Training Students to Intervene in Information Systems Inherently Involves Organizational and Technology Skill Acquisition

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Abstract- **The radical restructuring in enterprises caused by both global competition and technological innovation has created a new class of problems requiring a synthesis of organizational and technological skills. This class of problems is of central importance to all enterprises today and is critical to Small Medium Enterprises (SMEs). In this paper we explore our hypothesis that these problems exist and can be meaningfully identified and attacked by both university researchers and managers within enterprises. We further hypothesize that it is possible to design a program of training that prepares individuals to tackle these problems in real world situations by teaching both organizational and technology skills within a single program. We present case history data from four separate training programs that we have conducted along these lines in order to evaluate our hypotheses. Our data include the course structure, evaluations from students, professors, and industry partners as well as evaluations of the experiences of our students while applying their new skills in solving problems at a participating enterprises site.**

I. A New class of problems requiring a synthesis of organisational and technological skills

The pace of introduction of innovation in enterprises has never been faster. New technologies, new services, products and markets emerge with unprecedented speed. As obvious as this observation may seem to be, it has important implications for the way of doing business on one hand and for the way of correctly training people on the other hand [1]. In such a continuously changing environment, new paradigms for higher educational curricula need to be investigated and deployed [2].

We believe that the introduction of most of these innovations have, at their core, problems requiring a synthesis of organizational and technological skills. In fact the effects of the introduction of innovation are not limited to information management. They can profoundly change the organization itself.

For instance, as a result of such evolution, virtual enterprises are emerging as a new industrial paradigm [3] [4] as more and more companies reduce their wholly owned activities down to a core competence and run lean. They employ outsource service providers for a large range of operations.

The agility, or the continuous change of such enterprises, creates a strong requirement for integrated solutions and for people capable of managing the introduction and successful deployment of these solutions. If we are to effectively teach the practitioners who will be developing and adapting IS solutions for industry, we have determined that we must include instructional components directed at both organizational and technology skill acquisition.

A. Our Working Hypothesis

Based upon our early experience teaching the use of IS both in university traditional curricula and higher education courses for adult students, we concluded that in order to solve effectively enterprise problems, it was necessary to teach the students more than just the applicable technologic skills. Proficiency with the tools was necessary, but it did not guarantee that problems could be solved in real world settings. We quickly realized that the ability to function in small groups and the ability to understand common patterns in organizations were equally strong in determining the outcome of an intervention at an industry site. Proficiency with the technology alone was not sufficient.

We can organize our intuitions about the interaction between organization and information processing technologies into the following hypotheses:

- Problems with organizational and technology aspects can be identified and are important to both to large and medium-small enterprises now
  - ✓ They will be difficult to find because they involve sensitive issues at the core of the enterprise (not to be shared with outsiders)
  - ✓ Problems with both aspects can be small enough to be meaningfully attacked by a single individual
- Organizational and Technology skills can be taught to individuals in a combined program
  - ✓ An Active Learning Methodology will be effective
  - ✓ Teaching small group interaction can be effective
  - ✓ Internship is essential for motivation and context
- Students trained in this way will be able to solve real problems in enterprises settings
  - ✓ Students will find the practical experience satisfying and valuable
  - ✓ Industrial partners will feel that the intervention of the students at their site has been a success
  - ✓ Industrial partners will want to hire such students and want more interns from future training courses

These three major hypotheses, together with their subsidiaries, have formed the guiding principles behind a series of training courses and interventions at enterprises sites that we have carried out during the past five years. In the remainder of this paper, we summarize the context in which these hypotheses were derived, describe our training experiences, present what we have learned about the validity of the hypotheses, and briefly describe some of our future plans.

B. International Responses to these Issues

Educational programs trying to integrate technical, organizational and business aspects have been in place for several years. In Germany, you will find *Wirtschaftsingenieure* from faculties of Engineering, i.e. graduates that have passed programs combining Economics and Engineering, and *Wirtschaftsinformatiker* from faculties of Economics, who have studied Economics and Informatics. The general structure of these programs is a 2-year education, which is basically common for all students, followed by a specialization in Economics for engineers or Informatics for economists. Also in Sweden, similar programs have been established since the early 1980s, mainly under the name of *Systemvetenskap*.

At many European universities you will find programs that combine systems analysis and development with skills in organizational analysis and improvement, leading to a Bachelors or Masters degree. These integrated programs have been an early attempt to bring together skills from different disciplines.

For students with a background in other areas, it is also possible to study individual courses of these programs in addition to their normal tracks. Another possibility is to complete traditional curriculum with ad-hoc post-graduated education like Master courses on selected topics [2].

C. Our Response focuses on post-graduate training courses and on SMEs

The Laboratory for Informatics Engineering at the University of Trento is involved in a multi-year program of research, technology development, technology transfer, and professional training on the use of emerging information and communication technologies for supporting enterprise innovation. The main body of experiences we have gather from our work with local enterprises has been focused on Small and Medium Enterprises (SMEs) in the private sector and with relatively large enterprises in the public sector.

Our experiences on the problems related to the introduction of innovation have been collected during the years through three main channels:

- applied research projects with enterprises,
- internships projects in connection with a three year degree course in Engineering Informatics of the faculty of Engineering, and
- internships projects in connection with higher education training courses both for unemployed people and for life-long training of enterprises personnel.

SMEs face a specific challenge as the pace of technological advancement quickens. In order to keep pace with new information-based tools for engineering design, these SMEs need new problem solving and knowledge management tools [5]. They need to analyze the new tools and methodologies, select the most appropriate, deploy the solutions and train their workforce. Larger corporations can relay on the presence of various skills within the company to create successful teams, can afford external consultants to assist the change management, and broadly based training programs, while SMEs cannot.

The typical result from this lack of analysis capacity of SMEs is the focusing of their interest on particular one-dimensional problems, either connected to the technological or the organizational aspect only. By collecting and monitoring SMEs proposal for research and internships projects we have been able to identify this trend. The majority of the proposed projects involved the deployment of a particular innovation (technological or organizational) that the middle management of the enterprises believed to provide a competitive edge. Most of the times the innovation required massive entrepreneurial challenges: radical re-invention of internal or external processes, managing alliances and networking strategies, issues related to organizational memory and knowledge management problems. In the course of time, we have developed original responses to these needs.

II. Training students towards an integrated organizational and technological culture

We believe that organizational and technology skills can be taught more effectively to individuals in integrated educational curricula. This type of courses help in acquiring the integrated culture needed for professional figures to tackle the class of problems described in the first section .

Designing these training programs presents different challenges: contents, structures and methodologies need to be carefully analyzed and implemented. Educational strategies to address the problem of effectively linking Information Systems theory and real world issues need to be proposed, analyzed and tested.

In this paper we will present and discuss contents, organization and methodologies for four types of post-degree courses for new professions for qualified/graduated unemployed people.

We have started our experiences with two courses offered to post-degree students on mainly technological topics:

- "Distributed databases" (DB), dealing with computer networking environments, groupware and database design and applications
- "Decision Support Systems in Geographical Information Systems" (DSS), aiming to prepare professional persons capable to bring together basic computer science knowledge in the specific field of Graphical Information System, with operative skills on advanced computer based tools such as decision support systems.

The types of problems that we were able to collect and identify together with the managers of participating enterprises provided us with the drive to complete our offer with two other courses proposed to post-graduate students. These courses were design from the beginning with an emphasis towards an integrated culture in order to respond more effectively to industrial issues.

One course titled "Information Systems and Business Process Re-engineering " (BPR) focuses on providing the skills necessary to manage projects of process re-engineering connected to the introduction of IT tools.

The second course, titled "Master in Enterprise Innovation" (MII), aims to train persons capable of assisting the top management of an enterprise during the evaluation, the deployment and the subsequent monitoring of the introduction of innovation. The course has been focused on four main areas of industrial interest: (1) competitive advantages in alliances and outsourcing strategies (2) new forms of work organization (teamwork and groupware) (3)

new forms of business communication (virtual enterprises, e-business, e-commerce) (4) new methodologies and tools for enterprises knowledge management.

These four courses differ in the final goals and are targeted to different segments both of students (post-degree, post-graduate) and final professional profiles (practitioners, managers and consultants). Therefore, they differentiate in the selection of contents topics and in particular of emphasis for the various areas (IT technology or organizational and management disciplines). Nevertheless they share a common structure and teaching methodologies, based on our main assumptions:

- Active Learning Methodology (ALM) can be effective to achieve the specific goals
- Teaching small group interaction can be effective
- Internship is essential for motivation and context

In the following we will proceed in illustrating the main points in regard to structure, contents and teaching methodologies used within this framework.

III. Courses Structures

All the training is delivered in intensive courses of 1,000 hours in about six months - eight hours a day. Consistently with the need analysis and working hypothesis outlined in the first section, we have structured these courses in three phases [6].

D. Phase One - Building of Common Core Knowledge and Skills

Each student/teacher collects detailed information on student's prior knowledge (subjects and skills), and outlines the class needs in his/her subject. Content and methodology can thus be adapted to the real class. Trainees acquire a common core of knowledge and skills to be put into practice in the next phases. We give emphasis to case study and relevance to theory rather than to theoretical explanations *per se*. Trainees take active part in the learning process through hands-on task-based case studies, IT lab activities, teamwork, simulations, etc. Teambuilding activities are widely used across the subjects, so that students develop a sense of belonging to a real learning group rather than simply being individuals in the same class.

E. Phase Two - Fieldwork and Class Project

Students develop awareness of the economic context, both locally and internationally (this includes a one-week visit to innovative enterprises in Europe), and of the connections among the classroom «subjects». Their main activity is a class project in small co-operative groups, where they have to use all their knowledge and skills to carry out a complex task, while the teachers/trainers are supervisors and consultants.

F. Phase Three – Enterprise Internship Project

To give students an opportunity to put what they have learnt and experimented in class into *real* practice, they are sent to enterprises to carry out individual projects. They work there for three-four days a week, and then come back to the class, where they report and reflect on their work, solve problems with the teachers, get hold of further information/knowledge if needed, etc. They are asked to write an ongoing diary, and a weekly report. At the end, they produce a final report where they illustrate their projects from objectives to results.

IV. Courses contents

The four courses can be naturally paired into two groups in regard to contents. The post-degree courses having a high percentage of IT content as compared to organizational content. The post-graduate courses show different balances of presentation of disciplines, modulated by the differences of final aims of the two courses.

Some training areas are common to all programs. In particular:

English Language Area: to give participants basics of the English language. The module is taught in two weeks in England and is combined with a guided visit to enterprises involved in process innovation.

Cooperative Work Area to introduce the students to the environment and problems of cooperative work in public and private firms.

Industrial Internship between 160 hours and 240 hours (depending on the course), to provide the students with an experience in a real working environment. Each internship project is selected and designed together with the managers of participating enterprises trying to merge their needs with the curriculum and preparation of the students. The basis requirements for the projects, looked at carefully in the selection, are:

- real enterprise problem
- presence of interested industrial tutors
- possibility to structure the work in phases (analysis, design, deployment and testing)
- good match with the professional profiles envisioned in the course

In the following the selection of disciplines and training areas made in the design of each course is presented.

The DB course specific IS content is about 80 percent devoted to IT skills and 20 percent to organizational skills. The course focuses into 4 main training areas:

1. Organizational and Economic Area: 100 hours, finalized to give participants background knowledge on social, legal and economical aspects of working in this field. Modules included, among others, are: basis of Management Science; Introduction to application of databases in the industrial reality; Case-studies on introduction of innovation in industries: Guided visit to an industrial environment outside of Italy (England)

2. Computer networking environments: 130 hours to introduce the students to the use of the new IT environments in the workplace. Modules included, among others, are: Introduction to operative systems, Office automation; Computer networking, groupware;

3. Databases theory and practice 130 hours, to provide students with the knowledge of advanced computer tools and application in the field of distributed databases. This area includes practical tutorial of advanced (workflow analysis, database design and use, Access, SQL servers), internal projects to analyze and deploy technologies.

4. Groupware applications: 130 hours devoted to Computer Supported Cooperative Work theories and practice. Practical tutorials with Lotus Notes as the main tool are provided as well as internal projects to analyze and deploy the specific technologies.

The industrial internship project included 160 hour in the enterprise and about 160 hours in class devoted to the analysis and the documentation of the project with the assistance of teachers

The DSS course specific IS contents is about 80 percent devoted to IT skills and 20 percent to organizational skills. The course focuses into 3 main training areas:

1. Organizational and Economic Area: 100 hours, finalized to give participants background knowledge on social, legal and economical aspects of working in this field. Modules included, among others, are: basis of Management Science; Application of GIS in the local industrial reality; Numerical cartography; Marketing; and 40 hours of visit to a working environment outside of Italy (Austria or England)

2. Databases theory and practice: 200 hours to introduce the students to the use of the new computer technologies in the field of distributed databases. Modules included, among others, are: Introduction to Operative Systems; Office Automation; Computer Networking; Practical tutorial of advanced (database design and use, Access, SQL servers), Internal projects to analyze and deploy technologies

3. GIS and DSS: 200 hours, to provide students with the knowledge of advanced computer tools and application in the field of GIS and DSS. This area includes practical tutorial of advanced applications (Arc-Info and Arc-View) as well as internal projects to analyze and develop applications

The industrial internship project included 160 hour in the enterprise and about 150 hours in class devoted to the analysis and the documentation of the project with the assistance of teachers.

The BPR course specific IS contents is about 60 percent devoted to IT skills and 40 percent to organizational skills. The course focuses into 2 main training areas:

1. Macro-area of IT: 240 hours. This area covers two sub-areas. An area on Information Systems and Networking, where the design, the use the management of distributed Information Systems in enterprises is presented. A second area devoted to Computer Supported Cooperative Work (CSCW) presenting the new IT tools to support teamwork, to implement groupware and workflow analysis.

2. Macro-area of organizational culture: 160 hours. This area encompass three area characteristic of sub-classes of problems collected from the local enterprises needs:

- business process reengineering in manufacturing enterprises, with a focus on the analysis of organizational models and on the optimization of internal organizational processes.
- marketing with a focus on the management of tourism enterprises
- change management with a focus on the change brought by communication technologies and the emergence of virtual enterprises

The industrial internship project included 240 hour in the enterprise and about 100 hours in class devoted to the analysis and the documentation of the project with the assistance of teachers

The MII course specific IS contents is about 1/3 devoted to IT skills and 2/3 to organizational skills. The course focuses into 3 main training areas:

1. Macro-area of business administration: 144 hours presenting the economic and business background as well as focusing on the competitive advantages and challenges of different business strategies, as alliances, outsourcing and mergers.

2. Macro-area on economy of innovation: 144 hours focusing on new form of business communication in virtual enterprises, new form of work organization (teamwork), and on issues in change management as well as knowledge management.

3. Macro-area on IT tools: 144 hours devoted to the presentation, analysis and use of IT tools to support innovation: groupware tools, e-commerce tools, knowledge management tools and enterprise resource planning tools.

The industrial internship project included 240 hour in the enterprise and about 100 hours in class devoted to the analysis and the documentation of the project with the assistance of teachers

V. COURSES METHODOLOGIES

The kind of culture that we want to provide to our students (inter-disciplinary, synthesis of diverse competencies) requires a special care to the selection of effective training methodologies, that need to adapt to different context and issues.

Main focus in our training methodologies has been

- bottom up approach: problem-solving teaching practice also in the phase of knowledge acquisition, followed by theoretical framing and reflection
- teaching small group interaction [7]: the group becomes in fact the main stage for training. We present and apply teamwork concepts from the beginnings of the course: effective communications methods, teamwork organization and dynamics. Teamwork is then applied in proposed projects of increasing complexity.
- use of participative procedures and techniques (Active Learning Methodology). ALM favours «activism» as opposed to «academism» [8] that is, the active involvement and responsibility of the learner in the learning process, the group as learning setting, problem-solving learning by doing, two-way communication, and discussion as learning method. It seeks consensus over objectives, contents, methods and strategies between teachers and learners, to enable them to pursue the «co-construction» of knowledge. It focuses on process rather than product, because its aim is to make learners aware of their learning, and encourage them to discover and reflect on their most effective learning strategies. In relation to this approach we have activated two main activities:

  (1) class project work: this is a bridging activity between the core knowledge and skills acquisition of phase one and the work in enterprises of phase three. Learners are given a problem to solve in groups in a fixed time. The task is of the same type and as complex as the ones they will be given by the participating enterprises later on, so they are forced to apply all their knowledge and skills at once, as in the real world. Its main objectives are: (i) the acquisition of higher-range cross-curricular cognitive competencies, like the ability to acquire new knowledge,

to create higher-range cognitive frameworks, and to evaluate their relevance to the given problem; (ii) to develop the ability to manage complex situations and to make decisions in the presence of uncertainty, to select information from a wide context and to work with others in co-operative teams.

(2) internship project: in this phase, students are sent to enterprises to carry out a real project. Contents are negotiated between teachers of organisational management and IT, who are tutors during the work experience, and enterprise managers. The projects are then matched with course participants' skills and needs. The work experience is «diluted» over a period of two and one half months: learners are with the enterprises two-three days a week, and back in class for three-two days. While in enterprises, they are visited once a week by their tutors. In class, they are given support, explore relevant options and solutions to their project, reflect on what they have done, and are sustained in their role in the enterprises by the methodology co-ordinator in individual listening activities

The training methodologies themselves, together with the various disciplines presented in the course, become matter of study, discussion and analysis for both students and teachers. This, in order to provide students with first case studies of meta-analysis of processes.

VI. Report and Analysis of Internships Projects

The different types of training courses we have running have involved so far about 150 students (ca. 100 post-degree and 50 post-graduate). In the course of our training activities we have therefore organized and run about 150 internship projects. We report in the following data from these activities collected and analyzed at different levels:

- analysis of projects by trainers
- analysis and evaluation of projects by enterprises
- analysis and satisfaction of projects by students
- response of the job market: monitoring of job positioning of students

G. Analysis of projects by trainers

We have asked trainers participating to the internship activities to collect data for the analysis of the projects in terms of kind of interaction with enterprises, emerging classes of problems, discipline area of projects and market sectors. The evaluation of the success of projects has been carried out in conjunction with participating managers of the enterprises. The analyses have been collected in final reports from trainers.

A general aspect that emerges from these reports is the different attitudes between top management of the enterprises and middle management in regard to the kind of projects to tackle, both in SMEs and in large organization. Top management is prepared to face the challenge of an integrated approach to innovation. They are very sensitive and open to the idea of a full-spectrum analysis of particular topics and they seek contacts with possible partners to face the challenges (university, consultant etc.) Middle management are resisting these ideas and are more interested in day by day routine innovation problems, more easily separated in the two macro-area (technological – organizational).

Another general aspect is the separation of the projects proposed by enterprises, in regard to innovation, into three main groups: analysis prior to innovation, deployment of innovation, monitoring the process after innovation:

- analysis prior to innovation: these projects are more likely to present an integrated problems and are the ones at the top of the interest for the top management
- deployment of innovation: essentially operative problems, most often of a technological type that requires operative skills (programming, customization, scheduling of activities etc.)
- monitoring after innovation: again the need for integrated knowledge and culture is high. The collection of data, the identification of critical points, and the final analysis requires different kind of skills like contextual analysis, data gathering, knowledge of technology solutions

Table I summarize data of the market sectors where the internships were carried out, together with the classes of problems encountered.

TABLE I: DATA FROM ANALYSIS OF PROJECTS BY TRAINERS

Market Sectors	
Manufacturing	33 %
Tourism	11 %
Services	56 %
Classes of problems	
Non-separable	75 %
IT	20 %
Organizational	5 %

The first data on market sectors essentially provide a realistic picture of the kind of activities present in our regional area and serves as a feedback to guide our course contents.

The second data in Table I are supporting the original hypothesis that a new class of problems, requiring a synthesis of skills, exists. Relevant examples of these types of problems, as collected in our projects are:

- collection of internal data for the creation of databases involve the harvesting of internal non-formalized procedures; the subsequent deployment of the tool impacts with existing working practice and organization. The success of the innovation is strongly influenced by human and organizational factors that need to be known and analyzed in the design phase.
- the availability of Geographical Information Systems is of little use without the development of a culture/training on the potentiality of this tool; on the other hand the development of GIS culture is slowed down if the deployment of easy and rapid GIS data distribution tools are not implemented (web based GIS browsers)
- organizational analysis to obtain improvements are best implemented with the knowledge of the potentiality offered by IT tools to help in the implementation of the process reengineering.
- the existence of traditional logistic problems, usually considered merely as targets for IT solutions, are seen in

a new light due to the introduction of new external regulation. Their solution is intrinsically linked with collection of tacit knowledge about the existing procedures.

- creating a common identity and vision is an important element in the process of building an organization, especially if it comprises various entities and is diversified into multiple business areas (as is the case for Cooperative Enterprises). Identity and vision are intertwined with organizational culture and communication that need to be harvested. Additionally they can be empowered by the introduction of groupware tools.
- groupware can serve as a set of tools for facilitating closer interaction and better communication between individuals, especially if they are geographically dispersed. However, the use of technology will not bring about improvements per se. It must be combined with the creation of an information-sharing culture and work-processes that support it.

It must be noted that 2/3 of all projects were for post-degree students and were proposed initially as practical IT projects, but in the majority of the cases were hiding either management or organizational aspects. Only one-third of all projects were design for post-degree courses and enterprises were solicited to search among their most critical domains. The majority of the proposed projects in this case were expected from the beginning to require inter-disciplinary knowledge.

The subject areas covered by the projects were naturally strongly connected to the disciplines presented in the courses. The major group of subject areas being connected to IT innovation introduction (distributed databases, groupware, GIS, knowledge management tools). The other subject areas being related to business process re-engineering, decision support systems to management, marketing, e-commerce, IS administration, knowledge management analysis, change management analysis.

H. Analysis and evaluation of projects by enterprises

We have conducted an extensive monitoring of the motivation and evaluation of the internship projects in participating enterprises. At the end of projects we have collected these data by means of open questionnaires to be compiled by the managers involved in the definition of the project. From 1996 to 1999 we have collected data corresponding to 65% of the involved organizations. In agreement with operational research, the collected percentage is sufficient to extract meaningful trends out of the data.

We report here some main outcomes of the research. In particular we report data in regard to the motivation of the enterprises to why they are seeking internships projects and in regard to the final use of the results from the projects.

Table II collects the answer to the question on the motivation of the enterprises. The image of the internship that emerges from this data is seen as an opportunity to experiment innovation (35 %) as well as to get in contact with young human resources at the end of a market-oriented training curriculum (32%).

The evaluation of the results of the projects by enterprises is collected in table III. Essentially all projects have been considered useful by the organizations, a good measure of the success of the internship. In 35 % of the cases the results are being used directly in routine activities, an indication that all related problems were considered and solved.

In ca. 62 % they were used as an excuse to provide new vision to problems, to address process re-design, and test-try new solutions.

TABLE II: MOTIVATION OF THE ENTERPRISES IN ACCEPTING INTERNSHIPS PROJECTS

Experiment introduction of technological and organizational innovation	35%
Get in contact with young human resources at the end of a market-oriented training curriculum	32%
Get in contact with young human resources for potential hiring	24%
Try to find a match for actual position vacancies	8%

TABLE III: USE OF THE PROJECTS IN THE ENTERPRISES

Final results/products in use in enterprise activities	35%
Has provided new insight in the problem	22%
Has permitted to experiment new solutions not tested previously	20%
Has permitted to reconsider actual processes and activities	20%
Not used	3%

I. Analysis and satisfaction of projects by students

We have collected data relevant to the internship projects and regarding level of satisfaction, collection of problems and analysis from our students with different methodologies:

- mapping of expectations: initial and in progress
- individual interviews at different phases of the project
- group activities on the evaluation of projects, methodologies and needed tools

About 85 % of all students are either satisfied or very satisfied with the internship experiences. These levels of satisfaction were provided with the support from different arguments:

- being able to get in contact with a real world problem
- being able to relate with people in a working environment
- being able to effectively work with people toward the solution of a problem of interest
- being prepared both disciplinary and methodologically to face the challenge of real world problems
- being able to tackle the proposed problem in the planned time

This majority group of students considers effective both the course contents proposed and methodologies used towards their actual use in the solution of their internship problems. When the problems encountered did not mach directly their knowledge or skills, they have been able to apply methods and strategies from the courses to successfully face the challenge of the unexpected problems. They were also satisfied to have had the chance to work on individual projects and that the individual problem was usually small enough to be tackle in the scheduled time.

The unsatisfied group of students (ca. 15 %) provided the following main arguments for their negative opinion:

- lack of important competencies toward the solution of the problem. Primary this inadequacy was described to be in the organisational and human area.
- too complex problems
- problem snot well-defined at the beginning of the project
- inadequate interest from participating enterprises managers

It is interesting to report that the average data reported, differentiate in the two groups of courses: the satisfaction level lowering to about 83 % in the two post-degree courses and rising to 90 % for the post-graduate courses. Another finding also augments these data: the strong correlation between not successful projects (marked by a high level of discontent by student) and student's feeling of lack of important competencies, mainly in the organisational area.

These data are consistent with our initial hypothesis that an integrated culture assists in finding better solutions to enterprises problems.

J. Response of the job market: monitoring of job positioning of students

Since the start of our training activities, we have activated a monitoring process aimed at the job positioning of our students after the course. At present we have updated data up to spring 1999. We have collected data through phone interviews and they correspond to 87 % of the involved persons. Table IV reports main results from this monitoring.

TABLE IV: EMPLOYMENT DATA

Employed	67%
Unemployed	16%
Other	16%

In the employed group (67%), we find ca. 23 % of consultants (mainly post-graduates), the rest employed in enterprises. The 16% of the unemployed group consists of 75% of post-degree students. The last group ("other") includes mainly two categories: persons attending their military or civil service and persons that has decided to continue his/her education enrolling to university curricula. Also in this case the majority of persons belong to the post-degree course.

VII. CONCLUSIONS AND FUTURE AGENDA

We have not been able to test all of our hypotheses in a rigorously analytical manner. We have, however, obtained considerable experience and the data collected permit us to address most of the hypotheses.

K. Problems with organizational and technology aspects can be identified and are important to enterprises now

Our experience securing about 150 projects for our students at enterprise sites has clearly demonstrated that these hybrid organizational and technology problems exist and are considered highly important by our industrial partners. We have also found that senior management is even more sensitive to the need to explore this type of project than are middle managers.

Our hypothesis that these projects might be difficult to find because enterprises would be reluctant to expose a type of problem that could be central to the core of innovation at their site to an intern proved false. We were easily able to communicate the type of problem we were seeking and were generally able to find this type of problem. In other cases where we thought that we were (reluctantly) accepting a project with only an organizational or technology aspect, we generally found that the apparently missing dimension emerged during the project.

Finally, our hypothesis that problems with both aspects can be small enough to be meaningfully tackled by a single intern has proven correct. The feedback data from the students and the managers support this conclusion.

L. Organizational and Technology skills can be taught to individuals in a combined program

We find support for this hypothesis from our experience constructing the course and evaluating the practical experience of the students. Our Active Learning Methodology has proven effective in stimulating the students to become involved in helping to define their experiences and learning agendas. This feature is particularly important with adult learners, who come to the training course with experiences and background knowledge that are generally richer than those of undergraduates.

We have been able to teach small group interaction to our students and we can verify their skills here using the laboratory experience with teachers as mentors and the experience of the interns at the industry sites. Indeed, we have included the material based upon the experiences of students in our early training courses, where we were able to see the consequences of a lack of these skills.

Finally, we conclude that the internship experience is an essential aspect of teaching adult learners. These students require direct confirmation that the skills that they are gaining have direct applicability in the world around them. We see this reinforcement of the importance of the internships in the reviews and evaluations provided by the students.

M. Students trained in this way will be able to solve real problems in industry settings

We have analyzed the results of all of our internship experiences. When we look at the evaluations by instructors, the impressions of the students derived from a combination of questionnaires and interviews, and the survey results from the industry partners, we see a strong pattern. Although not all projects are a success, the majority are either directly successful at solving the original problem or are perceived as

having successfully introduced the new technology to the industry partner. Indeed, almost all of our industry partners seek additional internships in later courses because of their favorable impression of the results.

Even students that are not able to solve their internship problem are frequently able to view the experience in a positive light. Students whose project is a success clearly gain a considerable satisfaction from the result.

A number of industry partners have gone on to hire their intern as a direct employee. In the general cases, either other enterprises or consulting companies have hired the intern and used the skills gained as part of innovation projects at other industries. By their questionnaire results, their requests for additional interns, and their hiring practices, our industry partners have demonstrated that IS professionals trained in both organizational and technology skills are an important addition to their organization.

N. Where Do We Go From Here?

We plan to continue to present courses in the general area of higher education training in both technology and organizational skills so that they can be part of the design and development of the information systems of the future. At present, the size of our internship projects is limited to a project that can be tackled by a single individual. In our future work, we plan to explore larger projects that can be solved by teams of students.

As we have mentioned, our students arrive with considerable background skills because they are mainly adult learners. Even though we attempt to teach both organizational and technology skills, any particular student may have either a better background or aptitude in one area and not the other. Thus, we see that our students are not generally equally proficient in both skills. In our previous training course design, we have not directly dealt with this potential asymmetry. In the future, we will try to match students with complementary skills into teams for their practical experience. We hypothesize that this pairing will allow our students to solve even more complex IS problems while preserving the balance between organizational and technology issues.

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