

# Adapting the Case Model Approach for the Delivery of Engineering Ethics Professional Development Units

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## ABSTRACT

This article describes an action research project conducted at Los Alamos National Laboratory to resolve a problem having to do with the ability of licensed and/or certified engineers to obtain the ethics-related professional development units (PDUs) needed to maintain their credentials. A case model approach, with online delivery, was selected as the optimal pedagogical model for the target audience; the rationale for this decision is described in detail. Examples of the case scenarios used are provided as are resources from which engineering-related ethics cases can be obtained. Response rates indicated that the approach was effective in helping licensed professional engineers obtain the needed PDUs. The rates of correct responses to the scenarios provided suggest that a desirable level of knowledge transfer had occurred. Suggestions for future improvements include supplementation of the online courseware with a facilitated asynchronous threaded discussion board, blog, or wiki to emulate the richness and feedback of case models presented in a classroom or workshop setting that is lost in online instruction.

**Keywords:** Case Studies in Education, Ethical Case Studies, Engineering Case Studies

## 1. INTRODUCTION

As one of the premier research laboratories in the United States, Los Alamos National Laboratory (LANL) employs a number of engineers who have become credentialed within their engineering discipline either by attaining a Professional Engineer (PE) license or through certification conferred by a professional society. Generally, maintaining such licenses and certifications requires the engineer to participate in continuing education activities to obtain a certain number of professional development units or hours (PDUs or PDHs). PEs registered in the State of New Mexico (NM) are required to obtain at least four PDHs in ethics every two years [1].

As part of its contractual obligation to the US government, the Laboratory provides a mandatory one-hour general ethics course to all workers annually. Topics over the past several years have included conflict of interest, raising and resolving ethical issues, and standards of conduct and business ethics, among others. Courses are delivered online, using traditional computer-based training methods. These courses enable PEs to claim two PDHs biennially, leaving a gap of two additional PDHs every two years.

LANL is located in rural Northern NM, approximately 100 miles from the nearest commercial airport. There is little in the way of vendor-provided engineering-specific ethics training available in the area, and budget constraints have made supporting travel for training difficult.

Given the large target population (roughly 120 individuals) who need ethics PDHs on a biennial basis, it was decided that in-house delivery of engineering-ethics training that could be used to fulfill PDH requirements was the preferred solution. Because of the recurring nature of the requirement and the static nature of the information, it was determined that workers should be exposed to an initial, in-depth training followed by annually updated refresher training (which is defined as a “short-term course aimed at recall and reinforcement of previously acquired knowledge and skills” [2]).

Developed in accordance with the Systematic Approach to Training (SAT), the initial training covers the elements of the NM *Code of Professional Conduct – Engineering and Surveying* (NMAC); ethical obligations to the engineering profession and other professionals; and various federal legal requirements, most especially export control law, that have the potential to impact the practice of engineering at the Laboratory. It has been delivered both in classroom and online settings (currently, only the online version is supported). Although the initial training does incorporate some case-based “test your knowledge” exercises, it is primarily a lecture- or presentation-based pedagogical model.

Research in the field of “andragogy” (the art of teaching adults [3]) dating back to the 1970’s, however, suggests that lectures, and especially lectures in which the same information is repeated, may not be the ideal instructional model for adult learners. Therefore, as we designed the engineering ethics refresher training, we looked to other instructional designs.

## 2. RATIONALE FOR SELECTION OF THE CASE MODEL APPROACH FOR CONTINUING EDUCATION

Knowles’ model, which has evolved over the years (his seminal work has been continually updated and is now in its seventh edition [4]) contains six core principles related to andragogy that influence instructional design decisions for adult learners:

- 1) the adult learners’ need to know not only the subject matter, but also to understand the why, what, and how underlying it
- 2) the self-concept of the learner and the tendency toward movement from dependency upon an instructor to greater autonomy and self-directedness as learners age
- 3) the prior experience of the learner – particularly their mental models, that can be drawn upon as resources – and the need to use techniques that incorporate the adult learners’ experience base as an integral part of instruction
- 4) the adult’s orientation to learning being problem-centered and contextual
- 5) the dependency of adults’ readiness to learn on the developmental phases associated with the various

roles that they play/have played in their (professional) lives

- 6) the basis of adults' motivation to learn being in intrinsic value and personal payoff

Because they focus on problems, rather than subject matter, and are designed to facilitate immediate application in everyday life, case studies are an ideal method for adult instruction. In the case method, knowledge is acquired while dealing with a real-life problem and not in isolation of its context [5], consistent with the fourth of Knowles' principles listed above. "Although the case method does not actually provide real experiences, it is personal as it puts the burden of thinking on the learners and arouses their interest by making them active participants [6]." This characteristic is responsive to both the adult learner's need for self-directedness and for engaging his/her own experience base.

While development of skills generally requires an element of actually doing the skill-based activity, the case method provides the opportunity for skill development through presentation of different cases that exercise the same skill over a period of time [5].

Finally, because cases involve real people with real problems, they are also more likely to stimulate adult learners than are subject matter-based lectures or texts [7]. The narrative presentation format also encourages learner engagement [5].

Note that the selection of the case model approach was driven not by the subject matter to be taught – in our case, engineering ethics – but rather by the target audience – the adult learner. Therefore, there is the potential to apply case model-based learning in other professional disciplines, such as health care, law, and public accountancy, in which there are continuing education requirements placed on adult learners. In addition to sharing the characteristics of adult learners described above, like our target population of licensed and/or certified engineers, these audiences are all motivated to complete continuing education for personal payoff – maintenance of the license or certification needed for continued employment in their profession – which reflects Knowles' final andragogical core principle [4].

### 3. DESIGN OF THE ENGINEERING ETHICS CASE STUDIES

Clark [6] describes case studies as being of one of two forms. The first type uses short and specific situations in which the problem is apparent. The learner is asked to demonstrate his/her problem solving ability by applying principles that have been taught previously. The second type is not so much about a problem needing a solution, but about appreciating different perspectives on a situation. This type provides complex information that requires deep analysis and focuses on problem identification as well as finding solutions. The Food and Agriculture Organization of the United Nations (FAO) (see reference [5]) refers to these two types as "caselets" and "comprehensive cases," respectively.

The case studies used in the engineering ethics refresher courses are more in keeping with Clark's [6] first type, as they are typically short (one page or less) and require the learner to apply the knowledge gained from the initial training experience.

Many of the engineering ethics case studies used in the refresher training do, however, share one characteristic of Clark's second type, namely, the need to consider multiple perspectives on the problem. As the case study unfolds, the learner may be asked to take the position of the involved worker, coworkers, consultants, or managers, exercising Knowles' [4] principle regarding an adult's readiness to learn being dependent upon the learner's phase of development in various roles and as suggested by the FAO [5].

Because the engineering ethics refresher courses are delivered online rather than in a classroom or workshop setting, one of the integral aspects of the case method, namely discussion with a group of co-learners [5], is lost. Recognizing that much of the value of the discussion is in the feedback provided to the learners which positively reinforces learning [5], the courseware was designed with branching, wherein the learner takes different paths through the material depending upon the correctness of their responses. Selection of the "best" response to a particular feature of the case leads either to consideration of additional portions of the case or to a new case. Selection of a response that is not the best option leads to feedback as to why the response is not the best option and, in some cases, the opportunity to further explore the rationale underlying the "best" response by answering additional questions.

#### Learning Objectives

Cases were selected to reinforce the learning objectives developed for the initial training. These included:

- Enhancing learners' knowledge of ethical conduct expected of engineering professionals and of how to apply this knowledge in situations requiring ethical judgment; subject matter associated with this objective specifically addressed the NMAC *Code of Professional Conduct* as well as the codes of conduct promulgated by the major engineering professional societies
  - The NMAC rules address five topics:
    - 1) Protection of the public safety, health, welfare, and property
    - 2) Specialization and the performance of services only in specific areas of competence
    - 3) Issuing public statements
    - 4) Professional relationships with one's employer or client
    - 5) Solicitation of professional employment
- Familiarizing learners with the principles of business ethics
- Familiarizing learners with ethical conduct regarding authorship and publication
- Enhancing learners' knowledge of how to use and protect information in an ethical manner
- Providing learners with information regarding where to go for additional resources on ethics and ethical conduct

Because no one case reinforced all of the learning objectives, a suite of cases was selected for each refresher. In 2010, the refresher included five multi-part cases; in 2011, there were four. Collectively, these cases addressed all the objectives.

### Case Study Resources

All of the cases used in the refresher courses are based on real engineering-relevant situations derived from a variety of sources, including the following web sites:

- American Society of Mechanical Engineers Ethics Center  
<http://www.asme.org/NewsPublicPolicy/Ethics/EthicsCenter.cfm>
- National Society of Professional Engineers Board of Ethical Review  
<http://www.nspe.org/Ethics/EthicsResources/BER/index.html>
- New Mexico State Board of Licensure for Professional Engineers and Professional Surveyors Disciplinary Actions  
<http://www.sblpes.state.nm.us/discipline.html>
- Online Ethics Center for Engineering and Research  
<http://www.onlineethics.org/Resources/Cases.aspx>
- The American Lawyer  
[http://www.americanlawyer.com/current\\_issue.jsp](http://www.americanlawyer.com/current_issue.jsp)
- The Center for the Study of Ethics in Society  
<http://ethics.tamu.edu/pritchar/an-intro.htm>

### Adapting the Cases

While we tried to stay true to the details of the cases, it was sometimes necessary to adapt the cases to bring out salient features of the NMAC, LANL policies, or relevant laws and regulations. Generally, we begin by presenting a high-level, factually accurate summary of the case, with the only adaptation being removal of the names of involved individuals and substitution of names like “Eddie Engineer” and “Mike Manager” to enable students to track the participants through successive presentation of the case without compromising individual privacy.

Additional details about the case are presented in subsequent “frames.” The case is doled out in small increments, with questions probing various ethical principles embedded within each segment. Fictitious situations or characters may be introduced to allow the scenario to explore aspects that were not present in the real case.

Figure 1 shows a portion of a case in which a fictitious situation is added. The case is drawn from the *American Lawyer* description of *U. S. A. v. John Reece Roth* [8], which deals with export control issues associated with allowing a foreign graduate student access to export controlled technology. The segment involving electronic transmission of export-controlled data to a foreign country is fabricated.

In Figure 2, Eddie and Felix represent real people who were involved in the Swinging Bridge incident, which is adapted from Kardon’s 2010 case study entitled “Bridge Collapse and the Duty to Warn [9].” Sam, however, is a fictional character who is introduced to allow the scenario to explore some LANL-

specific policies that were not part of the real case. Introduction of fictitious characters also facilitates having the learner take the position of actors other than those who were directly involved.

In both figures, the sequence in which the segments are presented is for illustration only. In the refresher, there were additional segments presented for both scenarios. In Figure 1, branching takes a learner who has provided an incorrect response to an explanation of the correct answer. In the refreshers, branching often takes the learner to additional questions that reveal the basis for the correct response, as is shown in Figure 2.

## 4. METHOD

In this effort, we have used the paradigm of action-research, which aims at both improving the subject of the study (in this case, the ability of licensed and/or certified engineers to maintain their credentials by fulfilling professional development requirements related to ethics) and generating knowledge simultaneously [10]. We followed the classic “Action Research Cycle,” as described by Sussman and Evered [11], which comprises five stages: diagnosis, action planning, taking action, evaluation, and specifying learning.

Diagnosis involves identifying an improvement opportunity or a general problem to be solved. Our diagnostic thought process is discussed at length in the introductory section of this article.

Action planning involves the consideration of alternative courses of action to attain the improvement or solve the problem. Action taking involves the selection and implementation of a course of action. As alluded to in the “Introduction” and “Rationale” sections, case-based instruction was one of several pedagogical models considered. The reasons for its selection are outlined in the rationale.

Evaluation involves the study of the outcomes of the selected course of action. In our case, “success” was defined in terms of the participation rate among members of the target audience, percent of correct responses (as a surrogate for knowledge transfer), and informal feedback received from participants. Because the objective was not a comparative analysis of case-based vs. other pedagogical methods, no data regarding the efficacy of the case method *per se* were collected.

Finally, the specifying learning stage involves reviewing the outcomes of the evaluation stage and building knowledge by describing the situation under study. Development and dissemination of this article fulfills the specifying learning stage of this project.

The output of the specifying learning stage may lead to additional iterations of the cycle, serving as input to a new diagnosis. See the “Discussion” section below, for ideas for follow-on work that emerged as we considered how we might improve upon the current effort.

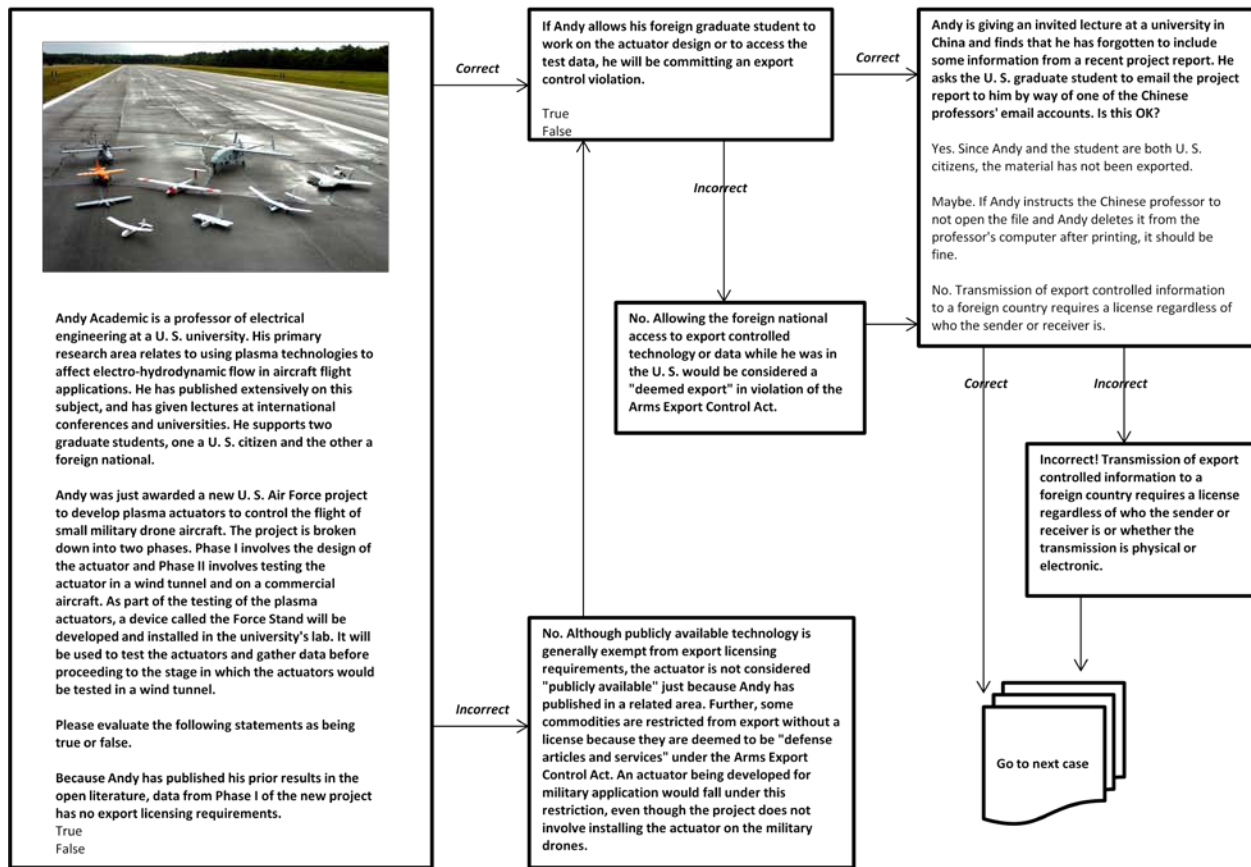


Figure 1. Example of a Case Embellished with a Fictional Situation

## 5. RESULTS

Participation rates were acceptable, with ~47% of the target population completing the 2010 refresher and ~59% completing the 2011 refresher. Better communication regarding course availability in 2011 most likely accounts for the higher participation rate.

Percent correct responses for the case queries were similar for the two courses with an 86.1% percent correct response rate for the 2010 refresher and an 85.2% rate for the 2011 refresher. In the 2010 course responses, there were no case queries for which less than 70% of respondents selected the best response. In the 2011 course, two of the 14 primary (non-remedial) case queries had less than 70% of respondents choosing the correct response. Interestingly, both of these queries pertained to LANL policies rather than the NM Administrative Code or regulatory requirements. Further, one of the two queries tested the same knowledge (regarding where within the Laboratory one would go for help in resolving an ethical issue related to publication and authorship) as had been tested in the previous year's cases – in the 2010 course, 76% of respondents chose correctly, while only 57.4% selected the best response in the 2011 course. The nature of the question requires recall of information rather than problem solving; therefore, it may not have been suitable for use

in a case study paradigm. The low pass rate, however, indicates the need to find a way to refresh this knowledge.

Informal, unsolicited feedback received from participants was generally very good. The only negative comments we received had to do with learners being uncomfortable with the lack of a definitively right or wrong answer for many of the scenarios. Although the FAO notes that this is a potential weakness with the case method [5], in this instance, the issue more likely derives from the nature of ethical dilemmas than the case method, as similar feedback was received in regard to the initial training, which was primarily subject-matter- rather than case-based.

## 6. DISCUSSION

Observations about the action taken and the results described above suggest additional opportunities for improvement. As noted previously, online presentation of cases lacks the richness and feedback associated with cases presented in classroom or workshop settings. Future plans include supplementation of the online courseware with a facilitated asynchronous threaded discussion board, blog, or wiki. It is hoped that this will enable emulation of some of qualities provided via discussion that is lacking in the current courses. The option of discussing the cases with peers and/or a mentor may also help to alleviate

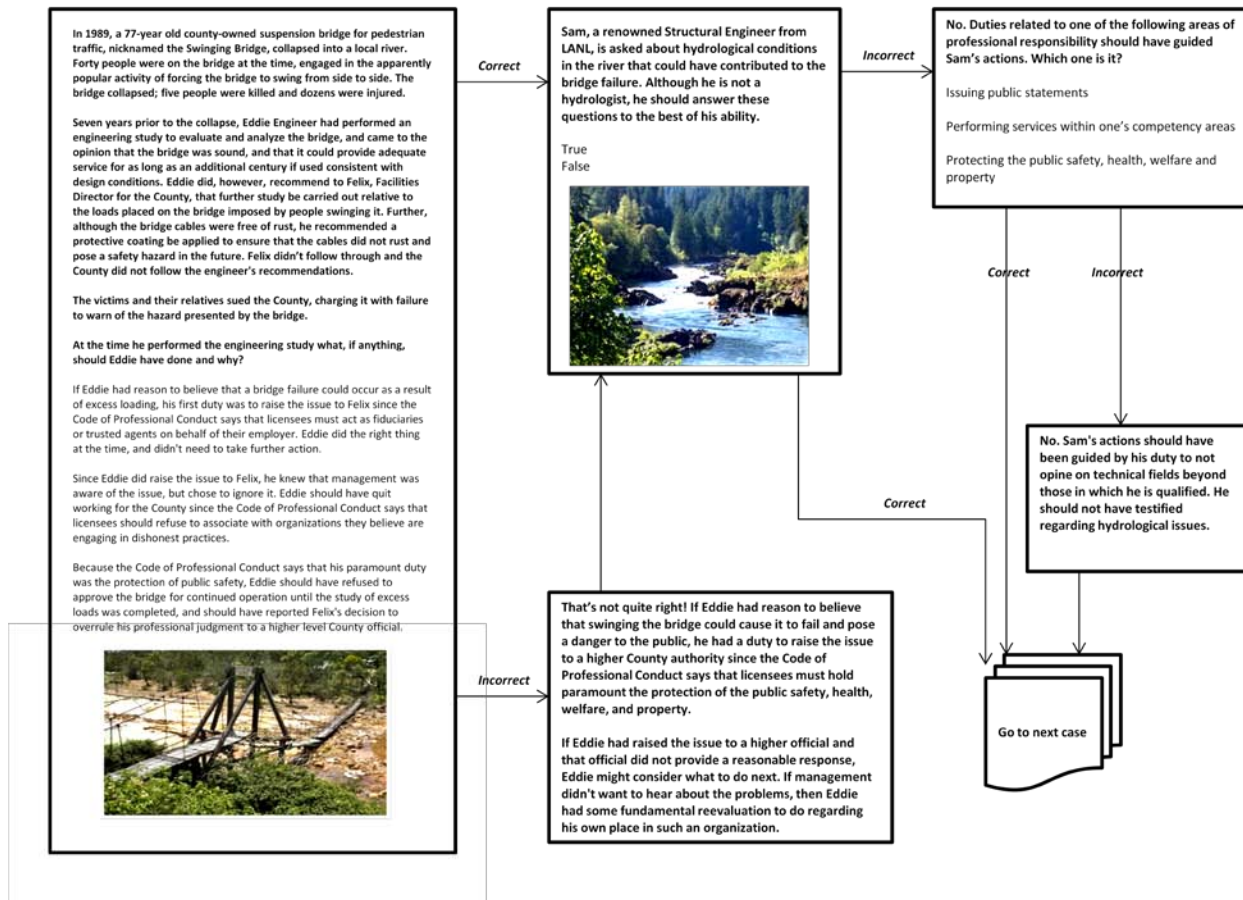


Figure 2. Example of a Case Embellished with a Fictional Character

learners' discomfort with the squishiness of the answers to ethical issues.

Formal feedback will also be solicited from participants<sup>1</sup>, using a modified version of Thalheimer's [12] learner survey. Unlike many "smile sheets," which ask general questions about the learning experience, this survey format asks learners to respond to specific learning points covered in the learning intervention. Capturing data about the *value* of the individual key concepts provides more meaningful information about changes that should be made in future learning interventions. In addition to addressing the overall rating topics seen in most smile sheets, the evaluation form also asks two critical questions related to how likely the concepts learned will be utilized on the job and how likely the concepts will be shared with others. This provides information regarding whether the training is likely to have an impact where it was intended. Thalheimer asserts that this evaluation format supports learning and performance

<sup>1</sup> Formal feedback was not solicited in 2010 or 2011 due to limitations in LANL's training infrastructure. A new training management system was implemented in Summer, 2011; the new system has the capability to survey participants in online learning activities.

because it provides a repetition of the key learning concepts at the end of the learning event.

Modifications to Thalheimer's [12] basic structure will include questions related to participant preferences regarding case-based learning both with and without augmentation with asynchronous discussion as compared to preferences regarding other instructional methods along the andragogical factors suggested by Knowles [4]. This will allow us to validate our conclusion that a case-based model was the most appropriate method for delivering the educational experience to our target population and to gauge the effectiveness of threaded dialogue in improving the richness of the learner's experience and the quality of the feedback provided.

## 7. ACKNOWLEDGEMENTS

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