Journal for Geometry and Graphics
Volume 3 (1999), No. 1, 93–98

The Future or Graphical Communication Education in the New South Africa

Johann Pretorius

Mechanical Engineering, Rand Afrikaans University
PO Box 524, Aucklandpark, 2006 South Africa
email: jp@ing1.rau.ac.za

Abstract. This paper discusses the course in Graphical Communication at the Rand Afrikaans University. Not only the teaching method and the course and lecturer evaluation are presented in detail, but also an outlook on future possibilities concerning research, teacher education and curriculum development is given. One of the main educational problems is the very low level of spatial perception in the historically disadvantaged communities in South Africa.

Key Words: Graphics Communication, Descriptive Geometry education

MSC 1994: 51N05

1. Introduction

The contents of the first year engineering course Graphical Communication, includes various important components such as spatial perception, machine drawings, descriptive geometry and computer aided drawing. An independent body does course and lecturer evaluations on a semester basis to identify any possible problem areas. Teaching methodology's used during the course are also investigated and analysed in order to derive new methods to improve and maximise the spatial perception learning ability of students. Problem areas are identified and addressed by adapting the course to suit the needs of the Engineering Council of South Africa and the general engineering industry.

Student evaluation methods are investigated and recommendations are made to solve the problem of students with varying spatial ability at entry level. Problem learners are currently identified at an early stage during the course so that extra remedial classes, using three dimensional objects and computer aided solid modelling packages, can be scheduled to improve these students ability and understanding. Combining all of the above mentioned elements into a first year course together with future possibilities such as research, teacher education and curriculum development to conform to the outcomes based curriculum 2005 program, necessitate very careful time management and planning.

ISSN 1433-8157/$ 2.50

2. Boundary Conditions

Even though South Africa, like the United States of America, is a relative young country when compared to countries from Europe, it boasts with eight engineering faculties at universities throughout South Africa. Engineering is further taught at eleven technicons where students would complete their studies to receive a diploma in engineering. All of these facilities have courses in technical drawings and descriptive geometry but the total amount of courses and the contents thereof may differ from institution to institution. To ensure that standards of education at these facilities are kept at the highest possible level, all the educational institutions are visited by the Engineering Council of South Africa every five years, to accredit their complete engineering educational program.

The Rand Afrikaans University (RAU) has six faculties including the Engineering faculty where Electrical, Mechanical and Civil engineering disciplines are taught. All students follow the same syllabus for the first eighteen months of their study in engineering before specialisation takes place. During the first year of study two of the six courses taken by first year engineering students are engineering orientated courses consisting of Introduction to Engineering and Graphical Communication.

Svensen [1] said, *"Drawing is a language, the oldest language and the one universal language. It should be recognised as a language and should be taught as a language."* Traditional drawing education has up until very recently been done mostly on drawing boards. Technology and the everyday use of computers has led to computer aided drawing and design which has become so popular, that computers are utilised as an educational tool of great importance. This is the way in which the course Graphical Communication is currently being taught at RAU by combining traditional drawing on drawing boards with computer aided drawing and design packages.

Computer packages are not only used for creating drawings but are also used as a visualisation aid. Miller [2] noted that a course taught in solid geometry should be considered as a prerequisite for a course in drawing as it would form the foundation for visualisation. Using modern solid modelling computer packages at RAU an attempt is made to enhance the learning ability of problem learners when coupled with orthographic view completion problems.

Until recently, very little descriptive geometry, sketch work or any technically orientated subjects were being taught at elementary school levels in South Africa. Secondary schools provided scholars with the opportunity to select their own subjects which could include drawing or some technical subjects. The scholar however is not complied to take such subjects irrespective whether or not he/she wishes to study engineering after completing school.

3. Graphical Communication as Course

The year course in Graphical Communication is taught to all disciplines of engineering students during their first year of study. Approximately half of the students enrolling for the course in Graphical Communication had never been introduced to sketches or any form of technical drawing whatsoever. Half of the remaining students had taken technical drawing as a school subject from grade eight to grade nine while the remaining students have a very good basic understanding as they had completed school with technical drawing as one of their final year subjects.

Because of the above mentioned factors the education level of first year engineering students pertaining to spatial perception, technical drawing and descriptive geometry vary immensely. This makes the task of the lecturer much more difficult, especially in the beginning of the first semester as half the class could easily become board while the other half fails to understand anything. Currently the RAU course content in Graphical Communication consists of the following:

- Introduction to Spatial Perception
- Oblique Planes
- Dimensions
- Tolerances
- Manufacturing Techniques
- Sections
- Machine Drawings
- Assembly Drawings
- Descriptive Geometry
- Computer Aided Drawing

The course is presented throughout two full semesters, which consists of 28 weeks in total. Theoretical classes are conducted in one lecture of forty minutes per week followed by a three and a half hour practical session where students complete assignments selected from the text book *"Engineering Graphics"* of Giesecke et al. [3]. Homework assignments consist of free hand sketches and completion of views typically of the same magnitude and difficulty as problems found in the book *"Technical Drawing Problems"* by Spencer et al. [4]. It was found through experience that one lecture per week to introduce new concepts and a long practical session with knowledgeable help available to the students, presented the best possible results. Student involvement, class attendance and an overall better understanding of the work measured these results.

Two semester tests are written during the first semester of which the first test is based on knowledge gained on spatial perception, basic drawing skills, tolerances and dimensioning techniques. The second semester test includes all previous work up to and including machine drawings and students are required to complete a machine drawing drawn in either first or third angle orthogonal projection of given mechanical isometric figures.

A student requires a minimum semester mark of forty percent for the first semester to be able to continue with the second semester. The semester mark is calculated using the homework assignments, practical assignments and semester tests. The second semester mark is calculated in the same manner as the first semester mark and the average of the two marks taken to provide a year mark. The final exam is written on all the work done throughout the year and usually consists of the completion of a partially finished working drawing, the completion of an assembly drawing and one or two descriptive geometry questions. A typical descriptive geometry question could be seen in Fig. 1.

After successful completion of this course in Graphical Communication the students continue studies in technical drawing in the second semester of their second year in a course labelled Design 2B.

4. Student and Course Evaluation

All first year students that enrol at RAU must complete aptitude tests compiled by the Human Science Research Council [7]. These tests also include spatial 2-D and spatial 3-D tests as two

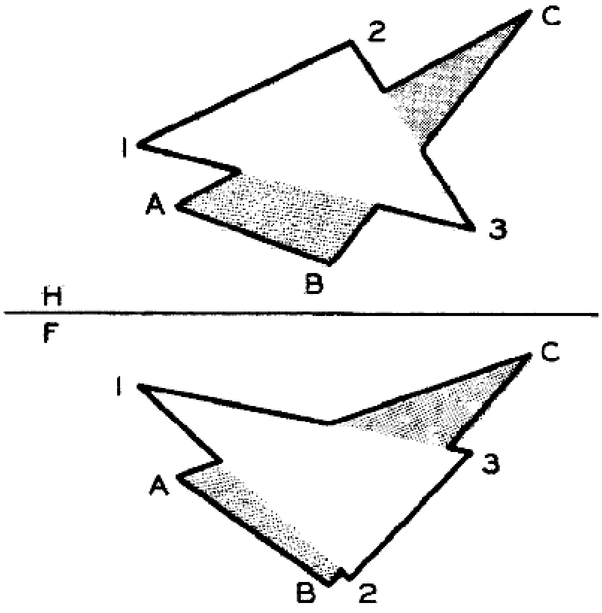

Figure 1: Indicate the intersection of the planes ABC and 123 by using the projection method EARLE [5]

separate tests. Each question in the spatial 2-D test consists of five figures, of which one does not fit in with the others. Visualisation of rotation in a two-dimensional space is required. This test measures the Visualisation Factor (Vi or Vz) rather than the S-Factor, Spatial Relations or Spatial Orientation. The latter does not require the spatial transformation of a configuration, but rather the ability to recognise an object when viewed in different positions or from different angles as described by PAWLIK [6]. On the other hand, this test requires the ability to visualise the final result of a rotation or movement of a configuration as can be seen from Fig. 2.

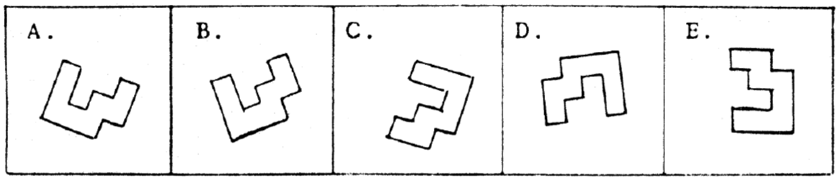

Figure 2: Two-dimensional visualisation of rotation test [7]

The 3-D spatial tests consist of two sections of which in each item in the first section the testee has to choose from a group of five drawings of three dimensional blocks, the one which exactly fits on to another given block as can be seen from the example given in Fig. 3. Each item in the second section consists of drawings of five rotated cubes. The testee has to indicate the one block or cube which does not belong with the other four. This test measures the General Reasoning Factor R and the Visualisation Factor Vz. Results of both these tests are used to identify problem learners for whom remedial and extra classes can then be scheduled.

Course content and lecturer evaluation are done regularly by the Bureau of University Education. This evaluation is done by means of a nameless questionnaire given to all students to complete. An analysis is then done of the student feedback and the global results is given

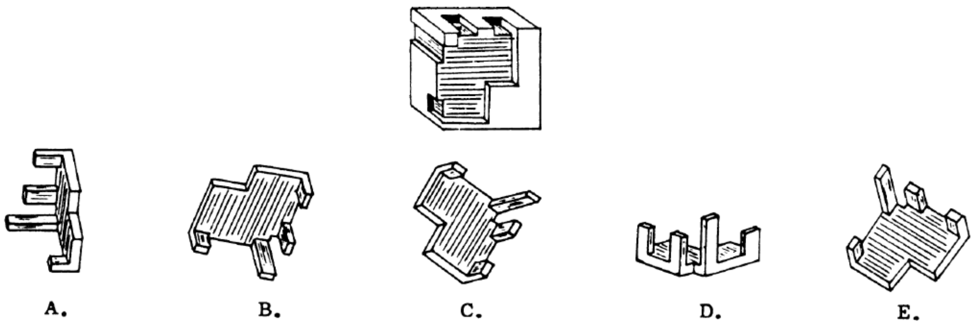

Figure 3: Three-dimensional spatial test [7]

back to the lecturer, head of the department and the dean of the faculty. Course content and teaching methodology is then adjusted if necessary to achieve better results keeping in mind that the course still has to comply to the standards of the Engineering Council of South Africa.

5. Current Developments

The need for research into spatial perception and three-dimensional understanding was identified after attending the previous conference in Cracow, Poland in 1996. Since then, some research work has been established in the field of spatial perception ability of learner pilots and problems that flight training schools may encounter during training.

The mechanical engineering and optometry departments at RAU are currently investigating the possibility of a joint research field to establish a relationship, if any, between students with spatial perception learning problems and eye-related problems. An article [8] written by Slaby triggered interest for this investigation.

The Engineering Faculty has recently started with a course, Introduction to Graphical Communication for grade 12 scholars to encourage them to study engineering and to try and create an awareness of spatial perception and its importance in a growing technical society. Coupled with this course RAU is currently breaking new ground considering the teaching of engineering through distance education. Although distance education in engineering is still in the planning stage, RAU strives to be the first university in South Africa to be able to provide students with this method of learning.

Teaching methods and course curriculum currently used at tertiary institutions cater only for engineering students, excluding many people form understanding spatial perception. The future of the new developing South Africa depends on technically skilled people and innovative methods based on a sound scientific and engineering background. Until recently there had been a lack of technical orientated subjects in the pre-tertiary schooling system which has led to the incorporation of a new subject labelled Technology. This subject has been introduced into the school system since the beginning of 1997 implying that components of Graphical Communication will form an integral part of this Technology course.

A lack of teachers qualified to teach spatial perception presents an enormous problem that urgently needs to be addressed. This is where the future role of university expertise in the new South Africa will become increasingly important especially in the area of teaching spatial perception and three dimensional vision to both school pupils and teachers and not only to engineering students. The aim of the Faculty of Engineering at the Rand Afrikaans

University is to upgrade the qualifications of teachers interested in teaching components of Graphical Communication at pre-tertiary school level. This can only be achieved by initiating and sustaining a program to upgrade the qualifications of teachers in spatial perception.

6. Discussion and Conclusion

It was found that a very low level of spatial perception existed in the historically disadvantaged communities in South Africa. This could clearly be seen during the completion of practical sessions and homework assignments. This low level of spatial perception can be rectified by introducing remedial classes, working at a slower pace while using wood models and computer aided solid models which can be rotated and viewed from different sides. Ladies first year students, studying engineering, feel that they are at a disadvantage when they start their studies but end up doing much better that students with too much previous experience.

Work done by schools and tertiary educational institutions in promoting technology and technology awareness will ensure that spatial perception and descriptive geometry form a critical part of education in the future of the new South Africa.

Acknowledgement

The author wishes to acknowledge the financial support of the Faculty of Engineering at the Rand Afrikaans University, without which the presentation of this paper would not be possible.

References

[1] C.L. Svensen: *Drawing in Engineering Education.* Journal of Engineering Drawing **12**, no. 3, 6–7, 20–21 (1948).

[2] C.L. Miller: *A Historical review of applied and Theoretical Spatial Visualisation Publications in Engineering Graphics.* Engineering Design Graphics Journal **60**, no. 3, 12–33 (1996).

[3] F.E. Giesecke, A. Mitchell, H.C. Spencer, I.L. Hill, R.O. Loving, J.T. Dygdon, J.E. Novak: *Engineering Graphics.* 5th edition, Macmillan Publishing Co., New York 1993.

[4] H.C. Spencer, I.L. Hill, J.T. Dygdon: *Technical Drawing Problems.* 3rd edition, Macmillan Publishing Co., New York 1980.

[5] J.H. Earle: *Descriptive Geometry.* 2nd edition, Addison-Wesley Publ. Co., Reading, Mass., 1971.

[6] K. Pawlik: *Concepts and Calculations in Human Cognitive Abilities.* Handbook of Multivariate Experimental Psychology, Rand McNally, Chicago 1966.

[7] F.A. Fouche, N.F. Alberts: *Human Science Research Council — Senior Aptitude test.* Institute for Psychometric Research, Rand Afrikaans University, Johannesburg 1980.

[8] S.M. Slaby: *Seeing is (Or is not) Believing?* Proceedings 7th ICEGDG, Cracow, Poland, 29–32 (1996).

Received August 14, 1998