

## Educating management: by case

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**ABSTRACT:** The article reflects on personal experience when providing undergraduate engineering students with the basics of management by a core subject titled *Engineering Management*, which formed part of the Professional Orientation stream in one School of a Faculty of Engineering, and was available as an elective to students from other schools and faculties. As with most subjects in tertiary education, two types of examples were required; one type for illustrative purposes and another for testing purposes. For students specifically in business and management studies, what is termed a *case study* has become accepted for both purposes, and the article outlines how the same instrument was developed and used effectively for undergraduate engineering students in a management subject, and what a case study requires to be satisfactory when so used.

### INTRODUCTION

When presenting the subject titled *Engineering Management*, which formed part of the Professional Orientation stream, the author experienced a totally unexpected three-dimensional problem, which only became apparent over three semesters.

The first dimension was that the students were not oriented towards thinking about management-type problems. After all, they had entered a school in a university faculty in order to study engineering, which they understood to include machines of all types and the mathematical procedures that go with machines. They also expect to learn all about using computers to solve matter-of-fact problems, and management does not fit into that scheme. Indeed, the author found most students entered the subject unenthusiastically because they were dyed-in-the-wool engineering *nerds*.

The second dimension was that the subject was only an introduction-to-management, with only one semester (about 40 classroom hours) available, so it could only be an outline, generally with breadth substituted for depth.

The third dimension stood out vividly: the students had been out in industry, and therefore most of them were not really interested in studying management when they arrived in the subject because they *knew*, in general terms, what management was about from having worked under managers. In addition, some had already been working at a supervisory level and, as such, had some experience as managers that increased their *knowledge*.

### DISCOVERING THE PROBLEM

Having graduated from Macquarie University with an MBA, the author automatically assumed the task would be easy. Many

fellow MBA students were engineers and, after all (this was the sub-conscious reasoning), with an education foot well into the doors of both disciplines, engineering and management, followed by practice in each, explaining the latter to the former should be simply presenting a generalised summary (which was why the first dimension was unexpected).

All that was needed, the author initially believed, was a tightly scaled-down statement of what management was all about. Not the full content of the three years times 12 hours per week that had been experienced at Macquarie, just an introduction to management. This was correct, in principle (which is why the second dimension was unexpected).

So, the form selected began with basic management concepts, an outline of the four classic functions of management (planning, organising, leading and motivating, and controlling), then the management resources, and finished with some of the mathematical procedures that management uses. This was *so obviously* the way to go because it is generally the route taken by so many management texts. Incidentally, this is no overt, covert, direct or oblique criticism of any of the many excellent texts that have been published. The author has come to realise they are all very good – for *management* students. Even, probably, for *postgraduate* engineering management students. But this is not the case for *undergraduate* engineering students.

Did that form work? Well, to some extent it did. There was evidence in the form of a satisfactory mean of the grading figures to show that they were learning the subject matter. But after some three semesters, there was enough student reaction to show that, although they were learning *about* management, they were not becoming *involved* in the subject. This provided an indication of the first dimension: they were reacting like engineers, not managers. The subject was not *reaching* them, taking hold of them, thereby illustrating the effect of the second

dimension: the brevity and lack of depth. Furthermore, they were not enjoying it, they were just doing it, not relating it to their workplace experience (the third dimension, which was even more unexpected because their workplace experiences should have helped the subject to reach them).

## TWO CHANGES

It would be nice to be able to say that the change from that original programme was the result of the application of well-known educational principles. However, the truth is that the failure to interest the students was noted and dissatisfaction was experienced (by both lecturer and students). The decision to change the teaching process seemed to be logical, but was made on (at the time) purely pragmatic grounds, the desire for greater satisfaction. Afterwards, it was clear that it *did* follow sound educational principles, as shown by Kolb's writing on learning styles (which shows the lecturer learned something as well as the students) [1].

In the fourth semester, the class was unusually small, very suitable for a guinea-pig exercise, and some changes were made, based, as above, on gut-feeling logic.

The first change lay in solving the first problem, and involved making the subject relate more closely to their discipline. So the subject was opened, after some general chatter, with what were termed *the tools a manager uses*, usually given as *resources* (it should be noted that the word *tools* was used to encourage an engineering context to the management subject). These tools incorporated:

- Personnel: people, an organisation;
- Machines: production equipment;
- Materials: raw materials and product inventories;
- Money: wealth, cash flow, profits, etc;
- Time.

These were followed by some mathematics (including some elementary accounting), with an emphasis that these were *decision-making techniques*, the reason being that by the time the engineering students are two-thirds through their course (which is where students meet management) they have been *mentally marinated* in mathematical methods.

So, when students enter a new subject that, by its title, looks at least partly un-engineering, it therefore generates suspicion that it will be at least uninteresting to minds conditioned to *real engineering subjects* and, at worst, quite boring or difficult. But, if it opens with some engineering terminology and some more mathematics, simple and easy and black-and-white, then they are lulled into a comfortable state. They begin to think that this management subject, as they are receiving it, has much in common with some of the more familiar engineering subjects. After that, they can accept more readily the esoterically grey classic management topics, such as the functions of management, etc, which follow.

The second change came about by solving the second and third problems, and covered making the subject an even more rapid run through the essential and basic points (which now sounds paradoxical, but it worked), and to make it an emphatically real world subject. That was provided by the use of engineering management case studies, which allowed going faster by utilising cases for illustration and assignments.

## WHAT IS A CASE STUDY?

What is a *case study*? That is a good question. It is a teaching instrument used in management studies to promote discussion, and, indeed, it is a difficult question to answer to one of the engineering mindset because there is no engineering analogue. This will become more apparent in moving to define them.

In looking at the engineering education system, it can be seen that relatively few case studies have been written, indeed, almost none, for *true* engineering problems. There are many real-world examples of engineering problems, and examples can be found in the literature of monographs from the Engineering Case Library (eg [2][3]).

Books by Kletz and Petroski also show how the engineered mixture of hardware and software (plus the human factor, the ultra-software) has failed and allowed an accident to occur [4-6]. However, although these items are in an engineering context, they are more in the reporting style than problem-setting. They are studies of cases, rather than case studies.

Unfortunately, history has shown that once a design is on paper and approved, it can proceed without challenge to becoming a reality, as occurred with the walkway at the Hyatt Hotel, or construction of the Westgate Bridge. There is very little, if anything, *in the engineering system* to question or even monitor what goes on once the work leaves the design office. The result is that by the time someone notices something is wrong, it is too late; the sky is already falling. Or, in the real world of those engineering examples, the walkway and the bridge, showing something was, in fact, wrong.

Asking management academics to define case studies produces a variety of answers; everyone knows what they are, but there is no common definition. Alternatively, going to the relatively sparse literature on case studies provides a similarly mixed answer. However, and somewhat fortunately, all of the answers tend to converge into one general understanding. Instead of a brief definition, there is instead a lengthy explanation: a case study is a problem statement, suitable for use by students, and set out in narrative form, through which it should provide information that leads more to discussion of the problem, rather than to a solution. Indeed, one of the most common features is that there is no neat-and-tidy solution.

The following elements have been identified [7] as those necessary in a case study:

- It is a description of an actual situation;
- It has a problem and a person (or group) trying to solve that problem;
- There is no interpretation;
- It includes a number of variables;
- It cannot be reduced to one *point, issue, or problem*;
- There may be a core problem, but usually a number of other problems surround this core;
- Not all of the facts are available;
- Some of the *so-called facts* turn out to be half-facts or opinions [7].

All this is enough to make the matter-of-fact, numbers-oriented, engineering student uncertain whether to curse or weep, asking *where do I start?*

As a personal comment, the author's experience of case studies in a postgraduate management programme was that of being thrown in at the deep end. There was no introduction given or explanation of what to do, the materials were presented and students expected to get on with a discussion. Yet by the time the author faced cases, a lot of management instruction had already been received; as such, ideas of where and how to start were further developed.

## THE HISTORY OF THE CASE STUDY

Tracking the earliest use of the case study, or the *case method of instruction*, is difficult. It is said to have been in the Graduate School of Business Administration at Harvard University (a likely place) in the early 1900s, or even as early as the 1880s [8]. Alternatively, the first use of the case method has also been cited as 1911, although the first *casebook* was published in 1920 [8][9].

The latter reference remarks that the concept of case studies in business arose as an analogue of legal case law; the Dean of the Harvard Business School hoped that it might be possible to set up a body of precedents that would assist managers to make decisions correctly, just as lawyers and judges use cases in court. Now that a century has passed, management academics and practitioners agree that such a hope is just not on: there is too much variability in management situations for a rigid, quasi-legal system of precedents to work. The best a practicing manager can hope for is to recognise a problem-situation to be similar in some ways to a previous one, but by no means identical. The manager can then argue it through personally (or with colleagues) by reasoning: *when that came up before, I did that, and the result was good (or so-so, or bad), so this time I will do the same (or much the same, or something different)*.

The factor that allows a practicing manager to identify how good/indifferent/bad (or vice versa) action on the previous situation was, and what should be done this time, is experience, which is influenced by many personal factors. As noted by one highly regarded reference: *What a manager knows by way of verifiable fact appears to us less important than the attitudes, aspirations and values that he brings to his tasks* [10].

So, although the outcome for which Harvard originally hoped did not eventuate, something very good came out of those early attempts to transfer theory into practice: the development and acceptance of the case study as a valuable teaching method.

## THE LITERATURE

In the business and management areas of tertiary education, books of case studies abound. Examples can be found, stretching through many decades. Most of them are from the USA, (for example, ref. [10]) although one may find exceptions to that; there is the occasional one from a country like Australia or elsewhere [9]. There is no doubt that there are collections in languages other than English, but the overpoweringly global pervasiveness of American management culture has tended to concentrate the literature in one language.

A book that gives some detail on the history and development of the genre is quite rare, and only a few have been located [9][11]. Hunt et al devoted some five pages to the development [9]. Shapiro listed 34 references in his paper, many of which

may contain historical information, so other works may exist [8]. However, the impression that one gains is that any interest in the item itself has been submerged by the greater concern for getting the multitude of cases into print.

Literature on how to operate on cases also appears to be rare. Only three books have been located with any such information [9][12][13]. Again, it is suspected that there is little on this aspect because the method is so *obvious*.

Several movies and videos exist which are very useful case-type material. One video has been published with the sub-title *The process of learning by case studies in management education* [14]. This follows some MBA students through classroom and tutorial discussions, and interviews them to get their opinions on the case method. They generally approve both the case study method and the manner in which their lecturers present the work, but cynics may be inclined to suspect potential MBAs are smart enough to know the right answers to any questionnaire from a lecturer.

One unusual example of material used for a case study discussion occurred several years ago at Stanford University in California, USA, when a graduate seminar in management used a series of books on a fictitious company as basis with the author attending [15].

So there are many books containing case studies, or suitable material, and a small number on how to work through them.

## A CASE STUDY-TRIAL WITH UNDERGRADUATES

Returning to those first two or three semesters of teaching management to undergraduate engineering students, the author used some published cases in the subject in 1986. The result was most unsatisfactory. The cases were not *taken* by the students; the students found them flat and uninteresting, perhaps proving that undergraduates can indeed be a trial. The reasons for this failure are probably found in the *four principles of learning* [8]. The first of these is *the material must be of interest to the student* and the fourth is *learning is affected not only by the nature of the material but also by the efforts of the teacher* [8].

In the trial utilisation of published cases, these two principles became evident. Despite the inherent management-value of the material, it did not interest the young engineering students (ie *young* in that some students were a few years out of high school, some were ten or more years older, but all were *young* in the professional engineering sense). Also, it was obvious that the lecturer was putting no more effort into the work than having it copied out of a book.

A major reason for the failure to interest students in the copied case studies used also seemed to be the unrealistic presentation of the characters involved in them, a conclusion reached from hearing critique-comments from students. According to recognised principles of writing fiction, a vital element of characterisation is to present characters who *live and breathe*, not two-dimensional (or what seems, sometimes, to be one-dimensional) cardboard cut-outs. That lack of life is shown in many conventional cases by the style of monologue presented (NB not dialogue), for when some information is given by someone *speaking*, it is expressed as the reporting of one side of an interview, not as a conversation between characters. The

result is the characters are seen to be unemotional and unbelievably rational. If there is any suggestion of their personalities, it is stated descriptively, not by *showing* but by *telling*, thus contradicting an oft-quoted rule of thumb used and observed by fiction writers [16].

Another failing was the *package* nature of conventional cases used. Each one contained an incident, neatly put together, apparently contrary to two of the elements quoted above. The students seemed to find that unsatisfying as their comments showed; even as undergraduates, they were aware that problem-trees grow from little acorns. And the acorns shed by those trees seed new problem-trees, and so on, sequentially.

#### AN EXPERIMENT WITH A NEW TYPE OF CASE

The above experience led to the production of a new type of case, based to some extent on knowledge but totally fictional; this followed, in effect, the example of Stanford's use of Anderson's writings. To categorise these, they fall into the abbreviated case type and a mixture of background, exercise, situation, complex, decision and sequential types [11][8].

The format of each case was, strictly speaking, that of a *short story*. The trials showed this needed about six A4 pages, around 2,000 words, for it to present a situation with enough background for a student to identify with it and the characters, and make a decision from what was read. This format did not spring into life in an instant, indeed, not even in two. It took several semesters, perhaps six, to develop a passable standard of writing, partly, indeed principally, because the writer (being a typical engineer) had been trained to write matter-of-fact reports that proceed in a logical step-by-step manner.

On the other hand, an attractively readable short story should have a problem situation (easy, that is what the case is about), some conflict (which can become part of the problem), some suspense (more difficult in the teaching context), some realistic characters (why not? they are all around us), all put together in a narrative surrounding some scenario. All of those features are intended to enable the reader to identify with what is described. Now, it may be argued that this is exactly what a case study is, particularly the last point, for the basis of case study discussion is that students are expected to deal with the problem as if it were their own. But reading the majority of those published shows that they fall far short of having those features, thereby not achieving *identification* between students and the problem.

The starting point of the new case studies was the scenario, a fictitious company – but one with the characteristics of many large companies in which the engineering students worked, in particular a chemical manufacturer, with the cases based on the lecturer's experience in that industry. Indeed, the reason for selecting that industry was, simply, the author's familiarity with it. The essential features (for illustration and assignment purposes) of each case were devised to attract the students' interest, with each case being based in a technical environment with an engineering background-problem and characters, and containing an immediate close-at-hand management problem, which was surrounded by a broader management problem. One of the incidental spin-off benefits of the scenario to the students was that it introduced most of them to an unfamiliar industry.

Essentially, the triple-dimension problem was further solved by making each semester of the case studies a continuing series, with the ten cases in any semester forming a continuing narrative for both illustration and testing. This is an innovative concept that appears not to have been used elsewhere in undergraduate programmes or elsewhere. While one reference mentions a *sequential* form of cases, no examples have been found in the literature for use [8].

As already mentioned, each case was used to illustrate a feature of management, and also served as an assignment from which a decision had to be made after the analysis. The first five or six cases, in each semester, ended with a suggestion indicating the principal decision-problem in the case, but by the time the class approached the semester's end (usually case number 7), any explicit indication was omitted, with the problem and decision only to be inferred from the narrative, so students had to decide what the problem was, how it should be solved and what they should try to express. The reasoning behind that was that managers in the *real world* are expected to find their problems, not have them given in plain language. Somewhere, there was, sometimes, an unpleasant decision, which was a realistic practice run at what managers must do, not very often, but sometimes.

The continuous sequence concept was extended by joining semester-series to semester-series. This was actually thanks to a student who, after dealing with the earliest series, asked: *what happened after this?* He was told to come back and repeat the subject next semester (he declined the invitation), and the cases became a continuing series of series, with characters following through in the same (fictitious) company. There were, finally, 11 series, each of 10 case studies, yielding a total of 110 cases. Each of the case studies have been written for, and used by, undergraduate engineering students and contain components, including a spirit of adventure [17]. This is believed not to be found in the general run of those published.

Summing up with a most important point, the nature of the problems in these cases was that the student was required to use judgement, of which they learn little in an engineering course [18]. *Pure, science-based*, engineering problems tend to be factual and numerical, that is, skills-based and knowledge-based, with relatively little need, if any, to use judgement. Contrawise, much (if not most) of management requires use of that very-human facility, and the cases put that to students, week after week.

#### THE PROCESS OF WRITING THE CASES

On the one hand, this was an easy task because they were set in a familiar industry, using characters and situations from memory. Indeed, to be quite honest, they were based on real-life situations, experienced and observed personally, or reported by contacts. On the other hand, a six-page short-story-serial with a deadline every week for ten weeks was quite a task, as was devising a new series semester after semester. Indeed, the author believes that he should be pardoned for repeating some series.

The overall scenario was a large, old and staid, multinational company, stagnating as such do, and in which the chief executive wished to boost the firm back into life before he retired, so he decided to get a contentious project approved to serve as a training ground for a new generation of managers.

The overall plot followed through several years, beginning with a group of young managers trying to get approval for the project and fighting rejection by the directors of the firm (unaware that the chief executive was backing the project), they obtain approval for the project, build the factory, commission it (after which they find money was leaking from project accounts during construction), through the first year of operation, to conflict a few years later when Head Office insisted on increased production, to an accident series after the modifications and a change of factory management, all demonstrating that management problems do not come in isolation and that the manager's task is of a continuing nature.

Overall, there was background board level power struggle, of which the young managers out in the factory were dimly aware, but about which they could do nothing. The characters vary as widely, from the Chief Executive down to trades assistants, with a couple of students in the factory on work experience, (providing characters with whom the class could identify), and a university lecturer acting as the organisation's consultant.

Some matters apparently unrelated to the case were included, week-by-week, events and situations going on around one or more of the key characters in one or more of those surrounding areas. As examples, at *appropriate* times babies arrived, at a most inappropriate and inconvenient time, the factory engineer had to go into hospital; there was also a hint of an affair between the production manager and a maintenance foreman (noticed by only one student in the class!). Those additions may have seemed to be padding in the six pages of each case, but they were an indication of the apparently irrelevant *things that happen around a manager*.

From a literary viewpoint, all have strictly contrived plots; in fact, a critic would describe them as examples of the worst type of formulaic writing. That is because each series follows the same outline, which is the outline of the lecture series syllabus, the same outline as the author's text follows: management resources, decision techniques, and tasks/functions [19]. This, actually, follows real life: much of a manager's work is repetitive, day after day: at least 90% is boring, and with luck 10% is interesting and exciting. Having *been there* was great help in generating all that description.

Of all of the 11 series, seven have been used more than once, and each has been revised, cleaned and firmed up, before re-use. The seven revised series have been expanded into book format by adding a considerable amount of material that had to fit, logically, as part of the *story*, and serve as a useful outline of what goes on in engineering middle-management [20-26]. A few hundred copies have been sold, mainly to students.

## INDICATORS OF SUCCESS

The above indicates how the assignment series has simulated much of the real world engineers' work situation. The test of its effectiveness is shown by excellent student responses to it, many saying openly that they identify with the situations and the characters, even recognising some. Students have asked: *Do you know X* (naming someone where the student works)? Also: *Have you ever worked in Z Pty. Ltd* (naming where the student works)? The answer, always, has been: *Sorry, no*. This is believed to be important as success with the *acceptance* criterion. This has also led to a strong impression that there is much stereotyping in management

Nearly all of each class began by working only on the obvious and explicit question, the one that was stated in the first few, just as the recently-promoted engineer concentrates on work in his/her own defined area-of-influence.

As the class progressed, a reasonable proportion of students woke up to the importance of thinking outside the immediate work-environment and attempted to deal with wider issues, just as the experienced engineer-manager tries to pay attention to the next area around him/her, then to the one outside that. In such a short subject, the class could not progress to the outermost area of management, with only remark that the community *exists*.

Responses to the serial format were similar to the way in which the young engineer-manager learns from and *gets into* his/her new position; on day 1, he/she is introduced to the place and the people, and forms initial opinions; then, as the weeks pass, he/she gets more information and slowly (or rapidly, depending on the individual) achieves rapport with others, adjusts to and becomes comfortable with the general work situation.

It appears that reaching the *comfortable condition* with the series was, as in real life, related to getting to know the people that they were meeting in the assignments. So, just as one feature of the semester series caused the student to realise his/her management activities will be beyond his/her immediate geographical work area, another feature simulated the entry of the new manager into a new work group.

The best measure of success is by numbers: the surveys by the Centre for Learning and Teaching consistently showed high scores and, in one Autumn semester, as others learned of the subject (purely by word-of-mouth advertising), there were more students in the class from other schools and faculties than from the School that provided the subject.

The author measured changes in attitude to management in the students, in particular, by the Reddin Management Style Diagnosis Test, which was used several times at the beginning of the semester and at the end [27]. No precise analysis of the results has been made, but a comparison of the *before* and *after* styles indicated that change occurred in more than half of the students, generally in the *more effective* direction of management.

## ACKNOWLEDGEMENT AND THANKS

It would be remiss not to acknowledge the help of the compelled and captive audience, who gave critical feedback semester after semester. They all deserve thanks, even though their comments have had widely varying pH, some acid, some caustic, most sweet. Many of the twists and turns of the plot action were inspired by student comments, which, perhaps, show an unexpected quality of imagination as well of management development.

In particular, the assistance of R. Shapiro, who provided a copy of his most informative but unpublished paper on case studies, is also gratefully acknowledged.

The above case formula worked well through about ten semesters, which leads to the essential question: *why?*

## SOME CONCLUSIONS

The conclusions are based on a limited use of case material, but observations have also led to the following conclusions described below.

The overall general conclusion is that case studies are an effective means of presenting management problems, but, in addition, the author believes that what is required to make case studies both effective and acceptable, probably to all but especially for engineering undergraduates, is that they should contain more than one problem to make the student consider a number of parallel issues. Also, for engineering students, they should involve engineering-related management-issues. The combination of multiple problems and improved readability are needed *to bring the case to life*.

Both of these factors, it is believed, are essentials in getting the student's interest and, from that, the necessary *identification* with the problem.

But the major reason why they were successful was that they were written in an *entertaining* manner, so that by the second or third week of each semester, the class was looking forward to what would happen next, enjoying the week's reading as well as learning from it. The final, mostly pocket-book-size, printing, was provided to students at the end of semester, with ref. [20] the only one that was not of pocket-book size [21-26].

As a final point, it should be noted that it does appear that the case method of instruction, being intended for judgemental decision-making via a discussion of uncertainties, has limited application in *straight* engineering subjects.

## REFERENCES

1. Kolb, D.A., *Experiential Learning*. Englewood Cliffs: Prentice-Hall (1984).
2. Smith, C.O., *Diesel to Detritus*. Terre Haute: Engineering Case Library (1977).
3. D'Antonio, C. and Smith, C.O., *The Limp Ladder*. Terre Haute: Engineering Case Library (1981).
4. Kletz, T., *Learning from Accidents in Industry*. Tiptree: Butterworth and Co. (1988).
5. Kletz, T., *What Went Wrong? Case Histories of Process Plant Disasters* (2<sup>nd</sup> edn). Houston: Gulf Publishing Co. (1988).
6. Petroski, H., *To Engineer is Human*. New York: St Martin's Press (1985).
7. Commonwealth Public Service Board (CPSB), Training Section, Notes on the Use of Case Studies. Canberra: CPSB (1965).
8. Shapiro, R., Cases as an Instructional Tool in Management Education. Unpublished paper; contains 34 references on the case study teaching technique. Undated.
9. Hunt, J.W., Entrekin, L.V. and Popp, G.E., *Administrative Analysis Text and Cases*. Sydney: McGraw-Hill Book Co. (1977).
10. Christensen, C.R., Andrews, K.R. and Bower, J.L., *Business Policy Text and Cases* (3<sup>rd</sup> edn). Burr Ridge: Richard D. Irwin (1973).
11. Stenzel, A.K. and Feeney, H.M., *Learning by the Case Method: Practical Approaches for Community Leaders*. New York: The Seabury Press (1970).
12. Swenson, C.S. and Holland, P.J., *How to Analyse and Write Case Study Reports*. Palmerston: Dunmore Press (1986).
13. Ronstadt, R., *The Art of Case Analysis. A Guide to the Diagnosis of Business Situations*. Dover: Lord Publishing (1980).
14. Cranfield Institute of Technology. *A Degree of Understanding* (video). Cranfield: The Case Clearing House (1989).
15. Anderson, P., Personal correspondence with that author (1987).
16. Knight, D., *Creating Short Fiction*. Cincinnati: Writer's Digest Books (1981).
17. Ward, R.B., Adventures in engineers' management. *Proc. 1<sup>st</sup> Annual Convention and Conf. of the Australasian Assoc. for Engng. Educ. (AaeE)*, Sydney, Australia, 75-80 (1989).
18. Ward, R.B., Educating judgement. *World Trans. on Engng. and Technology Educ.*, 2, 2, 201-204 (2003).
19. Ward, R.B., *The Engineering of Management* (2<sup>nd</sup> edn). Sydney: University of Technology, Sydney (1997).
20. Ward, R.B., *A Plant for Appropriate Technology*. Sydney: University of Technology, Sydney (1991).
21. Ward, R.B., *A Project in Ammonia*. Sydney: University of Technology, Sydney (1996).
22. Ward, R.B., *A Commissioning in Ammonia*. Sydney: University of Technology, Sydney (1996).
23. Ward, R.B., *A Beginning in Ammonia*. Sydney: University of Technology, Sydney (1987).
24. Ward, R.B., *A Shutdown in Ammonia*. Sydney: University of Technology, Sydney (1987).
25. Ward, R.B., *A Hazard in Ammonia*. Sydney: University of Technology, Sydney (1988).
26. Ward, R.B., *A Murder in Ammonia*. Sydney: University of Technology, Sydney (1989).
27. Reddin, W.J. Management Style Diagnosis Test (2<sup>nd</sup> edn). Fredericton: Organisational Tests (1977).