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STUDENT ROLE PLAYING AND THE USE OF INTEGRATING CASE STUDIES IN MODERN TEACHING ENVIRONMENTAL ENGINEERING

To develop satisfactory industrial solutions modern environmental engineers require a solid educational base in science and engineering, together with a sound appreciation of the other factors which may influence the suggested engineering solution. In addition, they are usually required to work in multidisciplinary teams whilst developing the solutions. This paper describes an integrating case study, based on real engineering project, where students are required to role play in a mock hearing of planning application to construct a large private hospital. The private hospital is planned for wealthy overseas patients, but is to be situated in an area of high local unemployment. The case study has been carefully chosen to illustrate the numerous influences on the design of a project, including technical, financial and social parameters, whilst the method of delivery of the case study is designed to address the issues of team work and development of oral communication skills.

1. INTRODUCTION

In recent years, environmental pollution has been recognised in Western Europe and the U.S.A. as having important effects on the health of workers, on the effectiveness of industry and on the long-term sustainability of business. Reflecting these concerns, governments of these countries have introduced strict legislation designed to limit emissions from factories to air, water and land. It is proposed to reduce these emission limits progressively with time.

Most university courses in Poland teach environmental engineering and environmental control as an "end-of-pipe solution". The normal solution is to "retrofit", e.g.

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electrostatic precipitators may be fitted to a chimney stack to reduce emissions. This type of solution, however, will only be possible for current emission limits. When limits are reduced in future, a new "end-of-pipe solution" may be required. This philosophy can, therefore, be very expensive and have a very limited lifetime.

An alternative approach is to use a more holistic approach where the emissions generated by the industrial process are considered at source. This may, for example, lead to a redesign of the basic process to ensure compliance with current and future legislation.

For the past three years the Technical University of Wrocław has collaborated with the University of Paisley in Scotland. This paper describes the holistic approach used at Paisley in the teaching of environmental engineering. The Technical University is currently introducing this new philosophy into its courses.

2. THE PAISLEY APPROACH

To resolve the increasingly complex environmental problems posed by modern high technology, industry requires technologists with a very good basic grounding in technological skills, allied to a sound appreciation of other parameters which will influence their final decisions.

At any one time there are a number of technical solutions to any given problem. Not all of these are economically feasible – particularly for large-scale environmental problem where funding packages may use a mixture of national government, local government, EU, and possibly private sector finance. In addition, some solutions, which are both technically and economically valid, may contravene complex environmental legislation or, may not satisfy either local or national political sensitivities.

A pictorial representation of the problems facing the environmental engineer is given in the Paisley Box (figure 1), where the final validated solution must be able to pass all the boundaries of the box.

Quite clearly, any well designed educational programme must impart sufficient information to enable the potential environmental engineer to solve the riddle of the Paisley Box. At Paisley, the approach adopted in three modular MSc programmes (Environmental Management, Waste Management, Safety Management) is of a strong teaching base in science and engineering, coincident with short modular courses on law/economics/health and safety, etc. To ensure that student interest is maintained in what is clearly perceived to be a "support subject", a series of real case studies have been introduced at strategic points. In all cases, the studies have been chosen so that the final solution adopted requires the students to cross all boundaries of the Paisley Box.

In addition to requiring a wide range of technical skills, the modern environmental engineer will invariably be part of a multidisciplinary team. To be successful

this will require high levels of interpersonal skills, together with good communication (particularly oral) skills.

At Paisley, the requirements for integration of disparate course modules and the development of interpersonal and communication skills have been combined by introducing role playing exercises into a series of integrating case studies.

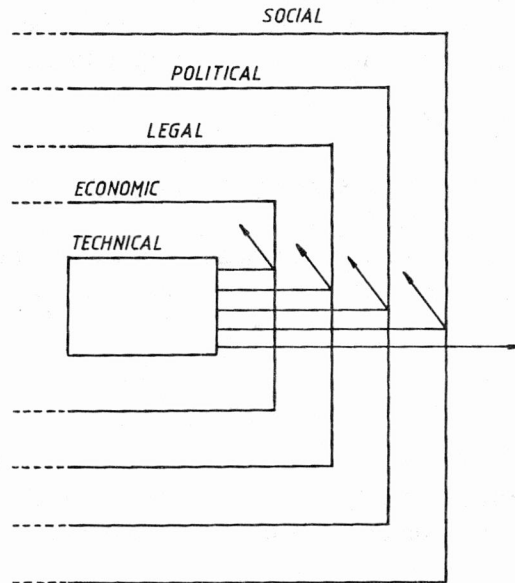


Fig. 1. The Paisley Box

3. THE TEACHING STRATEGY

Students are presented with a real life case study which has been carried out by a member of the course teaching team (the Tutor) as part of their regular industrial consultancy work. Before selection, any proposed case study would be vetted by the Course Leader to ensure that it possessed sufficient breadth for all boundaries of the Paisley Box to be investigated.

The students are presented with an overview of the technical problem by the Tutor, together with a view of the potential problems arising from other sources. The class is then divided into sub-groups with each allocated the task of representing a different interest group as appropriate, e.g. project design team, local authority planning department, river purification board, land developers, etc.

The groups are then allowed a period of time to research their subject area, before developing their brief. These are presented before the whole student group in, for example, a mock hearing for planning permission, or some other confrontational

meeting where each side is required to state and defend its position in open, critical debate. In such a confrontational debate, each group presents its case to the arbitrator (played by a Lecturer who had not been involved in the development of the case study and who could, therefore, act independently). The arbitrator at the conclusion of the debate will summarise the proceeding and make his or her decision on the overall case. At the conclusion of the hearing the Tutor compares the mock debate and the outcome with the actual hearing that he/she had attended. The Tutor will then go on to describe the technical solution used in the real project, together with the reasons for its adoption.

4. AN EXAMPLE CASE STUDY

One case study, which has been successfully used for three different student cohorts, is that of a proposal for the construction of a major private hospital in Clydebank, an area just outside Glasgow in the West of Scotland.

4.1. THE POTENTIAL PROJECT

Health Care International is a major company growing out of the Harvard Medical School at Boston, the U.S.A. The concept of their project was:

- to build in Europe a major private hospital carrying out high dependency operations,
- to link a hospital to a luxury hotel,
- to aim a product at the wealthy European, Scandinavian and Middle East market.

4.2. THE ORGANISATION

"Locate in Scotland" was a division of the Scottish Development Agency with a special brief to identify and attract major potential inward investment project for Scotland, thus helping to regenerate the Scottish economy. The division had a high profile in the U.S.A. and Japan and was successful in attracting a large number of companies to Scotland, particularly in the high-technology electronics industry.

4.3. THE SCOTTISH FACTOR

4.3.1. Pre-existing reputation outwith Scotland:

- good medical service,
- well trained medical staff,
- major teaching hospitals,
- outstanding clinical and research reputations.

- 4.3.2. Inexpensive land, together with a large pool of labour.
- 4.3.3. Good communications and travel infra-structure.
- 4.3.4. Good financial incentives via Central Government, Local Government and S.D.A.

4.4. THE LOCATION

- 4.4.1. Large plot of land available owned/controlled by S.D.A.
- 4.4.2. Adjacent to:
 - major river and port,
 - railway line and access to Inter-city Network,
 - local motorway and U.K. Motorway Network,
 - international airport.
- 4.4.3. Large pool of inexpensive labour available. Labour will have to be retrained, but training grants are available.

4.5. TECHNICAL FACTORS

Inspection of the land records indicated that a factory producing asbestos-based materials had occupied a section of the proposed building site. An investigation of

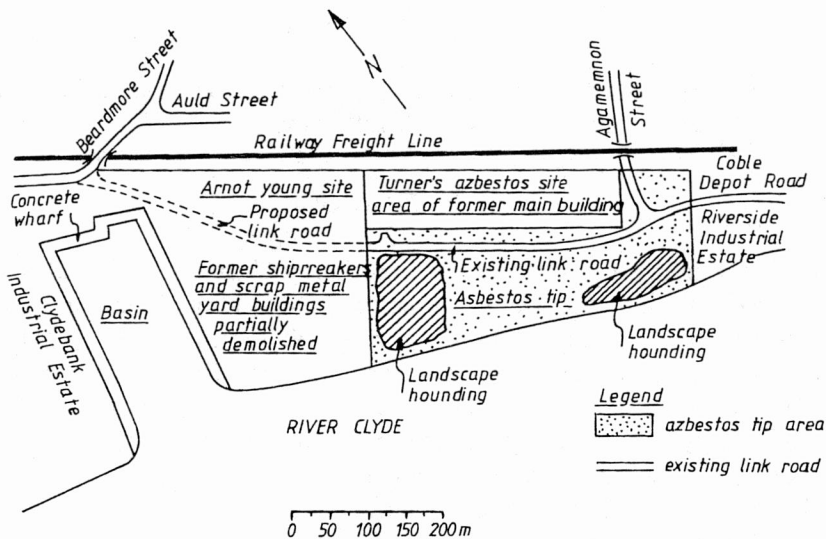


Fig. 2. Arnott Young site and Turners asbestos site existing layout

soil from bore-holes sunk on the site showed the presence of considerable quantities of asbestos, figure 2.

The Clydebank proposal occurred a number of years after redevelopment of the Clyde Submarine Base at Faslane. The latter was one of the first projects in the U.K. where a large area of asbestos contaminated land was treated, allowing a major civil engineering programme to be carried out. The asbestos related section of the project was carried out primarily by Scottish Contractors and at the proposal stage of the Clydebank contract, it was felt that there was a very considerable body of prior knowledge amongst local contractors and regulators. A well defined and structured work procedure was agreed, based on the previous project at Faslane.

4.6. ECONOMIC FACTORS

At the time of the proposal (1985) the Clydebank area was suffering from very high unemployment rates following the collapse of the traditional heavy engineering dominated industries. Job losses were estimated at: 80 000 shipbuilding, 20 000 Singer sewing machines, 160 000 in related support industries. In an attempt to attract new employment, the district was designated as a Special Development Area, attracting special financial assistance packages, e.g. low rate finance, little/no rates, start-up grants.

4.7. POLITICAL FACTORS

Scotland, in general, and Clydebank, in particular, at the time of the study, were politically left of centre and antiprivate health care.

4.8. SOCIAL FACTORS

Due to its long history as a major producer of steam powered ships, the Clydebank area has a high incidence of asbestos related lung disease and premature death. Consequently, the local community is very well informed, very knowledgeable, well organised and vocal. Also, a pressure group, called Clydeside Action Against Asbestos, had been formed some years earlier. This group was stridently anti-asbestos with a very strong local political lobby. Local people and the action group were well aware of the existence of the contaminated land. They had campaigned after the closure of the asbestos factory, some years earlier, to have the land stabilised with a covering of top soil by the Local Authority.

This had been carried out, with an assurance that the area would not subsequently be disturbed.

4.9. OTHER FACTORS

The medical community in Scotland were extremely worried by the size, type, and financing of the proposed hospital. They were particularly worried that the planned concentration on high dependency surgery would use a disproportionate part of the Scottish blood bank and may attract a disproportionate number of trained and experienced nurses and consultants, then working in the National Health Service.

4.10. THE RESULTS

- A modest technical and environmental problem.
- A large financial problem (£ 180 million).
- A very large political problem.
- A social dilemma.

5. THE CASE STUDY IN PRACTICE

The outline of the project, together with all the associated facets, is presented to the class. The class is then divided into six groups who represent:

- Health Care International,
- Scottish Development Agency,
- Consultant Engineers,
- Local Authority,
- Clydeside Action Against Asbestos,
- Local Residents.

The Group are given a fixed period to consider their arguments and develop their strategy. During this period free access is allowed to the Tutor. Questions from the students are freely answered, but no suggestions given as to the courses of action for the questioner. Also, no details are given of the actual build and methodology at this stage. At the conclusion of the fixed period, the "groups" are invited to present their cases to a "tribunal". For impartiality, the tribunal members are members of academic staff who teach on the MSc Course, but were not involved in the development of this particular case study. The Tutor attends as an observer only. After presentation from all groups, the tribunal gives its verdict on the planning applications, together with a short summary of why it made its decision. At the end of the proceedings, the Tutor will give an outline of how the project was actually developed and carried out.

This particular case study has been presented to three different student cohorts. All three "hearings" have been very lively indeed and have paralleled remarkably closely the real public hearing of the planning application by the Local Authority. In

two instances, the mock application has been successful, with the tribunal finding a well argued case by the “developers”. In one instance, the tribunal found that the consultant engineers had failed to satisfy the reservations held by the local residents, the Action Group and the Local Authority. In all three applications of this study, the teaching strategy has shown that modern environmental problems are extremely complex issues – requiring a broad training and, often, lateral thinking. Role playing has been shown to be extremely successful in developing inter-personal and communications skills, whilst the subject matter has integrated disparate strands of a complex modular teaching scheme.

6. CONCLUSIONS

Role playing case studies permeate the MSc Programme and have proven to be very popular with students. Employment rates for graduates completing the programme are encouragingly high, being amongst the highest in the University. Initial feedback from employers is also very encouraging in that graduates are reported to fit easily into existing teams and possess “integrative skills”.

GRANIE RÓL PRZEZ STUDENTÓW I WYKORZYSTANIE INTEGRUJĄCYCH BADAŃ W NOWOCZESNYM UCZENIU INŻYNIERII ŚRODOWISKA

Aby w sposób satysfakcjonujący ulepszyć rozwiązania przemysłowe, nowocześni inżynierowie potrzebują solidnej podstawy edukacyjnej i mądrej oceny innych czynników, które mogą wpływać na sugerowane rozwiązanie. Co więcej, gdy poszukują rozwiązań, zwykle powinni pracować w wielodyscyplinarnych zespołach. W pracy opisano integrujące badanie oparte na rzeczywistym projekcie inżynierskim – studenci grają role w pozorowanej dyskusji nad zgłoszeniem planu budowy dużego prywatnego szpitala. Szpital ten jest zaplanowany dla bogatych pacjentów zza oceanu, a ma być wybudowany na obszarze, gdzie panuje duże bezrobocie. Przedmiot badań został tak wybrany, aby zilustrował liczne czynniki wpływające na projekt, w tym techniczne, finansowe i społeczne, podczas gdy metoda wygłaszania opinii jest tak zaplanowana, żeby odnosiła się do celów pracy zespołu i rozwoju umiejętności ustnego komunikowania się.

ИГРАНИЕ РОЛЕЙ СТУДЕНТАМИ И ИСПОЛЬЗОВАНИЕ ИНТЕГРИРУЮЩИХ ИССЛЕДОВАНИЙ В НОВАТОРСКОМ ОБУЧЕНИИ ИНЖЕНЕРИИ СРЕДЫ

Чтобы удовлетворяющим способом улучшить промышленные решения, новаторские инженеры нуждаются в солидных эдукационных основах и умной оценке других факторов, которые могут влиять на предлагаемое решение. Когда они ищут решений, обычно должны работать в многодисциплинарных коллективах. В настоящей статье описано интегрирующее исследование, базирующее на реальном инженерском проекте – студенты играют роли в дискуссии над предоставлением планов постройки большой частной больницы. Эта больница запланирована для богатых пациентов из-за океана и она должна быть построена на территории, где имеет место большая безработица. Предмет исследований избран таким образом, чтобы иллюстрировал многочисленные факторы, влияющие на проект, в том числе технические, финансовые и общественные в то время, когда метод представления суждений так запланирован, чтобы относился к целям работы коллектива и развитию умений устного общения.