge and skills that are needed to address productivity issues. There are however a number of critical issues. Technical experts are few in number and within five years of retiring from work. The average age of a toolmaker or precision engineer in Australia is 54 years of age, 57 in the USA (Buchanan et al, 2002). The advanced manufacturing industry in Australia faces an immediate crisis as it struggles to attract and train new talent (DIIRD, 2002). In many cases industry based technical experts do not have training in teaching skills, and many with teaching experience lack recent industry knowledge. Furthermore, many of those still available to the system, while having a strong grasp of the technical competencies,

and the constraints of existing training packages, lack an understanding of the broader generic skills and business management competencies required by industry. At the same time it was difficult to identify TAFE teachers within the institute who had the required level of technical knowledge required by the precision engineering industry.

Securing the teaching services of near retirement experts proved to be a vexed experience. In Victoria and within RMIT University the nature of TAFE teacher contract arrangements is framed around and justified by classroom teaching allocation. Industry productivity solutions such as this project can have needs quite different. Scheduling of training in the workplace must work within the production demands of the business. A client can want a training solution delivered within a shorter time frame than the half-year planning cycle of class teaching requirements that an institute works on. Responsiveness to industry training needs is greatly constrained.

The teaching skills of TAFE staff has become limited by their often having spent too much time teaching in classrooms rather than out in the workplace which, as the ATF shows, demands; different approaches, greater flexibility and a wider range of teaching skills, over the past decade. Within this project a number of TAFE staff were quite distressed by the changing circumstance of the industry setting they were working in and the flexibility of approach and teamwork that this demanded of them.

Curriculum and Educational Design Capacity

The shift to Training Packages has been a shift away from curriculum based accreditation system to a competency-based system of accreditation. Past practices of teaching departments handing a new teacher a copy of a curriculum document to teach directly from, with no demand upon the teacher to develop teaching and learning practice, have been replaced by a system that expects a teacher to develop curriculum. The advantages of the new system are to provide the opportunity for re-engaging teachers in developing flexible, tailored approaches to suit differing clients and conditions. The consequence of the old system is that the expertise and practice required have declined dramatically within TAFE/RMIT.

There are only a limited number of educational designers and curriculum developers employed by the organization, too few to meet current industry demand. There is a central support group (CID) available but the parameters of this role is only that of mentor to teaching staff through the requirements of internal and external accreditation processes and curriculum development. This group is also a limited resource that is unable to meet current industry demand for new product development.

Implications for ANTA, OTTE and Institutes

Professional development is a key issue that needs to be addressed in order to meet the needs of industry. New and young talent needs to be developed to work in both industry and teaching. Strategies are required to ensure that existing knowledge of near retirement experts in precision engineering is passed on to a new generation of precision engineers and teachers. Current TAFE teachers need mentoring and support as they are asked to change their teaching practice. Educational and curriculum designer skills are needed in greater numbers to support the demands of industry training needs that are emerging as a result of the impact of new and rapidly changing technologies. New institutional models, processes and structures to facilitate the acquisition and development of required expertise are needed at both a state and institute level.

Research centres

A number of research centres were approached and consulted within this project. It was found that the understanding of research centres of how their expertise might be or become relevant to industry, varied.

One RMIT University research facility provided consultancy only on the basis of the client attending the university site to be shown how to solve their problem. However, the client required attendance on the production site to ensure that the solution proposed addressed the constraints of the setting. Research and development considered to be exemplary by the precision engineering industry internationally was being carried out by one of the Australian industry members in-house. A CSIRO Centre for new manufacturing materials worked on the basis of research that identified areas or issues of greatest need across manufacturing and did not engage in direct support on an individual client basis.

VCAMM identified good research outcomes for automotive and precision engineering industry problems had been achieved by taking a different approach. Their researchers will work within an enterprise on the basis of solving immediate productivity issues for up to two years before the enterprise staff begin to ask for research activities to be undertaken. The observation made was that the immediacy of production and scheduling demands and the nature of the education and training of designers and engineers intercede in an immediate recognition and appreciation of how research could solve their productivity problems. Over time working in teams with a researcher the internal development staff are able to begin to identify research projects that would be relevant to their companies productivity issues.

Specialist Centres and Victorian TAFE institutes

The severe shortage of expertise available to the TAFE system suggests the need for share arrangements of both staff and equipment through collaboration between institutes. In other projects we are working on for the tooling, plastics, automotive and aerospace industries collaboration with Victorian TAFE's will be essential to ensure that adequate expertise as well as specialised equipment are available to support industry.

Modern equipment for training is essential. But, it is expensive. CNC machines now cost in the vicinity of \$500,000 each. There is a diversity of new highly technical machinery that learners need to be trained to use. This is challenging the resources of the education and training sector in Victoria. Training in the workplace provides a good solution that works well for educational reasons. As the ATF identifies, research shows that learning at work provides an effective learning context. However, there are situations where the learner needs to experience machinery and technology that is not within their own workplace. Some companies are able to invite their competitors onto their site for the purposes of training. There are others who are not. One reason can be simple fear of loss of an 'edge' over their competitors by permitting them to observe production techniques. There can be valid safety or 'commercial in confidence' issues.

Victoria has Specialist centres and Industry Liaison Agents funded by the Office of Training and Tertiary Education (OTTE) are aiming to provide part of the solution. By taking a co-ordinated approach to the development of the centres and the equipment purchases made across the 18 TAFE institutes OTTE is taking a lead in ensuring that scarce resources are efficiently utilised. OTTE is encouraging collaboration between institutes in the sharing of staff and resources to support the needs of Victorian industry. However, the Victorian TAFE system has a recent history of each institute working within a competitive model. Institutes have been required to compete with one another for resources. Behaviours have emerged over time that now challenge the systems ability to address critical resource issues.

A critical implication for OTTE is what role to take to bring about innovation and the change of behaviour that is required within the systems so that it is able to maximise capacity to respond to the needs of industry.

Project manager

In this first project for the ATF and the business consulting model the RMIT University projects' manager responsible for the ATF projects worked closely with the of teaching, technical and research staff, referred to as the **skill set team**, and the enterprise, both in the on-site training delivery and in the off-site mentorship program. The implementation of the concepts underpinning the ATF learning model and the business-consulting model were a critical focus and it was considered important to have this closely managed. Close involvement also ensured that the implications of applying the two models were observed and recorded. A researcher was attached to the RMIT University team to support the recording. There were also institutional funding bodies ANTA, OTTE and DIIRD. RMIT University institutional structures and systems provided the forth point of tension that required management and close liaison during the course of the project and its reporting phase which is ongoing.

Particular issues observed were the difference in understandings and expectations of enterprise and educators. Each group has a different set of drivers that order priorities. For business the financial bottom line is the *raison d'etre*. If you do not make a profit you simply won't be there to improve your business and staff next week, next month, next year. Educators focus on ideas of quality and relevance of learning experience, tending to design these experiences oblivious of the imperatives of enterprise. Both DIIRD, 2002 & Buchanan et al, 2002, have identified this tension as a critical issue for Victorian manufacturing.

Within these two broad groupings there are sub-groups with varying perceptions of priorities that also had to be managed. Educators fell into sub-groupings with varying attitudes and approaches and within enterprise there were also differences between the business consultants, owners, upper management, middle management, financial and administrative staff, machinists, toolmakers, computer aided design/manufacturing specialists. Management of the varying needs and understandings of the types of participants required knowledge and understanding of each of these groups at project management level. The time demanded here was considerable and pointed toward a number of key issues to be addressed;

- Increased professional development facilities for all members of 'skill set teams'
- A new model for project management and direction

A project direction and management model has evolved from the experiences of this first project that is now being applied in the current new model projects. The refined approach has separated the project direction and management roles. Project direction currently covers;

- Relationship management of clients
- Liaison with key institutions; government departments, OTTE, DIIRD, DSE, VQA; industry bodies, ITABS, TIFA, AMTIL, PACIA, MPASAA; Industry Liaison Agents, other TAFE institutes, Specialist Centres and Registered Training Organisations (RTO's)
- RMIT University internal liaison across VET and Higher ed sectors, and between disciplines as well as administrative functions.
- Establishment and oversight of projects
- Management of outsourcing expertise in educational development and curriculum design, industry technical expertise, research centres, suppliers.
- Planning for transfer of new training solutions to relevant RMIT University section for ongoing delivery

- Building professional development for skill set team members.

Educational development and curriculum designers, sourced from within RMIT University and externally, work under the Project director to;

- Provide educational design and curriculum development based upon the principles of the ATF and the business consulting model
- Lead and work with the selected skill set team during the development and delivery phases of a project. The team typically includes representation from the client, industry expertise, RMIT University teachers from HE and TAFE, and can include members of other Victorian specialist centres, RTO's and TAFE institutes and relevant industry suppliers of goods and services. Thus, providing both quality design of training solutions and professional development for team members.
- Liaise with the client during development and delivery.

Professional development

A mentor has been chosen to lead a support group for teachers working in industry on the future projects. The mentor will run a regular support workshop in which teachers are able to share their experiences, debrief and build their understanding of teaching in a supported structure. The mentor will report to the project director and liaise with the educational developers and curriculum designers.

The experience of working on skill set teams provides all members from vary sectors to gain knowledge and skills from one another. Providing a supported environment with both mentor and educational developer we hope will enhance the change of practice experience for team members.

In conclusion

The first trial of the Applied Technology Framework and an innovative approach to enterprise consulting confirmed and enhanced understandings that industry workforces need training support to help them adapt to technological and organisational changes which impact on their work. This is especially true in those industries whose survival depends on their ability to use technology innovatively in order to work smarter. Those in industries experiencing very rapid change need to be able to utilise and adapt technological advances as soon as they are developed so as to stay on the leading edge of work practice to ensure their viability and financial survival. The training support required typically needs to be customised to meet individual enterprise needs and work practices.

The ATF seeks to establish a framework which allows learning related to the resolution of workplace problems associated with the introduction and use of new technologies to be supported and, where possible, recognised in terms of industry competency standards and vocational qualifications. The ATF has been designed around a set of nested qualifications ranging from a Certificate IV in Applied Technology through a Diploma, Advanced Diploma, Bachelor and Graduate Certificate in Applied Technology. It represents a flexible approach that is focused on learning from work and learning from and with others, through work group problem solving and investigative projects that are aimed at addressing work place needs and issues. The consulting model provides a framework within which an organization such as RMIT University is able to respond in a timely way to the needs of industry.

The business consulting model was successful in meeting the needs of this client. The project highlighted ways in which the project direction and management elements of the model will evolve as a result of the experiences of this first project. This is now being applied in the current new model projects. The refined approach has separated the project direction and management roles.

However, there are implications that arise from this change of approach to education and training.

- There are a broader range of skill and knowledge needed than just the technical skills that the Australian system currently is focused upon. Underpinning skills and knowledge that would be needed were communications, planning and risk analysis, design of systems and processes, research and internet use.
- Enterprise culture in Australia need to recognise, and learn to better utilise, the existence, importance and role of the workers existing knowledge and skills.
- Supplier's do have dual and interconnected roles of both seller of their product, or service, and provider of knowledge essential to their industry that sits under a product or skill. This concept needs to be addressed in positive ways.
- Research centres need to consider expanding in new ways of working with industry.
- Implications for ANTA, OTTE and Institutes. Professional development is a key issue that needs to be addressed in order to meet the needs of industry. New institutional models, processes and structures to facilitate the acquisition and development of required expertise are needed at both a state and institute level.
- A critical implication for OTTE is what role to take to bring about innovation and the change of behaviour that is required within the systems so that it is able to maximise capacity to respond to the needs of industry.

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