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# Engineering Communication*

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ABSTRACT: In this paper, the authors provide a review of an engineering communication course taught at Kaunas University of Technology (KUT), Kaunas, Lithuania. The *Engineering Communication* course at the KUT was introduced 10 years ago, with the main objective being to emphasise the importance of engineering communication in engineering education. The authors provide a brief outline on the *Engineering Communication* study programme as it relates to students and discuss the essential features of communication skills. The authors also examine the impact of communication in the design process, particularly as it relates to new technologies.

## INTRODUCTION

Engineers may be technically competent; however, they often lack good communications skills that are necessary in order to transfer information and reasons. This situation makes excellent technical skills superfluous. It is obvious that communication skills are critical tools for success.

Many learning institutions have engaged in research studies relative to this topic. For example, the American Society for Engineering Education (ASEE) investigated which academic subjects are the most important to the engineering discipline [1]. The investigation included 4,057 graduate engineers who had several years of engineering employment. The results revealed that communication skills are the front-runners of the 38 academic subjects investigated. The sequence of importance is listed as follows:

- Technical writing: 2;
- Public speaking: 4;
- Working with individuals: 6;
- Working with groups: 7;
- Talking with people: 9.

Another investigation, *Engineers of Distinction*, included 245 engineers in its study. The results emphasised exceptional importance of the ability to communicate in the engineering discipline [2]. The investigation also uncovered an important factor relative to the time that engineers dedicate to association at workplace.

Ed Gilbert pointed out that young engineers dedicate 20% of their time for conversation and another 20% of their time for writing, amounting to 40% of their total time [3]. This percentage increased to 80% as an engineer's position advanced [4].

All the facts mentioned above show the importance of engineering communication. The concern then becomes how to best introduce all this to an engineering academic discipline.

Based on the authors' 10 years of instruction experience at Kaunas University of Technology (KUT), Kaunas, Lithuania, in this subject matter, it is hoped that their discoveries and methods of instruction will be useful to other academics at other learning institutions.

## SUBJECTS IN ENGINEERING COMMUNICATION

The underlying objectives of the *Engineering Communication* course taught at the KUT are as follows:

- To introduce the basic procedures that comprise engineering communication;

*A revised and expanded version of a lead paper presented at the 8th *Baltic Region Seminar on Engineering Education*, held in Kaunas, Lithuania, from 2 to 4 September 2004. This paper was awarded the UICEE diamond award (joint first grade with one other paper) by popular vote of Seminar participants for the most significant contribution to the field of engineering education.

- To expose students to the wide spectrum of activities involved in the field of communication;
- To demonstrate the relevance of different subjects in technical communication;
- To emphasise the importance of verbal and non-verbal communication;
- To develop a fuller awareness of the social and environmental responsibilities of the engineer;
- To encourage and emphasise the importance of responsibility, discipline, attitude, teamwork and honest effort;
- To provide a situation in which students have the maximum freedom to *carry out their own decisions*.

The study programme has been designed to expose and stimulate students in the following basic themes:

- The essence of engineering communication;
- Communication models and their application;
- Systematic methodology in communication;
- Engineering creativity and types of arguments;
- Strategy of communications in the design process;
- Searches and sources of information;
- The principles of technical writing;
- Elements of technical article and report personal documentation;
- Oral communications;
- Types of visual aids and their application;
- Professional responsibilities and engineering specifications;
- Ethics and cultural behaviour in communications.

The mentioned topics are presented to second year students in the spring semester. Thirty-two hours of instruction and 16 hours of practical sessions are presented.

The following are required of all students in the course:

- Attendance at every lecture and practical session;
- Active participation and contributions both during and outside of sessions;
- The preparation of written reports as individuals and team members;
- The presentation of a portion (for team members) or all (for individuals) of the final oral report.

Each team or individual must submit one copy of the final report for evaluation.

The purpose of the report is to communicate to those unfamiliar with a problem and its results in student *design*. The report is to be considered as being written for a student audience or for a group of engineers and company executives who are anxious to find out about a particular problem. The aim of the report is to convince the target audience that the solution is worthy of their consideration.

The most important criteria in the judging of the report are the quality of work displayed in the report. Imagination and creativity must also be taken into account. Each report must be presented at a seminar that is arranged at the end of semester before the theory examination.

Each report must also have the listed elements:

- Title page;
- Abstract or summary;
- Table of contents;
- Introduction;
- Description of the problem (body);
- Conclusions and recommendations;
- Bibliography;
- Appendices, including:
  - Curriculum vitae or resume;
  - Covering letter or letter of transmittal.

The final examination grades are based on an individual's performance to meet the requirements stated above. The members of the team do not receive the same grades. Each student has an equal opportunity to receive a grade regardless of the outcome of his/her report and according to the knowledge of other themes.

## KEY TOPICS IN ENGINEERING COMMUNICATION

In this paper, the authors evaluate only several of the questions presented in the survey of the engineering communication education programme. Only those sections that are of particular interest are discussed in detail. Other results gleaned from the delivery of communication subject at the KUT can be discussed in future papers.

The existing definitions of communication are now surveyed to determine how they fit with regard to engineering communication. From the authors' point of view, the most acceptable definitions of engineering communication can be simply described as follows:

- *The flow of intelligence from one mind to another* [5];
- *The successful transmission and exchange of information between the sender and the receiver of it* [6].

## The Process of Communication

The basic model of the communication process is exhibited in Figure 1. The communication begins from a perception of the problem. The sender has information to communicate to the receiver. An encoding process occurs when information is translated into a systematic set of symbols (language) that express what the sender wishes to transmit. The product of encoding is a message. The form of the message depends on the nature of the communication channel. The channel is the medium through which the message will be carried from the sender to the receiver. The message may be a written report, face-to-face communication, telephone call or transmission via a computer network.

When a message reaches the receiver, it is interpreted in light of receiver's previous experience. Feedback from the receiver to the sender indicates how the message has been transmitted. Feedback presents the sender with an opportunity to determine whether the message has been received and whether it has produced the intended effect – the adequate perception of the problem by the receiver and transfer of the meaning.

The communications process encounters various difficulties that are related to psychological and semantic interferences (barriers). Psychological interferences are associated with the communications environment and can include the following:

- Non-identification of the purpose;
- Lack of respect by either party for the other (the sender and the receiver);
- Preconception of either party;
- Preoccupation of either party;
- Failure to establish the best channel;
- The sender is not clear;
- The sender/receiver is not open to feedback;
- Emotions are ignored;

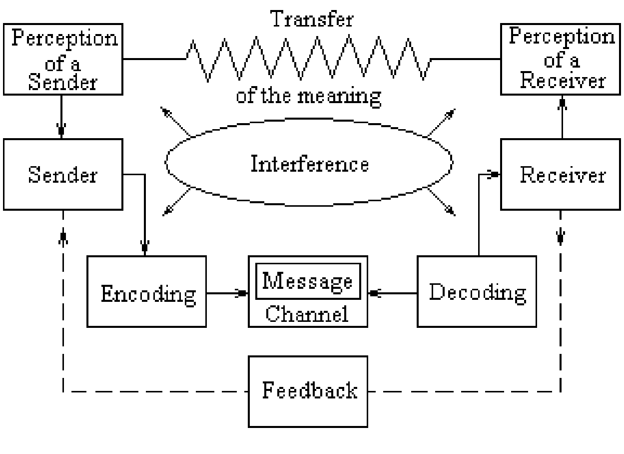


Figure 1: Basic elements of the communication process.

- Failure to get on receiver's level;
- Defences are triggered;
- A lot of other less or more important barriers.

## Product Design Specification (PDS)

Semantic interferences are associated with improper selection for preparation. Common words from a technical discipline take on a specialised meaning that can be completely unknown to the receiver. Therefore, engineering students in communications must present basic word meanings that enable proper engineering decisions. Word meanings must be thoroughly understood and applied in future applicable courses. This basic mining task is known as Product Design Specification (PDS) [7].

PDS involves a detailed listing of the requirements to be met in order to produce a successful product or process. Elements of PDS (see Figure 2) cover the formal means of communications between all participants of the processes of planning and creating successful engineering design. All elements of PDS should be determined and, whenever possible, expressed in quantitative terms.

## Communication in the Design Process

There is another important aspect: communication in the design process. This identifies with certain specifics and requires an applicable strategy. The simple model presented in Figure 3 illustrates a number of important aspects of the design process. Design starts with knowledge of the state of the art information-technology. The needs of society provide the impetus for design. When a need is identified, a need must be conceptualised as some kind of structure.

The design concept must be subjected to a feasibility analysis until an acceptable product is produced, or the project is abandoned. When the design enters the production phase, it begins to compete in the world of technology. Each step of the design loop requires communication with all participants of the design. Design is a creative process and all new creations are a result of communications strategy of some kind.

## Systematic Methodology Approach

Every phase of design communication has its own purpose. However, common principals remain the same, requiring an application of the systematic methodological approach. The systematic approach is exhibited in Figure 4. In formulating the purpose objective (aim functions), it becomes absolutely necessary to investigate all the components of the model and to find a

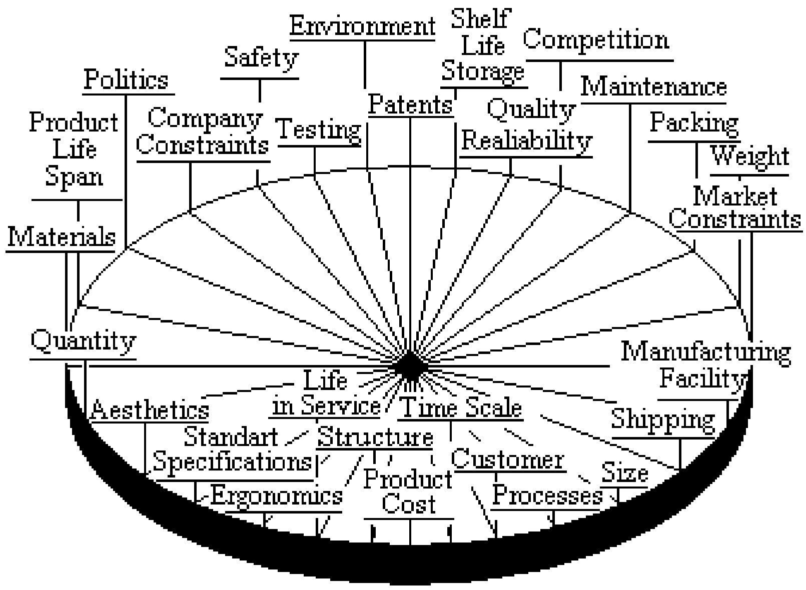


Figure 2: Elements of Product Design Specification (PDS).

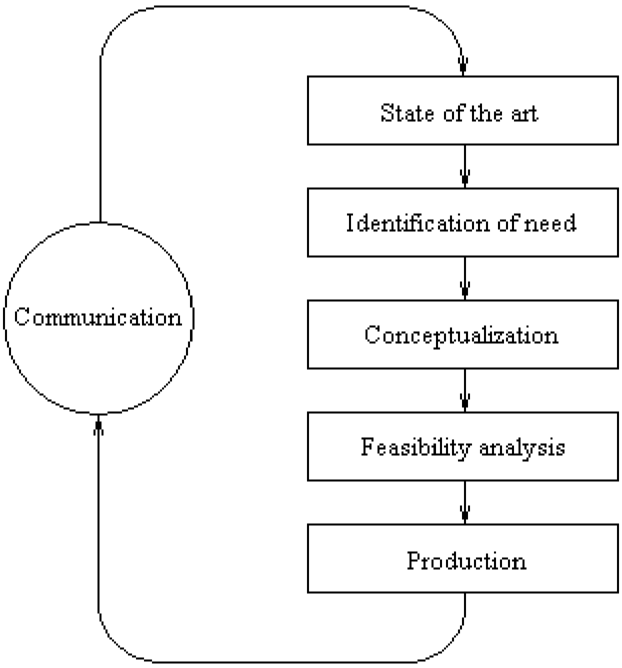


Figure 3: A simple model of the design process steps.

compromise between the technical requirements and ensuring economic support, social acceptance, market analyses and management support.

All of these requirements, together with analyses and the determination of environment, are the basic needs in motivating the structure of a system or other products of design. Understanding communication from this point of view becomes possible by ensuring the affections of engineering activity.

These affections greatly depend upon the possibility to adequately understand the challenges of new technologies and new achievements in science by both of the communicating sides. Therefore, delivering the subject of engineering communication to different specialties of students becomes necessary in order to achieve the following:

- Emphasise new tendencies in design and technology;
- Compare these new tendencies with the traditional ones;
- Show the necessity to overcome the traditional ones in future courses of study.

For example, in the Faculty of Mechanical Engineering, a new design strategy is being introduced that as a result of the dramatic changes in computer technologies and the wider availability of software tools for design and production. Engineers are now using Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM) and Computer-Aided Engineering (CAE) systems for everyday tasks, not just for demonstrations. International competition, the decreased availability of skilled labour, and an increased emphasis on quality have also forced manufacturers to utilise CAD/CAM/CAE systems to automate their design and production processes. As a result, educators

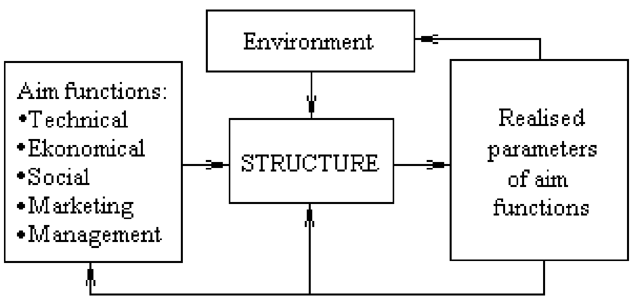


Figure 4: A model of the systematic methodology.

at engineering schools are experiencing new pressure to change the way that they teach design-related courses in order to equip their students with the ability to interact with CAD/CAM/CAE systems and have the knowledge of their fundamental principles [8].

The foundation for the application of computers in the product development process is the development of models of products utilising CAD. Information from these models then forms the basis for design analysis, for planning and organisation of the manufacturing activity, and for the control of machines that manufacture the products.

In the traditional design process, complete design descriptions are generally produced in the form of engineering drawings and diagrams. These are issued by the design department of a company for analytical evaluation, and for the preparation of plants and instruction for manufacture. Inevitably, the manufacturing specialists and design analysts find aspects of the design that they feel should be improved, and so the design is returned to the design department for the modification of drawings.

In come cases, modification may occur many times – one large aerospace manufacturer is said to change each drawing an average of 4.5 times before the final release – and thus the whole process is both time consuming and costly. Furthermore, because the considerations of manufacturing and other specialists are taken into account after the design drawings have been produced, the design departments tends to concentrate on the functional aspects of the design at the expense of easy manufacturing, maintainability and so on. Engineering using CAD seeks to overcome all these limitations by bringing together a design team with the appropriate combination of specialist expertise to consider, early in the design process, all the elements of the product lifecycle, from conception through to manufacture and use in service to maintenance and disposal [9].

The traditional approach to product development is often described as an *over the wall* approach, because each department involved in the process tends to complete their work and then metaphorically throw it over the wall to the next department. These barriers in communication between the phases of product development are broken down in engineering by utilising CAD to enable faster and more responsive product development, as well as a higher level of product quality. The sequential and concurrent approaches are compared in Figure 5 [10][11].

So the aim of CAD is to apply computers to both the modelling and communication of designs. There have been two different approaches that are often used together, namely:

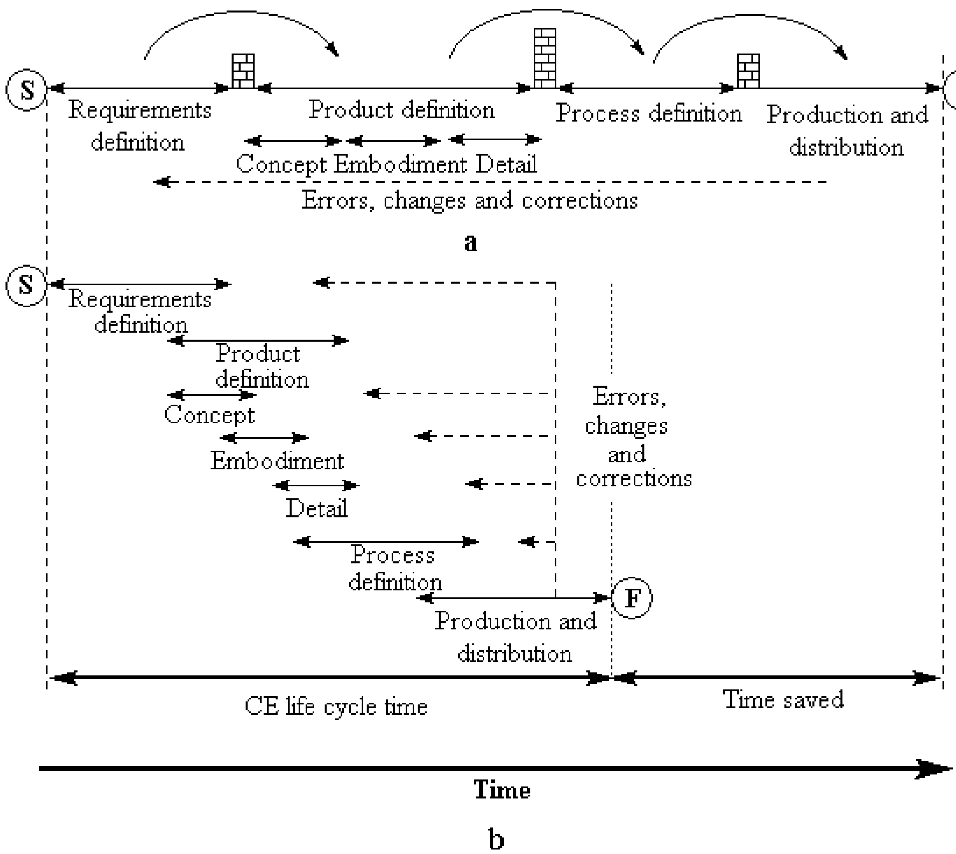


Figure 5: Product development from start (S) to finish (F). Note that a = sequential product development; b = concurrent product development.

- At the basic level, computers are used to automate or assist in such tasks as the production of drawings or diagrams and the generation of lists of parts in a design;
- At a more advanced level, computers can provide new techniques that give the designer enhanced facilities to assist in the design process.

In efforts of engineering communication education, great importance is directed towards an evaluation of the audience, an analysis of technical writing, visual media and others. These concerns are constantly analysed and investigated in many textbooks and articles of specific journals [12-17].

## CONCLUSIONS

Engineering communication is an insupportable part of engineering education. The *Engineering Communication* programme offered at the KUT possesses certain specifics and requires connections with fundamental engineering principles and rules.

The authors' 10 years of experience at the KUT in presenting and improving the *Engineering Communication* programme, provides evidence that the proper coordination between theory, practice and student seminars permit the presentations of student efforts. These elements facilitate basic student preparation for further and advanced studies and success, as well as in the engineering profession.

Students acquire a proper knowledge of the basic elements used in report preparation. Basic report items, such as the introduction, the report body, the conclusion and other aspects provide a sequential effort for the proper presentation of facts and information.

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## BIOGRAPHIES

Jonas Dulevičius is a professor of the Department of Mechanical Engineering at Kaunas University of Technology (KUT) in Kaunas, Lithuania. He graduated from Moscow Technical University in 1961 and then spent 10 years on the research and development of fuel fed systems of jet engines at the Moscow Specialised Bureau of Design and Technology. He received his Doctor's degree from the Moscow Research Institute of Technology in 1967, and his Habilitated Doctor's degree in 1980 from the Samara University of Aircraft Engineering and Aerospace Technology, which was named after the academic S.P. Koroliov.

Since 1971, he has been delivering courses on Machine Elements, Engineering Design and Engineering Communication at the KUT. He has published more than 100 scientific papers and two monographs in different fields. He is also a member of the University Board and President of the Professors' Club.

Liudvika Naginevičienė is an associate professor in the Department of Mechanical Engineering of Kaunas University of Technology (KUT) in Kaunas, Lithuania. She is a graduate of the same University. For several years, she worked at a textile factory and, after that, returned to her native University as a research scientist. After completing her Doctorate in 1972, she began to deliver courses on Measurement, Machine Elements and Engineering Communication, as well as other subjects. She is the author of six textbooks and more than 50 research papers.

She has been elected twice to the Kaunas City Council, firstly from 1995-1997 and then from 1997-2000. During the last term, she was a City Board member and the Head of the Science and Education Committee.

## $8^{th}$ *Baltic Region Seminar on Engineering Education: Seminar Proceedings*

edited by Zenon J. Pudlowski, Norbert Gr nwald & Romanas V. Krivickas

These Proceedings consist of papers presented at the $8^{th}$ *Baltic Region Seminar on Engineering Education*, held at Kaunas University of Technology (KUT), Kaunas, Lithuania, between 2 and 4 September 2004. Eight countries are represented in the 29 papers, which include two informative Opening Addresses and assorted Lead Papers. The presented papers incorporated a diverse scope of important and current issues that currently impact on engineering and technology education at the national, regional and international levels. The level of Lithuanian participation indicates the nation s commitment to advancing engineering education in the higher education sector.

In this era of globalisation, much needs to be done and achieved through creating linkages and establishing collaborative ventures, especially in such a highly developed area as the Baltic Sea Region, and the KUT definitely leads the way in these endeavours. Hence, the aim of this Seminar was to continue dialogue about common problems and challenges in engineering education that relate to the Baltic Region. Strong emphasis must be placed on the establishment of collaborative ventures and the strengthening of existing ones.

It should be noted that the Baltic Seminar series of seminars endeavours to bring together educators, primarily from the Baltic Region, to continue and expand on debates about common problems and key challenges in engineering and technology education; to promote discussion on the need for innovation in engineering and technology education; and to foster the links, collaboration and friendships already established within the region.

The papers included in these Proceedings reflect on the international debate regarding the processes and structure of current engineering education, and are grouped under the following broad topics:

- Opening addresses
- New trends and approaches to engineering education
- Quality issues and improvements in engineering education
- Specific engineering education programmes
- Innovation and alternatives in engineering education
- Important issues and challenges in engineering education
- Case studies

All of the papers presented in this volume were subject to a formal peer review process, as is the case with all UICEE publications. It is envisaged that these Proceedings will contribute to the international debate in engineering education and will become a source of information and reference on research and development in engineering education.

To purchase a copy of the Seminar Proceedings, a cheque for \$A70 (+ \$A10 for postage within Australia, and \$A20 for overseas postage) should be made payable to Monash University - UICEE, and sent to: Administrative Officer, UICEE, Faculty of Engineering, Monash University, Clayton, Victoria 3800, Australia. Please note that sales within Australia incur 10% GST.

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