HUMAN RESOURCES DEVELOPMENT IN INDUSTRIAL WASTE MANAGEMENT USING PROJECT CASE WORK METHODOLOGY

C. Visvanathan and Mandar Parasnis

Environmental Engineering Program

Asian Institute of Technology

P. O. Box 4, Klong Luang, Pathumthani 12120

Thailand

1.0 Introduction

In the sixties and seventies, environmental engineering was a domain of civil engineers or chemical engineers as the environmental problems then were restricted primarily to only domestic and industrial waste disposal. The trends in the recent times, however, demand a more holistic approach and a more concerted effort from engineers and technocrats with varied academic and professional backgrounds.

In recent times, however, due to the increasing knowledge of the adverse impacts of the waste discharged to the environment and the limited assimilative capacity of the receiving bodies, the environmental legislation all over the world is encompassing more and more aspects of industrial operations. The emerging trade barriers, international agreements and treaties are forcing industries all over the world to restrict and treat the pollution created by manufacturing operations.

Further, it is not only waste emissions that are being regulated by these legislations, but the entire production process and choice of raw materials - and at instances even the final product - is being put under a strict scrutiny. The problem of industrial waste management therefore, is not limited to only waste treatment but involves a *cradle-to-grave* responsibility on the waste generator. It thus covers multi-faceted issues like raw material selection, cleaner and environmentally friendly manufacturing practices, product redesign and safe disposal of residual wastes without significant adverse impacts on the receiving environment.

1.1 Integrated Approach to the Waste Management Problem

The traditional approach to the problem of industrial waste management has been that of *end-of-pipe* waste treatment. This expensive approach, however, does not completely obliterate the pollution problem but it merely transforms one form of pollution to the other i.e. liquid wastes to solid wastes or air pollution to water pollution. Teaching such concepts is a relatively easy task.

In recent times, the concept of Pollution Prevention or Cleaner Production is gaining some credence due to its pro-active nature and preventive approach. It emphasizes on reducing the pollution *at the source itself*. In many instances this approach has proved to be a highly profitable changeover while achieving substantial waste reduction.

However, in practice cleaner production practices alone may not result in total

elimination of industrial wastes and the reduced quantities and concentrations of the wastes need to be treated and disposed off. Therefore, an integrated approach combining both *end-of-pipe* approach and Cleaner Production philosophy could be an appropriate answer to the industrial waste management problem.

1.2 Need for Training for the Integrated Approach

The Integrated Pollution Prevention and Control (IPPC) approach attempts to eliminate the pollution problem *in totality*. Further, it also attempts to address the issues related to productivity, energy management and all industrial operations in a more "*sustainable*" way.

Such a comprehensive approach cannot be effectively implemented in industrial operations merely by traditional engineering education and/or an extensive shop-floor experience. A formal training incorporating a multi-disciplinary approach integrating inputs from various academic disciplines such as energy engineering, industrial engineering, business management and environmental engineering is essential to supplement the years of industrial experience.

Traditional black-board-and-chalk methods of classroom teaching would be of limited relevance in this regard, since the IPPC approach needs in most of the cases *hands-on* training. Moreover, since such a type of activity often calls for multi-disciplinary inputs, in many instances it is difficult to design a course suitable for all the participants with varied educational and practical backgrounds. Furthermore, a strong bearing with the real-life situations has to be incorporated while designing the training modules on IPPC for industry personnel for an effective training.

1.3 Project Case Work Training Methodology: An Appropriate Concept

Project Case Work (PCW) based training is an excellent teaching method for training such a concept as IPPC. The Project Case Work (PCW) methodology revolves around a near real-life scenario. The problem statement and all other necessary baseline information is given indirectly or implicitly in the form of technical reports, newspaper cuttings or transcripts of meetings etc. The information given is not necessarily complete (this resembles a real-life scenario). This calls for the ability of the participants to extract the relevant information from the available heap of data for problem identification and solving.

The tasks are structured in a step-wise manner with a considerable pressure of time requiring extensive inputs from the participants in the form of group work. Group work is essentially a role playing exercise as each participant is expected to play a role (similar to that in a real life situation) based upon his academic and/or professional background. Thus the ideas and inputs from individuals with varying backgrounds (and thus different approaches) need to be conglomerated to reach an acceptable and feasible solution to the problem. Thus the participants learn while arriving at the solution of the problem by means of the group work exercise and also through brief lectures/presentations by the resource persons.

A very important feature of this exercise is the tremendous pressure of time (which again resembles the real life scenario). The group work exercises are so designed that all the groups always work under the pressure of time. Group work sessions therefore normally extend much beyond

the stipulated time slots making the duration of a PCW based training program a very rigorous and tight-schedule working experience.

1.3.1 Advantages of PCW Training Methodology

To consider the advantages of the PCW methodology, the first and foremost advantage that emerges is the **Simulation of Real Life Situation** in all the aspects and stages of training. Typically, near real situations are generated in terms of the following:

- Implicitness and inadequacy of required data
- Pressure of Time
- Pressure of Outputs
- Team Work Approach to Problem Solving

Besides its close link with the real life situation, another important feature of PCW is the **flexibility of the target trainees**. This implies that this kind of education methodology has been found to be very useful for diverse audiences like graduate students, industrial personnel, government officers, officers from the development banks and also in community training. The crux, however, being that an appropriate PCW scenario suitable to the specific requirements has to be developed by the resource persons.

Experience has shown that the PCW training methodology is a very **enjoyable yet educative** training methodology.

1.3.2 Resource Person : Key to the Success of PCW

It follows from the foregoing discussion that the resource persons who develop the PCW training materials and then actually conduct the PCW based training are very important and an integral part of the entire training exercise.

The originator of the PCW concept has outlined in detail the desired qualities to be an effective resource person in a PCW based training course (Tharun, 1995 b) which covers various issues right from the organizational aspects to those related to group dynamics. However, in essence it is expected that in the PCW training approach, the Resource Person serves more as a :

- facilitator of the learning process
- technical adviser as needed
- catalyst of learning rather than a
- lecturer
- story-teller
- instructor

1.4 Project Case Work based Training Program for IPPC : A Case Study

A Project Case Work (PCW) based 4 day workshop was organized by the Environmental Engineering Program (EEP) of the Asian Institute of Technology (AIT), Bangkok jointly with the Carl Duisberg Gesellschaft, South East Asia Program Office (CDG-SEAPO). The workshop was organized for graduate students of AIT from various academic disciplines viz. environmental engineering, energy technology, business management and industrial engineering.

1.4.1 Development of Project Case for the Training Material

Considering this inter-disciplinary composition of the target trainees, the training material had to be developed carefully so that each academic discipline had something to contribute and a lot to learn.

The choice of industrial sector for the base case was therefore very crucial. After

assessing the various potential industrial sectors, Electroplating was adopted as the preferred industrial sector for which a case study was devised. While developing the PCW, the participating students were not expected to be or to become the experts on all the problems of the electroplating sector in particular. Rather it was chosen merely as a means to demonstrate the methodology of attacking the complex problems of waste management and in this regard, the choice of the electroplating sector was found to be most appropriate.

This was so because the electroplating process is not very complicated to learn for a new student, who may not at all have any background about electroplating and production practices. Environmental pollution problems are quite severe from this industrial sector and thus are very easy to be perceived even by those who may not have any background in environmental engineering. In addition, there is ample scope for improvements in terms of energy management and production engineering (which calls for inputs from participants with the respective backgrounds). In short, in the case of electroplating, there is little to learn for everybody about the process and a lot to contribute for IPPC while learning. Importantly, since not much time is spent in learning about the electroplating process, the majority of the time could be dedicated to learn about the IPPC approach and methodology that can later be applied in any industrial scenario.

1.4.2 The Project Case Work Scenario

The base case adopted in this workshop revolved around a medium electroplating shop with nickel and decorative chrome plating lines. The company is trapped in a typical deadlock of "expansion v/s environmental legislation" and of course has very limited finances. Specifically, the industry is asked to immediately commission its wastewater treatment facilities, but this requires a substantial investment. This means that construction of treatment plant is going to affect the company's ambitious expansion plan and at the same time non-compliance could possibly result in a shut-down of the plant. This forms the basis of the problem statement.

As mentioned earlier, all the baseline information is given in the form of technical reports, notes in the diary of the environmental engineer, drawings and the transcript of a meeting of the production staff of the company to tackle their waste management problem. This meeting marks a beginning of pollution prevention and control measures, thus leading to the solution of the industry's problem.

By abstracting the relevant information from the given heap of data, the participants were then expected to explore various possible options incorporating IPPC to overcome this deadlock and to solve the company's problem. A guidance on IPPC principles and practices could be found in the Training Manual and/or the presentations by the resource persons.

1.4.3 The Training Material

The Project Casework (PCW) Manual on Integrated Pollution Prevention and Control specially developed for this course consisted of four Books:

- Book 1 - *Project Casework Scenario*
- Book 2 - *Background Technical Material*
- Book 3 - *Lecture Notes and Work Sheets*
- Book 4 - *Games and Assignments*

The *Project Casework Scenario* (Book 1) provided the hypothetical *case* to be *work*ed on by the participants as a group

project for the duration of the workshop. It is a practical exercise that calls for the application of the theoretical principles given in subsequent components of the Manual. As mentioned earlier, the case deals with a medium-sized electroplating plant, which has been directed by the authorities to treat the effluent generated in the process to meet the standards. Real-world situations were simulated as far as possible and practicable. However, some data were simplified or condensed due to time limitations for the completion of the work.

Essential to the PCW exercise was that the participants should assume specific roles and become actors in the given scenario. Hence each participant had to play a role in the project team relating to his own real life academic and/or professional background. For example one may contribute to the team as Plant Manager/Production-in-charge, the other as Environmental Engineer, somebody else might act as Energy Specialist while somebody else might act as Financial Analyst.

The *Background Technical Material* (Book 2) contained the salient background information, which needs to be understood by the participants in order to tackle the problem scenario in Book 1. It contained explanations and elaboration about the project casework method, the metal finishing/electroplating process, the weighted sum method for ranking various options, illustrative economic analysis techniques and energy principles. It was expected that this part be read and digested prior to the workshop by the participants who may have different academic backgrounds, in order to bring them to more or less the same entry level of know-how and know-why.

The *Lecture Notes and Work Sheets* (Book 3) were expected to guide the participants through the step-by-step process of working out the problem scenario given in Book 1. This part was expected to be done in groups following the project casework methodology given in Book 2. It was also the content of the lectures to be presented by the resource persons during the workshop. One must look upon this "guide" as a general set of guidelines that can be modified to suit plant-specific needs, and not as rigid procedures to be followed. It prescribes a self-help approach, i.e. the tasks of planning, analyzing information, generating alternative solutions and evaluating them were to be done by the industry staff (participating "role players") themselves. Outside consultants may serve as initial catalysts, planning facilitators, and/or source of technical information - but not, as traditionally done, to perform the entire investigation.

The work sheets were intended to guide the participants to produce the necessary outputs per session. It was found that designing such worksheets excellently served the purpose of channeling all the groups - without affecting their freedom of work - towards some acceptable solutions. It could also clearly define the required outputs from each group during each session and hence were catalytic in keeping the progress of PCW "on track", which is otherwise characterized by its open ended nature as far as solution to the problem is concerned. These worksheets were designed such that the outputs in one session serve as inputs for the next session.

The *Games and Assignments* (Book 4) were the special "fun" exercises relevant to the problem scenario that were designed for "lateral" thought processes while revisiting the various principles and importantly, providing some "hands-on" experience in this otherwise paper-work training program. These "fun" exercises were found to be highly enjoyable yet very

educative and marked as one of the prominent highlights of the entire training programs. A detailed discussion on this is included in the subsequent sections.

On the whole, this printed material was to be used in tandem with lectures to be delivered by the resource persons and video presentations. The entire PCW exercise was planned to be a group activity whose success hinged upon teamwork, multi-disciplinary capabilities of the members, and creative thinking under the pressure of time.

1.4.4 Training Program Methodology and Logistics

The workshop venue was chosen to be a very comfortable yet isolated resort outside Bangkok. This provided an informal but conducive environment for such a rigorous training program. All the participants had to compulsorily stay at the venue itself and hence were available full time for the various activities in the workshop during the entire duration. All the conference facilities with audio visual aids and arrangements for group work were properly made at the venue.

The workshop hours were scheduled to be between 8:00 AM to 5:00 PM for project case work. Special “fun sessions” for "Waste Minimization Games" were conducted after dinner, between 8:30 PM to 11:00 PM. Usually all these sessions invariably used to extend much beyond these scheduled hours in order to complete the group work.

The general format of the workshop included a brief presentation by the resource person followed by the relevant group work. A number of interim presentations by each group were scheduled and a final presentation and preparation of the report was also expected.

The group work methodology was the theme of this PCW based IPPC training workshop, which provided an excellent opportunity for inputs from various academic backgrounds, thus addressing the problem *in totality*. All the participants were divided into four groups (with equal distribution of nationality, gender and the academic background).

To motivate the participants to put in maximum effort for the best output, an atmosphere of competition was created between the groups, and was maintained throughout the duration of the course. Prizes were given towards the end for the best group and also the commendable individuals for their contribution.

1.4.5 Waste Minimization Games

Not directly as a part of the PCW, but very much complementary to the overall training program, a number of waste minimization games were devised and played in groups. Here the participants could actually modify the existing plant layout on a thermocol model from the point of waste minimization, or rinse the dirty plates with different cleaning aids with minimum resource and also with minimum "environmental costs" or carry out the miniature "plating" operation and rinsing with optimal resource consumption and novel ideas.

A functional Games Kit was specially developed for this purpose and the games were so designed that the concepts which were described theoretically in the PCW manual, had to be applied in this hands-on training session. Again special prizes were announced for the winners of games and special weightage was given to innovative new ideas, which triggered the thought process of the participants in the desired direction. These sessions were thus found to be highly enjoyable - even though held

at an odd evening hour - and were found to be the best teaching aid to train the students the concept of cleaner production and pollution prevention.

1.5 Outcomes of the PCW based Training Workshop

First and the foremost, the participating graduate students learnt about the IPPC approach through the brief lectures/presentations by the resource persons and a number of relevant educational videos.

Secondly, for the given PCW scenario and the problem statement revolving around a medium scale electroplating shop, the participants actually applied the IPPC approach. A number of interesting pollution prevention options (like modification in plant layout, water conservation in rinsing by air agitation, drag-out recovery etc.) supplemented by metal recovery options (using ion exchange, evaporator, electrodialysis etc.) were recommended. These options were further evaluated on technical, environmental and economical grounds. All these tasks were carried out as group work and the participants could very well understand and apply the concepts of IPPC.

1.6 Conclusions

The PCW based training program organized for the graduate students of the Asian Institute of Technology, Bangkok was a success, in terms of educating pollution prevention and control concepts. However, the authors feel that the success of this singular workshop is not the issue, but the important point is that, this has exhibited a model training methodology for the complex issues of environmental management and sustainable development.

This training methodology is therefore found to be a highly educative yet enjoyable learning experience with help and guidance from eminent resource persons. Moreover, this methodology is best suited for training the topics related to environmental management due to its ability and inherent structure asking for multi-disciplinary inputs and teamwork, which is the crux of these concepts. Also, it is a very appropriate teaching methodology for professional skill development of engineers and managers working in industries.

The training package developed for this course is found to be extremely useful, not only for students but also for electroplating industry personnel. The Environmental Engineering Program of AIT is now exploring possibilities to join hands with international organizations to organize similar event for students as well as professionals.

In conclusion, this PCW based training approach was found to be the most appropriate method of effectively teaching the concept of Integrated Pollution Prevention and Control.

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