

# **Statistical Methods of Quality Assurance - A New Correspondence Study Programme for Engineers and Industrial Managers**

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## **1. The growing need for continuing education and professional training in quality assurance**

During the last decade, industry has put increasing emphasis on quality. Intensified competition on the market forced companies all over the world to focus on improving product quality. At the same time advances in computer technology allowed the use of relatively cheap and powerful hardware and software for quality control. More and more enterprises realise that a high standard of quality is an essential requirement for long-term success and are investing large amounts in the development of inhouse quality assurance departments. Consequently the number of people working in the field of quality assurance is increasing. Since most of them do not have any prior knowledge in this area, neither from their undergraduate or graduate education, nor from any other sources, they need to acquire a basic understanding of quality assurance while at work. Hence there is a large demand for continuing education and professional training.

## **2. Audience and objectives of a new correspondence study programme**

All industrialised nations have Associations for Quality Control that offer professional training. In the Federal Republic of Germany there is the "Deutsche Gesellschaft für Qualität" (DGQ, "German Society for Quality") that regularly offers seminars for skilled workers, technicians and engineers. The training material used by the DGQ was developed by practitioners for practitioners and, therefore, deals only with those quality control procedures already established and applied in industry. Most of the procedures are described in a recipe-like style and the theoretical background is partly omitted.

Besides the DGQ, there is an increasing number of smaller private institutions that have discovered the profitable market of professional training in quality control and offer seminars for high course fees. The instructors at these seminars are also mostly practitioners from large companies.

So far, German universities and technical colleges offer only a few and sporadic courses on the subject. Contrary to the Anglosaxon areas there is also a significant lack of didactically well written textbooks or monographs with emphasis on the theoretical aspects of quality control.

Under these circumstances the FernUniversität Hagen decided to develop a course in quality assurance which couples practical applications with academic requirements. Since the course is offered by the Department of Statistics and Econometrics, it seemed appropriate to focus on the statistical aspects of quality control.

In order to give an idea of the audience for which this course was designed, we need to say a few words about the University of Hagen structure and its student body. The FernUniversität offers correspondence study programmes and since its foundation in 1974, it has experienced a fast growth to a total enrolment of 41,000 students during the academic year 1989/90. These students were enrolled in the faculties of Economics (45.4%), Mathematics and Computer Science (29.6%), Electroengineering (8.4%), Education and Social Sciences (16.6%) and Law (2.7%). There are three different categories of students:

- (i) *Full and part-time students (67.4%)*: These are students working towards an academic degree. Within this category part-time students are dominant. Most of these practice a profession and hence can only study with a reduced course load.
- (ii) *Certificate students (23.8%)*: These students do not work towards a degree and only select specific courses. They obtain certificates for successful course completion. As above most students in this category have a job.
- (iii) *Visiting students (8.8%)*: Students in this category study at a traditional university and enrol only for selected courses at the FernUniversität Hagen.

The course "Statistical Methods of Quality Assurance" was designed to address the three groups simultaneously, specifically:

- (i) within the group of full and part-time students: prospective managers who study Business and Economics and select statistics as a major;
- (ii) within the group of certificate students: professionals of all kinds who are involved in quality assurance in their companies (engineers, technicians, industrial managers);
- (iii) within the group of visiting students: prospective engineers and managers who are enrolled at traditional universities that do not yet offer courses in quality assurance.

As can be seen the new programme was aimed at a very heterogeneous audience, i.e. students without any professional work experience as well as employed persons working in quality control related areas. In order to accommodate all this, the concept of the new programme had to satisfy the following general requirements and didactic guidelines:

- (i) *Suitability for self study:* The course had to be a complete introduction to statistical quality control. This objective required the material to be self-contained, to avoid any unnecessary abstraction, and to offer opportunities to practice and repeat work in order to ensure adequate understanding.
- (ii) *Combining academic standards with practical applications:* The course material needed to focus on practical applications without having the character of a recipe collection. Nowadays anybody who is responsible for quality assurance will need to know more than mere descriptions of procedures that omit the theoretical background. One actually needs to have a solid overall picture of the range of procedures and a good understanding of the basic statistical theory involved. This knowledge is crucial in order to use today's possibilities of automated data processing correctly and efficiently.
- (iii) *Transmission of new research developments into practice:* In addition to the standard procedures the course should also present results of recent research in order to encourage their practical application. For meeting this goal a detailed presentation of selected results from recent research had to be included. Further questions and aspects regarding recent developments as well as references to journal articles have the purpose of facilitating the process of transmission.

### 3. Programme content and components

The FernUniversität teaches mainly through the medium of written study materials which are occasionally accompanied by audio cassettes or videos. In the near future supplementary computer exercises will also gain more importance. To take this trend into account the option to use multimedia was included in the initial design of the new course in statistical quality control.

*Written media:* The core of the study programme is a course "Statistical Methods of Quality Assurance" that was designed by Professor Rinne (University of Gießen) and myself. This course was completed in July 1989 and consists of four study units that altogether require an estimated 130 hours of student work.

The first course unit presents the technical and industrial aspects of statistical quality assurance and the most important basic terms. This is followed by an introduction to the statistical instruments that are used in quality control (discrete and continuous distributions of quality characteristics, theory of testing statistical hypotheses). The subject of the second unit is acceptance sampling by attributes and by variables. Besides single, double and multiple sequential sampling plans, some of the sampling schemes which are widely used in practice are also presented. The third unit is dedicated to statistical process control. It starts with an outline of theory and practice of continuous sampling plans. Afterwards process control by means of control charts is discussed in detail. Besides the classical memoryless SHEWHART control charts a few less well-known control charts with memory are presented. The fourth course unit has the character of an appendix. It contains statistical tables, detailed solutions to the numerous exercises, commented references to further reading, an index, etc.

The progress of learning during the course is monitored through assignments. In order to get a certificate, students who successfully pass 50% of the submitted assignments can take a supervised written final examination.

*Audiovisual media:* The written material is supplemented by videos. These films are designed to illustrate central terms and concepts of the correspondence study course. So far, three films are available, two on acceptance sampling (offline quality control) and one on process control (online quality control). The theoretical concepts illustrated in these films are based on examples from industrial applications, i.e. fill-weight assurance in the process of packaging biscuits or controlling the diameters during the manufacture of piston rings.

*Interactive media:* At the moment, the personal computer has the role of a supplementary medium, mainly because not all students in the correspondence programme have access to a PC. As with the videos, the aim of computer-based exercises is to illustrate basic concepts of the subject. At the moment, computer exercises about process control by means of control charts are in development, and it is planned to offer these computer disks to interested course participants from 1991 onwards. The exercises can be done at home by the student and involve working with didactic data sets, as well as real data from industrial practice. With the help of these, or possibly their own data sets, classical as well as alternative quality control charts can be introduced and the students can graphically display these and the relevant test statistics.

#### 4. First experiences with the programme and an outlook on future developments

When the course was first taught during the autumn semester 1989/90, the enrolment was 248 students with a relatively small number of visiting students (only 24.6%). As soon as news about this programme begins to spread more widely, we expect a significant increase in visiting students. A textbook version of the course was published in October 1989 which means that the written material is now accessible to anybody. We are hoping that the course will play an important role in the intracorporation training programmes of large companies. The advantages for the employers are obvious, since conventional seminars are expensive and time consuming.

In order to evaluate the course and to get some comments, suggestions and feedback, we gave all students the opportunity to submit their experiences with the written study materials and to suggest modifications, but unfortunately only 3% responded to the questionnaire. Based on this low proportion of responses, it is difficult to draw general conclusions, but according to the comments which were received, the didactical concept got positive feedback and the level of difficulty was rated adequate. Also, students would have preferred an even stronger emphasis on applications and more examples from different areas of industrial practice.

During the coming years the development of this course programme in quality assurance will, besides strengthening the practical side, focus on two objectives:

- (i) *Integration of the programme into a European education programme:* The FernUniversität Hagen is a member of the European Association of Distance Teaching Universities (EADTU), which has the aim of encouraging European cooperation in the area of multimedia correspondence study. The university is also involved in an association named SATURN (scientific and technological updating through remote networks). Within the framework of these partnerships we intend to offer an English

version of the course "Statistical Quality Assurance" in different European countries. The translation of the study material started in spring 1990. In the first phase the translated course is planned to supplement a quality management programme which has already been partly developed in England at the University of Bradford and the Sheffield City Polytechnic.

(ii) *Development of an online version of the course:* As explained before, in the short term, the development of PC-based exercises is intended as a supplement to the course. In the long term, however, the goal is to give the PC a more important role. This could be achieved by offering the option of accessing the written components of the course through an electronic communications network. At the moment the Fern Universität Hagen is running a pilot project that tries to offer complete courses online, with the goal of creating new interactive forms of learning and making students independent of the rigid rhythm of receiving study material through the mail.

## 5. Final remarks

Technological developments are influencing the education and training programmes in quality assurance in two ways. A solid general view of the subject and a good understanding of the basic concepts, as well as knowledge of development trends, are becoming more and more essential. Nowadays technical details become rapidly outdated and long numerical derivations are fading into the background, hence losing their previous importance. Technological progress not only affects the material that needs to be learned but it also sets new standards for efficient communication of knowledge. In order to meet both these demands, i.e. modernisation of the curriculum and increasing use of new media, the cooperation and joint planning of different educational institutions needs to be intensified on a national as well as international level. If coordination begins at the first stages of designing new educational programmes then there will be a better chance that the various programmes, which are designed at different places, will grow together into a large network.