# Continuing Professional Development by Practitioner Integrated Learning


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## Abstract

To prevent skilled professionals from being phased out or forced into professions for which they are not talented, organized forms of lifelong learning are needed. Continuing professional development is an approach supporting lifelong learning. This approach is however criticized for being expensive and not providing the necessary knowledge. In response to this, we have executed a study in order to understand how universities can effectively support continuous professional development. By involving industry professionals as participants in university courses using problem based learning, we have designed what we call Practitioner Integrated Learning (PIL). This learning approach has shown positive effects in terms of level of learning, realism, knowledge diffusion, study load and costs. We present a 15-months action research project integrating 16 industry managers and 16 university students in a continuing professional development effort. Based on this study, we argue that PIL is a learning approach that effectively supports continuing professional development.



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***General Terms*** Design, Economics, Human Factors.

***Keywords*** *Lifelong learning, Continuing Professional Development, Practitioner Integrated Learning, Action Research, Problem Based Learning, Project Based Learning, PBL*


## 1. Introduction

There is a growing awareness, among individuals and organizations, of the need for organized forms of *lifelong learning* (LLL). When lack of knowledge causes career stall for the hard working and lost shares for market leaders, time proven strategies for learning and knowledge supply are questioned. As a reaction, many organizations seek to organize for lifelong learning among staff. The phenomenon is referred to as *continuing-/ continued-/ continuous professional development* (CPD) in some business sectors and for *continued- /continuing engineering educations* (CEE) in others.

In response to this awareness, a virtual market of CPD/ CEE/ LLL education has emerged. Actors on this market include consultants, training companies, certification organizations, government agencies, education centres within Universities, and (of course) the consumers, i.e. the companies and individuals that buy these educations. The market is particularly vital for medical professions in the United Kingdom and Canada, but substantial also for professions within Medicine, Engineering and Finance throughout the world.

Offerings on the CPD market are as diverse as on any other market: the kind of knowledge developed, the organization of teaching, and the means of charging vary with the providers. Knowledge kinds range from orientations and hands-on experiences to reflections on professional practice. Employed organizations include short courses [1], on-line courses [1], tailor-made-courses [1], in-house courses [1], postgraduate level part time courses [1], Work Based Learning [2], Facilitated work-based learning [3, 4], Problem Based Learning for continuing professional development [5], professional workshops, and CPD Clubs. The means of charging include flat-rate course fees, pay-per-hour consultancy, sponsorships, and courtesy of memberships.

As on any market, not all business is good business. Some consumers do not get the knowledge they need, and report on a need for better forms of CPD [6]. Some providers do not get their expenses covered and report on significant economical loss [7]. CPD efforts that go astray significantly damage the reputation of CPD as a whole. Incidentally, there is a growing research interest in the pedagogical, economical, and organization aspects of CPD among consumers as well as providers. Some of the CPD organizations employed today are the outcome of this research [5, 8-10].

The purpose of the research described in this paper is *to understand how universities can effectively support CPD*. Key variables of interest are level of learning, realism, study load and costs.

The paper approaches this problem by studying a course in Model Driven Development (MDD, [11]) shared by an organization with a recognized need for more effective CPD



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and a university. The organization studied is a subdivision within Ericsson AB in Sweden, developing telecommunication infrastructure components, using MDD; it has several successful products on the market, and is in the phase of tuning the organization for improved efficiency. In doing this, it has recognized a lack of understanding, among managers, about the intrinsic differences between code-centric and model-driven development, which lead to inefficient practices, suboptimal decisions, and authority problems. While practicing engineers have picked up the arts and skills of MDD the hard way, or in recent university courses, technical managers (that no longer have immediate contact with tools and techniques) have been left to steer by old experiences and values. Past attempts of training managers in MDD, using intensive courses, have not been effective: although basic knowledge in UML and some tool experience have been gained, that knowledge has been too shallow to significantly change management practice and authority. Realizing the practical consequences of having key staff on longer leave for education, and the economical consequences of customized training of key staff over prolonged periods, the organization has looked into strategic alliances with universities as a solution to its very specific needs.

The paper proposes a new organization of CPD, with particular emphasis on these needs; it seeks to provide for higher levels of knowledge [12] at low cost and low disturbance of the everyday work of managers. The basic idea is as follows. Many universities provide profession-oriented project courses as part of their ordinary curricula. These courses are often designed to provide higher levels of learning by active engagement in open problems and reflections. Many of these courses can easily be adapted to fit the needs and constraints of industry professionals. We argue that by involving industry professionals as participants in these courses the quality of these courses are increased, since significant practical knowledge is injected into university environments. The value of this quality increase outweighs the extra costs associated with the partition of the industry professionals. As a bonus, ordinary university students get a better education and a quicker foothold on the job market, as they meet industry professionals on a natural basis, in their daily studies. In short, mixing CPD students with ordinary university students doing project courses allows for a win-win situation between a company and a university. We refer to a setup that mixes industry professionals with ordinary students in project courses as *Practitioner Integrated Learning* (PIL).

The research question addressed in this paper is whether, PIL effectively supports continuing professional development of technical managers in MDD?

Our research strategy is action research [13-15] with a local improvement goal to increase the competence in MDD among industry managers and university students in Göteborg, Sweden. In the spirit of action research, we contribute to the body of knowledge in CPD by active and organized reflections on our practice.

The paper is organized as follows. Section 2 (An overview of PIL) describes PIL and its main characteristics. Section 3 (Qualities of CPD) define what we mean by effective support of CPD. Section 4 (Research Methods) gives a brief introduction to action research, and describes the action research phases (Diagnosing, Planning, Execution, Evaluation, and Learning) involve in this study. Section 5 (The PIL Story) defines the outcome of these phases, and discusses the effectiveness of CPD on the basis of our findings. Section 6 (Related Work) relates PIL to other approaches to CPD. Section 7 (Conclusions and Future Work) summarize our findings, and elicit what we see as contributions to the field of CPD.

## 2. An overview of PIL

PIL is intended as a system for continued, intermittent higher education (see Figure 1). An individual of generation A graduates from a degree program to start an industrial career on the basis of knowledge in area A valued by industry; the new employee thrives on and deepens this knowledge within a profession; after 15 years or so, knowledge of generation A has lost most of its value, whereas the value of knowledge of generation B is on the rise; at that point, a dose of higher education helps the individual to adjust course, catch up, and stay competitive among individuals of generation B now entering the job market; another dose helps when knowledge in C is on the rise. In this way, skilled individuals may maintain their profession rather than being phased out, or forced into professions for which they are not talented.

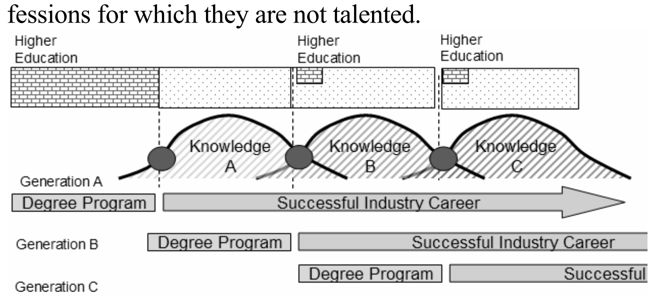


Figure 1. PIL as a system for lifelong learning.

PIL supports this system of education in several ways: it gives generation A professionals access to the learning agenda, culture, and attitudes of generation B students; it accustoms generation B students with the idea of coming back to university to join generation C students; it motivates, in a concrete way, generation B students to develop knowledge needed by industry; it reduces the risk of wrong career choices among generation B students (each of which harms the individual making the wrong choice, the individual phased out and the employing organization).

We recognize the following entities of this learning system:

- university students taking a full time degree program;
- CPD students coming back for higher education;
- the profession of concern to both these groups of students;

- the provider of higher education (a university institution);
- the consumer of higher education (a company or an individual);
- the PIL occasion in which CPD students and university students study together.

We collectively refer to the CPD students and university students as *participants*.

### 2.1 Profession-oriented and project-organized education

PIL relies on certain commitments, by the provider, to pedagogical strategy and organization of teaching. By pedagogical strategy we mean the view on what the purpose of learning is, what should drive learning, how the learning environment should be, which activities that build knowledge, which roles and responsibilities teachers and students should have, how the units of study should be structured, and what the purpose of grading for the learning in question is. Other names for this phenomenon are educational philosophy or teaching philosophy. By organization of teaching we mean the realization of a pedagogical strategy within practical constraints on money, time, staff, organization, student availability, and localization.

PIL relies on a *profession-oriented* pedagogical strategy. PIL is about helping students becoming professionals, and professionals becoming better professionals. Without a common focus on the profession of concern and without support from a learning organization that actively develops knowledge about this profession, the desired learning is not likely to occur. For institutions without a clear interest in real-world problems and in industry-academia relationships, PIL is probably not a good choice.

PIL also relies on *project-organized education* being part of the provider's ordinary curriculum. Because effective and efficient implementation of project-organized education is a challenge in itself, we regard PIL as feasible only when the provider has experience with project-organized education.

### 2.2 Co-localization

Another assumption made by PIL is that providers and consumers are co-localized. PIL relies on collaborative, face-to-face group-work over a prolonged period of time (2 months or more). PIL is to be carried out in parallel with ordinary job-tasks (as illustrated in Figure 1). This excludes extensive travelling, which takes time, and reduces the readiness of CPD students to skip prioritized job-tasks in response to critical events.

### 2.3 Differentiation

PIL differentiates the learning goals of CPD students from those of university students. It recognizes that the expected knowledge goals of CPD students and university students largely overlap, but also recognizes that learning goals are different in subject content, and in the kinds of knowledge [12] sought. For instance, learning goals for university students may include domain knowledge, tacit knowledge, and tricks-of-the-trade that CPD students already possess; learning goals for CPD students may include basics in emerging technologies (which university students already master), and an ability to reflect on the personal practice (for which university students are often not mature enough).

PIL also differentiates the expected efforts of CPD students and university students. The study load for CPD students is kept within bounds by group work, in which university students are expected to put in more hours and effort than CPD students. By openly declaring this, the risk for group problems rooted in relative efforts is reduced.

## 3. Qualities of CPD

Our definition of effective implementation of CPD relates to the following quality model of CPD (Figure 2):

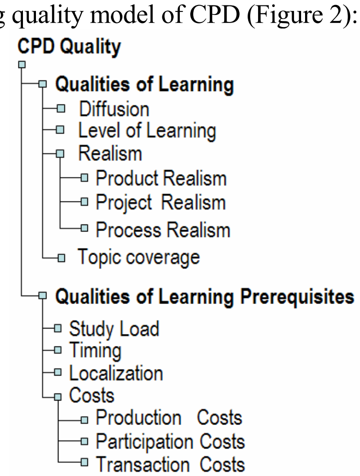


Figure 2. Qualities of CPD

### 3.1 Qualities of Learning

We are interested in the following qualities of learning:

- The *diffusion* of knowledge — the patterns of knowledge flow among the participants (and teachers) in a course.
- The *level of learning obtained* — whether learning has changed individuals' norms and values, influenced their work practices, or neither of these. (See Sec. 3.3)
- The *realism* of learning — the degree to which knowledge obtained relates to professional practice; we identify the following sub-characteristics:
  ***product realism*** — whether learning revolves around problems from within a concrete professional domain, or toy problems, or something in between;
  ***process realism*** — the degree to which the organization, the activities and the roles used in the project reflect those of a concrete organization (associated with the profession in case);
  ***project realism*** — the degree to which the setup resembles a real project with respect to requirements work, deadlines, deliverables, unforeseen events, and changed courses of action.
- The *topic coverage* — the set of topics and subtopics that knowledge is developed within.

Other qualities of learning, such as the *kinds of knowledge* obtained (whether knowledge is declarative, functioning, procedural, or conditional [12]) are also of interest, but not our main focus.

### 3.2 Qualities of Learning Prerequisites

To enable CPD it is vital to consider the particular *prerequisites for learning*. For CPD students, the *study load* must not be too high (as studies, for many, are possible only if they can be carried out along with professional and family-related activities and responsibilities); the *timing* of learning activities (such as the time of the day and duration of lectures and group-work, and the calendar time set aside for personal studies) must be synchronized to major activities; the *localization* of teaching must allow for participation without extensive travelling (which takes time, and reduces the readiness of managers to step up to superior tasks); the *costs* (consisting of *participation* and *transaction* costs) must not be too high. For providers, the *production costs* must not be too high or CPD will not be economical.

### 3.3 View on the Learning Process

Our view on the learning process is rooted in Argyris and Schön's theories of organizational learning [16]. We distinguish learning, which results only in *changed action strategies* (single loop learning) from learning that results also in *changed individual norms* (double loop learning) - see Figure 3.

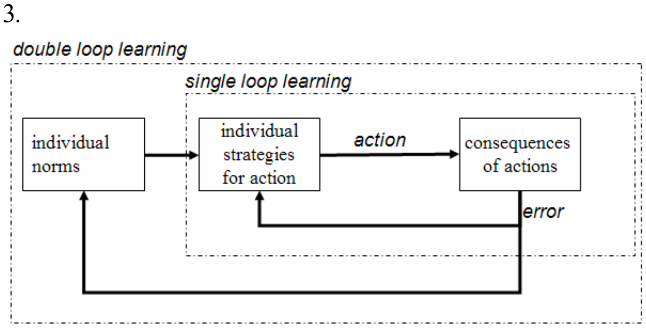


Figure 3. Single- and Double-loop learning

Double loop learning is more desirable than single loop learning, but also more difficult to obtain as it relies on higher level learning activitie**s** [12], in particular *reflection* [17, 18]. Critical reflection on personal actions is emotionally and intellectually challenging for the individual. It is organizationally challenging as the teaching, ideally, should stimulate, recognize, and reward changes of individual norms. Teaching methods for this exist, such as facilitation by highly experienced supervisors [19], but our experience is that these are often difficult to implement in practice, and sensitive to supervisor quality. PIL provides an approach to stimulate reflection that is less sensitive to supervisor quality.

### 3.4 Criteria for Effective Implementation of CPD

Our general view on effective CPD is that it increases knowledge of individuals towards goals rooted in professional practice, to reach higher knowledge levels. Thus CPD is not effective if the wrong knowledge is gained, or if it results in surface learning. Many professionals want and are able to study, but cannot because of a combination of practical and economical constraints, and lack of suitable offers. Most professionals do some occasional reading to catch up, and keep an eye on emerging methods and technologies. It is help to reach the higher levels of knowledge that is most needed, not help with the basics.

Based on our quality model, we have identified the following criteria for effective CPD education:

a) the product realism of learning is high,
b) the process realism of learning is high,
c) the examination rate is high (under high examination quality),
d) the level of learning has reached double looped learning,
e) knowledge diffusion between the value systems of the generations has occurred,
f) the study load is considered feasible,
g) the costs are considered price-worthy for both consumers and providers.

## 4. Research Method

Our research has the dual goal of both contributing to the body of knowledge in CPD (our research goal) while, at the same time, improve *university students* and *industry managers'* knowledge in model driven development (our improvement goal). Mathiassen's collaborative practice research (CRP) supports the realization of this dual goal, as does the insider/outsider perspective of Bartunek and Louis [20]; both have been beneficial and important in this research project. One of the authors (insider) has been working within Ericsson with the responsibility to increase industry managers' knowledge in MDD. Two of the authors (outsiders) have been working within the IT University of Göteborg with the responsibility to increase university students' knowledge in the use of model driven development of telecommunications systems, and to plan and execute a course in model driven development for the mentioned learners, using what we now refer to as PIL. A fourth author (outsider) from University West has joined the research project in the later phases to contribute with analysis, discussion and questioning in an unbiased way. The research strategy and data collection design presented below has helped us to answer the research question: *Does PIL effectively support CPD*?

### 4.1 Research Strategy

Our research strategy is action research [13-15] with a focus on understanding valuable realizations of CPD. The study was planned and executed following Susman and Evered's cyclical action research approach [21]. The timeline of our study is given in Figure 4.

We started by *diagnosing* that there was a need for increasing the competence both of Ericsson managers as well as new university students in the area of MDD. The diagnosing phase was followed by an idea of a joint course between Ericsson and the IT University—*the MDD course*. The course was *planned* and introduced into the software engineering and management curriculum during the spring and summer of 2006. The course was then *executed* during the fall of 2006 and *evaluated* from the mid-term evaluation to the final course evaluation. The *learning* activities started in mid November; this phase was finalized by writing this paper in the spring of 2007. The details of these five phases are presented in the forthcoming subsections. The cycle will be repeated, with a new diagnosis phase for the 2007 version of the course currently being planned.

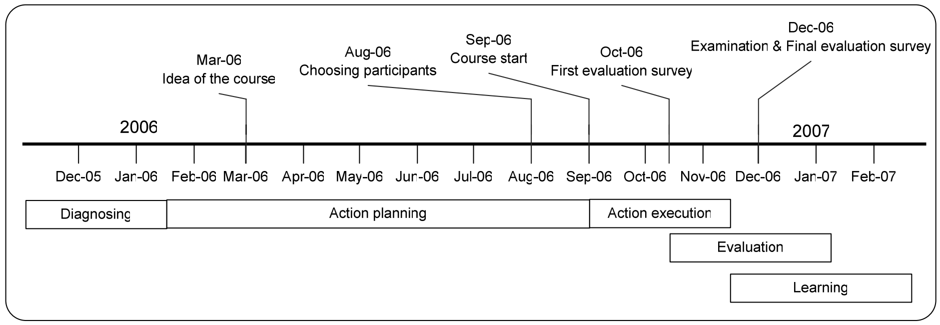


Figure 4. Timeline for the action research of our study

Thus, we have applied the three distinctive characteristics of action research [13]: i) the researchers were actively involved in solving practical problems, ii) the knowledge obtained was immediately applicable in practice, and iii) the research is a cyclical process linking theory and practice.

Finally, Baskerville and Pries-Heje [22] argue that the fundamental contention of action research is that a complex social process is best studied by introducing changes into that process and by observing the effects of these changes. We have done so, by changing the organization of established teaching methods at the IT University to accommodate for CPD.

### 4.2 Data collection design

Data collection was planned in the beginning of the execution phase. Table 1 below summarizes the data sources used. Our use of several data sources has facilitated triangulation [23] and reduced bias in our analysis.

| Data Sources | Explanation |
|---|---|
| Direct involvement | Three of the authors have been directly involved in and responsible for planning and executing the MDD course. |
| Open-ended, semi-structured interviews | One of the authors has had informal interviews and discussions with the Ericsson managers participating in the MDD course. Two of the authors have had informal interviews and discussions with the university students participating in the MDD course. |
| Management team participation | One of the authors has been a part of the Ericsson Management Team where the decisions about the MDD project have been taken. This management team has also been responsible for the selection of the industry managers that participated in the course. |
| Questionnaires | Three of the authors have sent out structured questions about appreciation and understanding of both the course content and course format two times during the course (half way and in the end): 5 open ended questions and 21 close ended ones (six-grade Likert scales). |
| Participatory observations | During the execution three of the authors observed discussions and actions in and between the different teams in the MDD course. |
| Written sources | Participants produced a large volume of MDD artefacts during the course. |

Table 1. Data Sources Used

## 5. The PIL Story

Ericsson AB is a world wide company developing telecom solutions for the global market. To stay competitive it is absolutely necessary for Ericsson to continuously increase the knowledge of their engineers and managers. It has become natural for Ericsson to work with different CPD approaches, but as this has turned out to be very time-consuming and costly, it is important for Ericsson to find more effective and efficient forms of CPD. In response to this need, Ericsson initiated what we now refer to as PIL.

### 5.1 Diagnosing

One of the authors (the insider) identified, together with senior managers at Ericsson, a need for increasing the competence in MDD among Ericsson's managers. It was a common opinion, among managers, that past CPD efforts had not been effective enough; a deeper knowledge in MDD was desired.

The insider started a dialog with a researcher/teacher at the IT University of Göteborg (one of the outsiders), with a suggestion to bring together Ericsson managers (with little knowledge in MDD) and last year, software engineering students (with little industrial experience) for a joint-learning-venture.

At the software engineering program, a class is treated like a big development project, divided into sub projects, which at the same time constitute study groups. In the beginning of a semester, groups function as independent study groups; they meet other groups in weekly seminars, and work on project-related sub problems in between. In the middle of the semester, groups gradually transform into project teams. Towards the end of the semester, a real project organization emerges; projects are finalized by a system integration effort and a demo solution. This particular organization of problem based learning, developed at the IT University, has been explored in various forms since 2004, and is now well understood.

Together, the insider and the outsider identified several benefits of a joint-venture. Experienced Ericsson managers would get the opportunity to learn MDD together with enthusiastic, "IT-hacking" university students. University students would get the opportunity to learn about real life, product development challenges, and values and strategies of the telecom domain, from experienced managers.

Upper management of Ericsson and of the IT University supported the idea, and the dialog went on: the two groups should work in mixed teams to take advantage of each others strengths; students and Ericsson employees should facilitate learning from "student to student" and not only "teacher to student".

### 5.2 Action Planning

We identified a number of requirements, which we believed were important for the effectiveness of the course. (1 – Topic coverage) Ericsson managers must gain enough topic understanding in MDD to understand its specific challenges, to be able to lead MDD projects, and to be able to support employees working hands-on with MDD. (2 – Study load) The course should respect the time-pressure the industry-managers had. (3 – Cost) The course must be price worthy. (4 – Realism) The course must be executed in an environment similar to the one industry experience on a daily basis. (5 – Diffusion) The course must provide possibilities for peer-to-peer learning across the two different groups of learners. (6 – Level of learning) Both groups of learners should feel they learn more and in a better way compared to other learning ventures. We planned a course as described in Table 2:

| # | Requirement | Plan |
|---|---|---|
| 1 | Topic Coverage | Participants will use Rational Rose RT (an MDD tool) and C++ to construct executable UML models, thereby getting an intuition of the activities involved in MDD projects, and an intuition for typical issues in MDD projects, and how they may be handled. |
| 2 | Study load | Four hours scheduled teaching per week starting at 3 pm (to avoid interference with regular work for the Ericsson managers) in 10 consecutive weeks. The eleventh week should finalize the course with a full week of laboratory work on system integration. |
| 3 | Cost | The course is to be set up as a regular, optional university course, within the software engineering and management curriculum at the IT University of Göteborg. Relying on their university degrees, Ericsson managers will re-register as university students (which the Swedish university system supports and encourages) to take the course. No financial transaction between Ericsson and the IT University is to take place. Involved costs are restricted to the time spent on planning, executing and evaluating the course at both sides, and the costs for the participation time. The university is paid by the government on a per-participant basis. |
| 4 | Realism | To fulfil the requirement of an environment similar to Ericsson's daily tasks, the telecom standard DECT [24] (Digital Enhanced Cordless Telecommunications) is selected for implementation. The implementation should cover the keypad of the telephone, the radio signalling, and all functionality in between. A project organization reflecting the architectural layers of the DECT-standard is to be used. |
| 5 | Diffusion | The course should be setup as a problem based learning design, as described in Sec.5.1 The different subprojects should consist of a combination of Ericsson managers and university students. The first part of the project thereby supports diffusion from students to managers, whereas the second part supports diffusion in the other direction. |
| 6 | Level of Learning | The course should force participants to make reflections on their learning, make participants feel that deep learning has been obtained, and further, that learning has been better compared to past learning ventures. |

Table 2. Requirements and Plan for the MDD course

We also planned to execute two structured questionnaires during the course to understand fulfilment of our requirements and a regular written examination to assess individual knowledge.

### 5.3 Action Execution

The course was announced at both Ericsson and the IT University, which attracted a lot of attention. 23 managers at Ericsson showed their interest for the course and 16 of them were selected by the senior management team to participate in the MDD-course. In similar fashion, 16 students were chosen by the program management team from a set of applicants from the software engineering and management program at IT University.

The first teaching activity (A1) consisted of a lecture introducing the DECT standard, and the scenario that the system should support — an "ask time" service. The following teaching modules (M1-M9) each consisted of a one hour lecture, two hours group work and a one hour joint seminar, and a set of problems for each group to choose from during the week, each relating to the module's theme, and a specific part of the DECT standard. The solutions were handed in the day before the next lecture and presented by each group during the same day at the joint seminar.

Lectures of A1 and M1-M8 were given by lecturers from the IT University at the IT University. Lectures of M9-M10 were given at the IT University by senior Ericsson engineers skilled in MDD. Teaching activity themes are presented in Table 3.

| Module/ activity | Theme |
|---|---|
| A1 | Introduction to the DECT Standard (Lecture) |
| M1 | UML structure: Classes and Class Diagrams |
| M2 | UML structure: Capsules and Structure Diagrams |
| M3 | UML behaviour: Sequence Diagrams and Protocols |
| M4 | UML behaviour: Statecharts and Action Prog. I |
| M5 | UML behaviour: Statecharts and Action Prog. II |
| M6 | Animating, Tracing, and Debugging Statecharts with RoseRT |
| M7 | Model Interfacing with Visual Studio |
| M8 | Modelling Guidelines + Model Integration |
| M9 | The Role of Architect at Ericsson |

| | |
|---|---|
| A2 | Integration (Full lab week) |
| A3 | Examination (Written examination) |
| A4 | Presentation (Public demo of the system built.) |

Table 3. Themes for the scheduled teaching activities.

The lab week (A2) was held at the Ericsson premises and managed by a project leader that had been elected among the course participants through an open voting procedure. During this week, the various parts of the DECT stack produced during the course were integrated into a complete system. Shortly after the project, a written 4h examination (A3) was held.

The MDD course was finalized by a presentation (A4) in which the course participants demonstrated the system built to invited managers from Ericsson and the IT University.

### 5.4 Evaluation

We evaluated the effectiveness of the PIL implementation based on the data sources presented in Table 1. We present the evaluation based on the requirements set up in the planning phase in Table 2.

#### 5.4.1 Topic Coverage and Study Load

73% of the participants rated the general value of the MDD course as good or very good while 27% are neutral. No one rated the course as bad. All course participants were also more positive than negative to the statement "I believe I fully understand the challenges related to MDD". Furthermore, 64% were more positive than negative to the statement "I believe I can support employees to become excellent in MDD". Finally, 95% were more positive than negative to the statement "I believe I'm capable of understanding and planning MDD projects". We believe this data show the course participants feel they have learned MDD.

100% of the students passed the examination (32 of 32 participants). The exam was problem oriented, and constructed to assess working knowledge with UML and RoseRT and an ability to solve DECT–based problems with state-charts Examination was performed by one of the outsiders, who has approximately 10 years experience of written examinations of PBL courses, with a typical pass rate of 50-80%. The system demonstration which ended the MDD course showed that the course participants had managed to build a working system according to the scope set up in the planning phase.

From the open-ended survey questions, semi-structured interviews and participatory observations, we learned that some of the course participants believed the MDD part should be put into more focus at the cost of the DECT standard (the DECT standard took more effort than the participants had expected). The modelling language and the modelling tool were perceived as a bit cumbersome for the first time. This, however, is a common problem with UML as mentioned in the survey by Grossman et al. [25]. Based on the perception of learning, the outcome of the examination, the working system built, and the diagrams produced, we argue that the course participants had satisfactory learned MDD.

Participation at the MDD lectures was a prerequisite for the knowledge diffusion between students and industry professionals. The average participation for all course participants was 77%. Several Ericsson managers explained during the course that it was challenging and required both their attention and time, but none of them complained about the set up of scheduled lectures. The university students had no complaints about lectures starting later during the day.

In the open-ended part of the questionnaire, the course participants claimed that the amount of time available as too little and indicated a need for its extension – some participants indicated the need for "more participant time for industry people". The university students also indicated that there should be more time for "working with Ericsson people". We argue, however, that it is common for most learning occasions that more time is required than available. We believe, based on the high participation on the lectures and little comments and complaining on the curse set up, that it is fair to claim that the requirement set up regarding the study load was fulfilled.

#### 5.4.2 Costs and Realism

For the university, the MDD course was a new course, but it was integrated into the software engineering curriculum. The software engineering curriculum was being updated at the time of introducing the course, which made the costs of introducing a new course smaller than it would have been if the curriculum was not changed. This resulted in marginal extra cost for the university in terms of production costs. For Ericsson, the set-up differed from existing and more commonly used CPD ventures. Ericsson paid no money to anyone. The normally very expensive participation cost was reduced to the time spent on participating in lectures and individual studies. However, there were some costs for planning and administrating the course. Each Ericsson participant was also inspired to spend out-of-office time on the course as they would get study points, which would add formal knowledge to their personal curriculum vitae. No Ericsson participants were prevented from participating in the course because of budget limits. It is fair to claim the economical set up of the course had a positive effect on the willingness from Ericsson to conduct this MDD course and send some of their very skilled and busy managers to learn more about state-of-the-art MDD. It is also fair to claim it was beneficial for the university, which had approximately the same production costs, but with increased number of students (paid by the government on a per-participant basis).

Most comments from the course participants (mainly during the elaboration) were about the lack of or need for more architectural work and integration planning. When confronting the Ericsson managers with the awareness of them bringing up these two certain arguments, they smiled. They recognized the similarities between the findings they made in the MDD course and the most common identified problems they normally experienced or heard of in a typical software development project.

From the structured questionnaire we could learn that 74% claim they are more positive than negative to the statement "Collaborating with participants from other domain (e.g. Ericsson/IT University) has significantly contributed to your learning". The course participants had no questions or comments regarding the teaching form during the execution of the course. There were however several comments regarding the choice of using DECT as a domain for the development project. The DECT standard was considered hard to understand and time-consuming to learn. 55% claim they are more negative than positive to the statement "Focus on real-life system (DECT) contributes to your learning (of MDD) more than focus on a toy system would have done". Practical experience based on the authors experience says that when considering toy-systems and asking the same question, the answer is the opposite. In those cases, the participants tend to argue "it is easy to learn how to model non-complex vending-machines, but when starting model real-life system it is much harder". It is likely that the time required to learn DECT affected the outcome of the answers on the value of learning when having real-life systems instead of toy-systems.

When we asked about potential improvements in the questionnaire, the participants identified "more leadership in the projects" and "improved specifications of the integration week". Again, these are needs often experienced by industry in their daily work. When asked about "what was good with this course", the course participants answered "the problems solved in groups", "the integration week" and "working with real specifications". On the other hand, when asked about "what was bad with this course", the participants identified understanding the DECT standard and integration problems as negative factors. We claim that these issues are similar to real-world situations in software projects. Reading and understanding different telecom standards *is* time-consuming and difficult. We argue it is fair to assume the MDD course had managed to imitate an environment similar to the one professionals experience in their daily work.

#### 5.4.3 Diffusion

From the structured questionnaire we could learn that 68% is more positive than negative to the statement "You have learned at least as much about MDD from fellow participants as from the teachers". Also, 84% answered they were more positive than negative to the statement "You have had many fruitful discussions with someone with another background than your own (Ericsson/IT University)". This number can be compared with the 77% that answered they were more positive than negative to the statement "You have had many fruitful discussions with the same background as your own (Ericsson/IT University)". It seems like the course participants had approximately the same number of fruitful discussions with course participants independent of background.

When asked about the good elements of the MDD course in the open-ended questions, the participants identified the mix of participants from both Ericsson and ITU. The participants also indicated that a good thing about the course was "to meet people from industry and test industry grade tools" and "to get to know the students and to work together". None of the respondents indicated that the mix of participants had any negative effect on the course. These answers indicate that mixing the participants was perceived very positively in the course. Based on the above, we believe it is fair to say the knowledge diffusion between the course participants has been quite successful.

#### 5.4.4 Level of Learning

Key indicators of achieved level of learning are the real-life challenges current in professional domains [12]. In contrast to other teaching forms, in this course the participants identified problems that are similar to the problems experienced in real-life development projects, i.e. the *perceived* realism was high. When asked about the potential course improvements, the participants indicated that more focus should be put on MDD rather than on the DECT standard, which in turn indicates that the focus on the real-life system might hinder the level of learning to some extent. They also indicated that an Ericsson employee could be involved in explaining how to build a system like DECT during the elaboration. This indicates that it is possible to make further integrations of practice in the PIL concept. When asked what should be extended if the course was given more resources, the respondents answered "more advanced MDD" and "more management of MDD projects". We also believe the answers regarding course improvements indicated that the level of learning in understanding the principles of MDD was fulfilled, as the respondents wanted to know more about MDD.

One other positive outcome of the actions taken for problem-solving and learning activities [16] was the discussions between the groups from different domains. The course participants have learned as much from fellow students as from their teachers. For example, by having a dialogue with students from Ericsson gave the ITU students opportunity to discuss real problems related to the Ericsson managers' everyday work. Such reflective discussions actually facilitated for the ITU students to try out their newly-learned skills. More strikingly, the Ericsson students said they have learned a lot from the ITU students. The younger generation provided enthusiasm and creativity in the class. This implies that there were many positive enablers of learning in comparison to other teaching forms. Thus, it makes it fair to argue the level of learning from the MDD course was very high.

### 5.5 Learning

Organizations like Ericsson seek to organize effective life-long learning for their employees. The existing CPD offerings are diverse and often both expensive and not enough knowledge enriching. This research focuses on understanding how universities can effectively support CPD by introducing a new systematic approach of teaching and learning – PIL. More specifically, in this section we give answers to our research question "does PIL effectively supports CPD" through discussing qualities of learning and learning prerequisites.

#### 5.5.1 Qualities of Learning

(Diffusion) In most CPD offerings there is a knowledge flow from teacher to student. For PIL, it has been important to achieve a knowledge flow also between the Ericsson managers and university students. From the evaluation we learned that knowledge diffusion between the course participants has been substantial. The different types of students have had fruitful discussions and their perception is that they have learned as much from fellow students as from the teacher.

(Realism) For CPD to be successful, it is important to reach a high degree to which knowledge relates to professional practice. The course participants identified issues like lack of architectural work, need for more integration and project planning, and need for improved specification during the integration of the system. These issues are known to be issues also in the daily practical work within industry projects, thereby fulfilling the project realism. The use of the DECT standard and many comments related to the difficulties of dealing with a concrete professional domain indicate the fulfilment of our product realism criterion.

(Level of learning) The level of learning is important in all kinds of learning ventures. Have the course participants learned in better ways compared to other learning ventures? Does the learning change individuals' norms, values and work practices? Double loop learning [22, 23] is more desirable than single loop learning, but it requires critical reflection on personal action to be accomplished. The smile from the Ericsson managers, when confronting them with the similarities between their complaints and problems in their everyday-work, is an important evidence of critical reflection. Another important proof of critical reflection is the comments for potential improvements of the course, where they argued for more project planning. Also this suggestion was met with recognizing smiles when answering them "oh, you think so". To claim real double loop learning we have to measure actions before and after the PIL course, which we have not. We do however argue we have accomplished critical reflection, which is a necessary step towards the valuable double loop learning. In addition to reflection, participants have been engaged in the following activities, which are all recognized as enablers for higher levels of learning [12]: hypothesizing, application to near problem, explanation, arguing, relating, and describing.

In short, there has been a knowledge flow between the CPD students and university students (#5 – Table 2), there has been a high degree of realism (#4 – Table 2), and there has been indication of double loop learning (#6 - Table 2). We argue the PIL set up has satisfactory fulfilled the criteria for effective CPD defined in Sec. 3.4.

#### 5.5.2 Qualities of Learning Prerequisites

For a successful integration of CPD and university students, it is necessary to organize the study load in ways that is manageable for the CPD students (in this case the Ericsson managers). We have learned that the participation from the Ericsson managers was high and that there was no complaints regarding the set up of the scheduled lectures.

Reports have shown that CPD tends to be expensive for both providers and consumers. For successful PIL, it has been important to lower the related costs. This research project has taught us that under certain circumstances (profession-oriented, project-organized education, co-location with industry) it is possible to minimize the production costs through giving the CPD course as a regular part of a university program curriculum. We have learned that production cost can be limited to regular course curriculum development costs, the participation costs can be limited to participation time, and the transaction costs can be limited to minor administration.

PIL had individual final examination and 100% were approved or well approved. We have understood that PIL, also on an individual level, assures knowledge build up. There was a successful coverage of the topic.In short, the study load was manageable (#2 – Table 2), the production, participation and transaction costs were low (#3 – Table 2), and the coverage of the topic is good (#1 - Table 2). We argue the PIL set up has fulfilled the qualities for learning prerequisites.

Does PIL effectively support CPD? Yes, at least for Ericsson managers learning MDD. The instance of PIL that the MDD course constitutes fulfils all criteria (section 3.4) and requirements (Table 2) set up, and we argue this shows that PIL effectively supports CPD for Ericsson managers that need to learn MDD.

## 6. Implementing PIL

The defining characteristic of PIL (i.e., mixing industry professionals and ordinary university students in project courses) allows for many organizations of teaching—the one presented in this paper being one. This said, there are some particular requirements on teaching organization, which we regard as success factors when implementing PIL:

**A carefully chosen Microworld [26]** in which learning is to take place. This microworld should be: fetched from the professional domain, self contained, large enough to bring out product realism, small enough to protect students from overwhelming, not too deeply embedded in a bewildering context, and — most importantly — fun. The chosen DECT standard was comparably small, self contained, had a vocabulary and organization typical for larger standard suites, and connected to equipment all participants were supposed to be familiar with. We delimited the world by providing participants with a simulator of the radio network..

**Focus on a simple, measurable project goal suitable for a public demonstration.** Goal setting, as known from sport- and organizational psychology, is a well known technique to enhance productivity of individuals and teams. After considering a variety of ambitious goals in our microworld, we settled for an "ask-time" scenario to be demonstrated by the use of a handheld (a laptop) communicating with a base station (another laptop) through the air-interface simulator (a third laptop). We presented the goal at the first encounter with course participants (A1 in table 3), and verified that the goal was met in the last encounter (A4).

**A project organization with groups responsible for complementary knowledge areas and software components.** Participants should be divided into groups, each responsible for developing knowledge about, and for delivering, a part of the system to be built. We considered several divisions of work, for the ask-time system, and settled for one based on the layers in the network stack of DECT.

**Progression in technical learning.** The teaching activities should be designed to incrementally develop the technical knowledge necessary to achieve the project goal. In our setup, the introductory lecture (A1) developed basic intuitions and a vocabulary for DECT. The initial modules (M1-M4) developed basic knowledge in UML, C++, RoseRT, and about the system to be built. Intermediate lectures (M5-M7) developed knowledge about technical aspects of RoseRT necessary for the project, such as, animation and debugging. Final modules (M8-M9) developed knowledge about modelling in the large: the need for a chief architect, modelling guidelines, and model organization to support concurrent work, integration, and revision handling. The lab-week deepened the knowledge about integration and modelling in the large, by challenging the participants with the inescapable problem of building a common, operational product.

**Progression in social learning.** The teaching activities should incrementally build the interpersonal relationships necessary to achieve the goal. In our setup, the problems of the first few models (M1-M5) were designed to turn heterogeneous groups into working teams: problems were set entirely within the groups' knowledge areas. Later problems (in particular M6) were designed to turn the teams into project teams, by requiring intra team communication. A project leader for the purpose of coordinating the lab week was elected on the basis of this experience (M8). The lab-week, being a stress test of the organization, developed knowledge about organizational pitfalls of MDD projects.

**Self Directed Learning.** Module themes and problems should be flexible, and adaptable to participant ambitions and interests; participants should be given increasing responsibility for their learning during the course. For instance, when our participants faced an appalling need for modelling guidelines to support integration, an originally planned theme (Use case based requirements engineering) was omitted to make room for this theme (M8). We also changed the nature of the problems during the course: initial modules provided a smorgasbord of suggested, group-specific problems; intermediate modules provided generic problems; final modules did introduce problems, as the groups—by that time—were themselves capable of this.

### 6.1 How PIL affects organization of teaching.

The organization of teaching just described is not PIL specific. On the contrary, it has emerged out of 3 undergraduate project courses in embedded systems programming and artificial intelligence (that used a coffee rostery, a container harbour, and robot soccer as Microworlds).

Using the experiences from these courses as a baseline, we can roughly analyse the impact of PIL compared to giving a project course for ordinary university students.

In the execution of PIL, most activities remained the same. Student- registration became slightly more complicated, due to the need for handling two categories of students instead of one. A new activity, committee work with the CPD partner, appeared.

The main difference from ordinary CPD was that activities normally distributed over a full workday were compressed into a 4h block, scheduled in the late afternoon. Another difference was that the university students were asked to take on more responsibility for completing the hand-ins than the Ericsson managers. As the 2.5h group work session were often to short to complete the problem chosen, and as the university students were appointed twice as many work-hours per module than the Ericsson managers (16h compared to 8h). A common repository was used, so an Ericsson manager could stay updated with and learn from the progress of the group during the week, jump in to work, and by the end of the week still feel (and be regarded as) as a contributing member of the team.

## 7. Related work

A history of the development of CPD and an analysis of current trends is given by Cervero [27]. Most closely related to PIL are CPD educations that employ problem based learning: we have identified facilitated work based learning (FWBL) [3, 4] and problem based learning for continuing professional development (PBL for CPD) [28] as part of this category.

FWBL approach lacks the generational knowledge diffusion of PIL, and does not share production costs with ordinary university education.

The form of CPD, as applied by University of Queensland [29], uses group work, thematic workshops, and mixes students from industry and academia. The format is an intensive 4-day course. There is no enclosing project.

## 8. Conclusions and future work

An action research project aiming to find realization for effective CPD has been conducted as a joint venture between Ericsson and the IT University of Göteborg. 16 Ericsson managers and 16 university students have participated in a course to learn about Model Driven Development. In summary our findings are as follows:

- We have defined a new form of CPD, based on joint ventures between universities and CPD consumers, and a win-win situation between these.
- We have identified qualities of relevance to CPD courses, in general, and of particular importance to Ericsson. The model is summarized in Figure 2.
- We have specified requirement for effective implementation of CPD (see Table 2).
- We have explored this form of CPD in one cycle of action research involving the planning execution and evaluation of the course using this form.
- We have shown that, when it applies, this format indeed can be an effective implementation of CPD, according to our definition of this.

Based on the evaluation and learning sections (5.4 and 5.5) we can recommend organizing CPD courses in the form of PIL courses to universities that are profession oriented, has project organized curriculum and are co-located with industry. PIL provides benefits for both professionals and students who are aiming at being professionals. It also attempts to decrease the time required for students to learn how "industry works". PIL also adds more feeling of industry-like projects for the whole software engineering curriculum.

PIL is believed to be applicable when the following conditions are fulfilled: the provider has a profession-oriented pedagogical strategy and a project-organized education; the provider and the consumer are co-localized. These criteria are fulfilled by institutions that use Problem Based Learning, Project Based Learning [30], or Problem Oriented Project Organized Education [31].

Our further work is focused on continuous improvement of PIL, its further evaluation, and deployment at other software engineering programs. Questions of particular interests are whether PIL is effective also for seasoned day-to-day developers, and whether win-win situations can be found in such national environments where the industrial partner needs to finance the PIL education to a larger degree than in our case.


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