INDUSTRY PROJECTS IN STATISTICS

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Industry projects in the final year of the Bachelor of Science (Computer and Mathematical Sciences) degree have been conducted at Victoria University of Technology for many years. The projects involve working on a real problem for an industrial, commercial or government organization and are conducted by small groups of students each under the supervision of an Academic staff member. Many of these projects are of a statistical nature such as statistical analysis of data, time series forecasting, quality improvement studies, econometric modeling or design and analysis of experiments. In this paper we describe the projects in detail and present support materials, adapted from previous statistically based projects, that we use to help the students to benefit both technically and professionally from the project experience.

INTRODUCTION

Victoria University of Technology's Department of Computer and Mathematical Sciences, from 1998 a section of the School of Communications and Informatics, has used final year Industry projects as a central part of their degree program since 1975. In particular, students undertaking a Computer and Mathematical Sciences degree with major studies in statistics do two one semester projects.

Students operate in groups of two, three or four under the supervision of a staff member and tackle a problem for a company or organization. Typical statistical projects involve statistical analysis of data, time series forecasting, quality improvement studies, econometric modeling or design and analysis of experiments.

CONDUCT OF INDUSTRY PROJECTS

Setting up of Projects

Before the project is began preliminary discussions are conducted between the Project Director and the particular organization involved concerning the broad nature of the project. Selected projects should be important (but not critical) to the company and realistically achievable by final year students in the time available. Ensuring sufficient projects are available is an ongoing task for the Director. Participating organizations are those that have previously had projects, connected with past students of the course, obtained from consulting contacts and even from combing newspaper advertisements recruiting graduates for statistically based work.

Each project has a Academic supervisor attached to it. Supervising projects is not an easy task for many staff members since supervisors must lead a team of inexperienced students on sometimes technically difficult tasks while dealing with a variety of industry sponsors. The Project Director has an important task of acting as a mentor to supervisors.

Orientation

Preparing students for the Industry projects is very important. Initially students are shown how to prepare for the first visit to the sponsor. The aim of this meeting is to introduce themselves to the sponsoring organization, to find out about what the organization does and the objectives and scope of the project. It is emphasized to students that they need to be prepared and flexible as no meeting will go exactly as envisaged and that they must listen carefully, take notes and ask appropriate questions.

Preparation of Project Specification

Errors of the third kind (Kimball, 1957) sometimes occur so the importance of properly defining the project is emphasized. We have prepared sheets and checklists for this and other tasks that need to be done during the project. We also provide examples of good and bad project specifications which we have adapted from previous projects. They are used by students as models when they prepare the specification to their own project. One of these models is given below. The draft specification is then submitted through to the project sponsor via the supervisor and made final at the second visit. This visit also gives a chance to check anything not understood at the first meeting.

Project Conduct

In almost all cases the conduct of the project is done at VUT. A Computer Lab and classroom is made available two days a week for project activities. Project groups meet with their supervisors one hour each week to describe their progress and plan for the next week. Students are expected to spend about 100 hours per semester on the project.

Project Title: A Computer Program to simulate the effect of statistical variations in Delay Detonator timing in out of Sequence firing.

Background and Description: ABC design, manufacture and supply detonating systems used in the mining industry. In order to maximize the rock-breaking efficiency of a blast, 'delay' detonators with various nominal delays are used to detonate blastholes charges in a controlled sequence. Statistical variations of the delay times of the detonators cause some blastholes to detonate out of sequence, lessening the efficiency of the blast. The purpose of the project is to assist in the designing of blasts by writing a computer program that will simulate blasts, allowing the quantification of the effect of the statistical variations on the chance of out of sequence firing.

Aim/s To design and program a user-friendly PC based system that will allow the input of the parameters of delay time distributions and output the chance of out of sequence firing for various types of blast designs.

Method

1. Agree on project scope and aims with ABC.
2. Develop a mathematical model of a blast.
3. Design and write the program using a suitable language.
4. Test the program
5. Write a User manual and train the user in the use of the program

Progress Talks

Students need to orally report to their peers and supervisors at least three times for each project. The first project talk occurs soon after the second visit to the sponsoring company and concentrates on outlining the project. The second talk occurs about five weeks later to present what has been done and what will be done to complete the project. The final project talk occurs during the final week of semester and is quite often attended by project sponsors. At each talk students are required to provide an abstract. Again examples adapted from previous projects are provided for students to imitate. One of these model abstracts is given below.

Project Report

At the completion of the project students need to prepare a project report for the sponsor. Each project report must have an Executive Summary which provides an overview of the work done in the project with conclusions and recommendations. Edited models of past reports are provided to students to assist them in preparing their own report.

Measurement Systems Variation at XYZ

The quality of products produced by XYZ is directly related to the accuracy and precision of the measurement devices used in production. Three methods of analyzing measurement variation have been used by XYZ but since there has nor been an analysis of the statistical properties of the three methods there does not seem to be a rational basis for preferring one method over the other.

The purpose of the project was to develop an approach to study the statistical basis of the three methods so that their relative merits could be established. Using Taylor Series and Bootstrap approaches we show that the 'Long' method has over twice the precision as the 'Short' method. The 'U.S. Body and Assembly' method gives an unbiased estimate of the precision only if there is no interaction between Operators and parts.

In our talk we will describe the background and aims of our project, outline the work that was done, draw some conclusions and make some recommendations based on our project. Specifically we will outline further refinements to our methods that would provide comparisons of the U.S. Body and Assembly method with the other methods and evaluate the methods with a range-based rather that an ANOVA-based estimate of precision.

Assessment

Assessment of the projects is always difficult. Our current practice is to award 10% for the specification, 20% for the second and final (but not the first) presentation, 20% for the draft report and 50% for the solution. This latter component includes methodology, initiative, conscientiousness and teamwork, progress reports and recommendations and conclusions. Since much of this marked by the individual supervisor the Project Director moderates the marks so that all groups are treated as fairly as possible. Most of the time all students in a group get the same grade but occasionally an individual student will be given a higher or lower grade.

SOME EXAMPLES

The following titles give some idea of the breadth of areas in which our students have done projects. In many cases larger projects are accomplished by setting intermediate goals for a number of consecutive semesters.

- Designing Industrial Plant Trials for Particle Boards.
- A Statistical Analysis to Identify the Existence of Peak Spreading on Urban Traffic Flow.
- A Study of Methods to Reduce the Variability of Octane Levels in Reformate at a Refinery.

- Quality Investigation of an Automotive Test Rolls System.
- The Relationship Between Returns in Australian and Long Term Bonds.
- The Determination of the Statistical Variation in Paper Properties of Fibre Boxes.
- Optimization of Urea Formaldehyde for Particle Board Manufacture.
- Daily Short Term Parking Related to International Flights at Melbourne International Airport.
- Forecasting Daily Gas Demand.
- The Design and Analysis of a Hospital User Satisfaction Survey.
- Limits of Explainable Variation in Road Crashes.
- Optical Density and Grammage of Paper.
- Quality in Photographic Film Manufacture.
- Process Capability Studies of Gas Meter Components.
- Forecasting Worker Absenteeism.

CONCLUSION

There are many ways of teaching students to *practice* statistics (e.g. Anderson and Loynes (1987), and all have their place in the undergraduate curriculum. We believe that Industry Projects is one of the most effective of these ways. However the students doing projects need support if they are to most benefit from the projects. The materials we have developed did not take much time to adapt from previous projects and yet they have been found to be invaluable in helping students to achieve their project goals and also prepare for full time employment.

REFERENCES

Anderson, C. W. and Loynes, R. W. (1987). *The Teaching of Practical Statistics*. John Wiley and Sons: New York.

Kimball, A.W. (1957). Errors of the Third Kind in Statistical Consulting, *Journal of the American Statistical Association, 57*, 133-142.