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New materials and developing English language competence in university students and teachers

G G Gurova¹, S V Reznik², and I R Shafikova¹

¹ Department “English for Machine-building Major” of the Bauman Moscow State Technical University, 5/1, 2-nd Baumanskaya str., 105005, Moscow, Russia
² Department “Rocket and Space Composite Structures” of the Bauman Moscow State Technical University, 5/1, 2-nd Baumanskaya str., 105005, Moscow, Russia

Abstract. Intensive international research in the field of new materials, in particular composite and nano-modified materials, means that students and teachers in the relevant departments of engineering universities need a high level of professional English-language communicative skills. Another factor is the increased academic mobility, which manifests itself in joint academic and research projects. The academic process at engineering universities must reflect these trends, especially when it concerns teaching of English. Bauman Moscow State Technical University is adapting a multi-level system created by collaboration of two departments: “Rocket and space composite structures” and “English for machine engineering faculties”. This system encompasses undergraduate and postgraduate students, as well as the academic staff of the department.

1. Introduction

The sphere of new materials, especially composites and nano-modified materials, is going through a stage of intensive development. This means that highly qualified specialists are in great demand, especially the specialists with advanced capabilities for self-development and personal growth. Engineers and researchers today must be able to communicate globally, promoting their own work and learning about the R&D conducted by their colleagues and competitors. To do this, non-English speakers require an adequate level of proficiency in English as a means of global communication. It is self-evident, that the foundation for this proficiency must be laid in the course of professional training, including the university-level education. Educators worldwide are well aware of the trend and are adapting the content and principles of the course in English for Specific Purposes (ESP) to the industry demands. Russia is no exception. Numerous Russian engineering universities are developing theoretical foundations and creating innovative ESP courses catering for specialists in various fields of technology [1 - 5].

The growing interest in the professional English-language competence has manifested itself in the new formats of the English language teaching and learning. Students today can see the immediate outcome of their learning effort with regard to the English language. There are joint degree programs with European universities; Master’s and PhD degree students can publish their research in international journals and attend international conferences. This means that apart from the linguistic competence in a given professional field, intercultural and academic communication skills are required that will ensure an effective presentation, a well-written paper and successful communication with peers worldwide.
Bauman Moscow State Technical University is at the forefront of innovation in the academic process. Engineering centers have been created that manage to combine cutting-edge research with diverse academic programs [6-9]. This synergy is primarily aimed at developing relevant professional competences and preparing the students for their future careers. It is especially valuable that these centers work in close cooperation with the leading industry players, thus ensuring that the competencies in question are in line with the current industry demands.

2. Teaching English at Bauman MSTU
The English language curriculum is adapted to the modular system of studies. The undergraduate course of English lasts six (in some cases seven) terms with 34 class hours per term. The course of English for the Master’s degree students lasts one year (two terms).

In the first and second year of study, each term consists of 3 modules devoted to one general engineering topic and one grammar problem. The English language curriculum during this period is universal for all BMSTU faculties and departments. The logic is clear: the engineering curriculum in the first two years is more or less similar for every faculty across the university, and the English language course complements the general course of studies.

Traditionally, the English language course at Bauman MSTU was extremely text-oriented, with a broad range of texts covering diverse topics: automobiles, aircraft, underwater craft, lasers, electronics etc. Grammar was presented in isolated portions and the main objective of teaching grammar was the ability to correctly identify the relevant structures and translate them into Russian. The choice of the grammar syllabus was determined primarily by the need to review the structures learned at school: the Simple, the Perfect and the Continuous verb tenses, the Passive Voice and the Conditional sentences. The same amount of attention was given to very narrow grammar aspects, such as participle, gerund, or infinitive, as these structures were considered to be typical for the engineering contexts. The lion’s share of the class time was devoted to reading, even though the texts themselves were far from being informative. Some information happened to be outdated, especially that on electronics, automobiles, IT. Comprehension of the texts was achieved and assessed through translation.

The huge advantage of this course was that it met the Russian learners’ needs, had a solid grammar foundation and a focus on morphology, and covered a wide range of topics. The emphasis on translation was due to the legacy of the grammar translation method, although the advent of computer assisted translation brought this approach to its untimely end. A very serious drawback of this course was the shortage of writing and listening activities. Speaking skills were also largely neglected. All of these justified the need for innovation in the linguistics department at Bauman university. One of the directions this innovation took is an updated course of English for the first and second year students [10]. The new modular course is student-centered, it covers all aspects of communicative competence and can be adapted for use in the virtual learning environment.

The fifth and the sixth terms are devoted to teaching English for the specific field of engineering. The course is based on the “Cambridge English for Engineering” coursebook, which relies on a functional syllabus, with the focus on professional communicative skills required by the future engineers, such as discussing performance and feasibility, describing component shapes and features, explaining tests and experiments, etc. This course is supplemented by independent background reading, with students autonomously selecting, reading and translating texts in their subject field. Students practice basic academic writing skills by means of producing summaries and précis of their reading texts.

The Master’s degree students have a two-term English course. The focus is on developing presentation and writing skills. The students are supposed to have mastered the expertise in their professional field and are capable of communicating their research interests in the academic and professional community.

There is a strong trend towards collaboration between the engineering and linguistic departments/One of directions it takes is the development of CLIL (content and language integrated learning) courses [11]. Another is creating tailored ESP (English for specific purposes) courses using the professional expertise of the engineering department and the language support offered by the linguists.
A good example is a multi-level system developed for Rocket and space composite structures department. The main feature of this system includes academics apart from undergraduate and postgraduate students. It is evident that academics need to be proficient in English in order to access international information sources, participate in international conferences, conduct business and academic correspondence, and interact with students from abroad. Academics who are proficient in English are supposed to motivate their students to use the English language in research and academic settings.

This assumption is illustrated by the dynamics of the participation in scientific conferences in the UK, organized jointly by the Bauman MSTU and the University of Glyndwr in North Wales. Initially? It was only academics who presented their papers, but with time postgraduate students followed suit. This contributed favorably to the publication activity statistics. Another evidence is the growing number of foreign students at the department, with academic communication conducted not only in Russian, but also in English [12].

3. Department of Rocket and space composite structures
The Department of Rocket and space composite structures was founded in 2002 to meet the growing demands of the aerospace industry for specialists in designing, fabricating and testing perspective rockets and space craft containing composite materials.

Composite materials have been used in rocket and space structures since 1950s. First, as ablative coating protecting the reentry module from extreme thermal loads, later, as composite solid rocket fuel and rocket engine cases from fiber-glass reinforced polymers. At the current stage of the rocket and space technology development, composite materials are indispensable in the following roles: deployable space structures (antenna reflectors [13], power-plant units, large-scale structures), nose cones, reusable space vehicles, and hypersonic aircraft with ramjet engines (figure 1).

![Figure 1. Ultralight space antenna reflectors from carbon reinforced plastic.](image)

A very important feature of the composite materials area is the multidisciplinary nature of the problems involved, including condensed-matter physics, nonorganic and high molecular compounds chemistry, mechanics, thermal physics, and materials science. The scope and the speed of R&D tasks formulation and implementation are determined by professional skills, knowledge, and competences of the key specialists.

Bauman MSTU has taken a multi-level approach to teaching professional competences in the field of composite materials for rocket and space structures. The system includes courses in science, general engineering and specialized subjects, hands-on laboratory and industry training. Students conduct R&D projects both inside and outside University.

4. Master’s degree program at the Rocket and space composite structures department
The department provides the Bachelor’s and Master’s degree programs in rocket technologies and materials science time. The specifics of the present day situation with regard to the Master’s programs is that students entering these programs can have extremely diverse academic background. Originally,
all the prospective Master’s degree students held a Bachelor’s degree from the same department. However, the flexibility of the two-tier system started to appeal to students. The department is experiencing an influx of students from other departments of BMSTU, other engineering and non-engineering universities. To illustrate the point let us look at the statistics provided by the department under consideration (figure 2).

![Figure 2](image_url)

**Figure 2.** Admittance for the Master’s degree program.

The bar chart shows a steady increase in the number of “outside” students since the establishment of the Master’s degree program. These students come from various faculties of the Bauman MSTU (“Engineering business and management”, “Autonomous radar systems”, “Environmental protection and industrial safety” and “Materials science”) as well as graduates of Moscow Aviation Institute, Baltic State Technical University, Samara State University, Moscow State University of Design and Technology and other engineering and non-engineering institutions. The key challenge in this case is the extreme diversity in the levels of professional and academic backgrounds.

The Master’s degree curriculum (Table 1) is based on the disciplines studied at the Bachelor’s level and an increasingly larger number of students do not have this foundation. The Bachelor’s degree curriculum of the “Rocket and space composite structures” comprises the following disciplines: CAD basics; Composite media mechanics; Composite structures mechanics; Fundamentals of physics, chemistry, and fabrication of composites; History of research in composites; Optimization of composite structures and procedures; Polymer composite structures development; Principles of scientific research; Technology of reusable space vehicles; Technology of processing and modifying new materials.

| Table 1. Master’s degree curriculum for the Rocket and space composite structures department. | Credit units (total) |
|-----------------------------------------------|---------------------|
| Math modelling                                | 3                   |
| Methods of scientific cognition               | 2                   |
| Materials science and advanced materials technology | 3               |
| Math modelling of thermally loaded composite structures | 3              |
| IT in the development of new technology       | 8                   |
| Composite materials and structures testing   | 7                   |
| Nanoengineering of spacecraft                | 3                   |
| Optimization of composite structures and methods | 3                |
| Heat transfer in composite structures         | 4                   |
| Interdisciplinary research issues            | 3                   |
| Forms and methods of scientific research     | 3                   |
| Science of metal composite structures design and fabrication | 3              |
| Science of carbon-carbon composite, ceramic and glass structures design and fabrication | 3            |
| Current issues of polymer composite structures design and fabrication | 3            |
| Theory of new methods of thermal protection design | 2                |
| Design methods of space antenna reflectors  | 2                   |
5. Content of the English –language course for Rocket and space composite structures
The central concern of this paper is teaching English to engineering students. However, if some students have the required expertise in their professional field and some do not – it indicates the need for a tailored English-language course that will allow the “outside” students to catch up with their peers in terms of professional competence. In this case, functions, vocabulary or grammar units can be taught based on the context of the engineering curriculum. For instance, sequence of events can be taught using the context of history of research in composites, while the use of noun attributes illustrated through the example of polymer composite structures development. The catch-up English language course for the Rocket and space composite structures department based on the engineering curriculum can include the following functional units.

- Describing a process/ methods/ motion, forces/ parallel processes/ sequence of events/ shape and appearance/ use or function;
- explaining dimensions/ forces/ needs, problems and solutions; stating objectives;
- expressing purpose/ strengths/ weaknesses;
- giving definitions;
- working with drawings.

The following vocabulary items:
- composite materials, properties;
- composites manufacturing processes verbs;
- physical forces;
- physics, chemistry terms;
- processes sequence/ simultaneity;
- shapes of composite parts;
- specifications of dimensions;
- stages in a composites fabrication process;
- types of composites fabrication equipment;
- verbs to denote movement.

6. Conclusion
The second language competence is now a requirement rather than an option. To be a part of the international professional community, a specialist is to be proficient at communicating globally – and this cannot be achieved without the English language. The foundation of this proficiency must be laid down at the university level. The English-level courses at engineering universities must be carefully tuned not only to the needs of the industry, but to the current challenges and demands. For example, the peculiarities of the two-tier academic system lead to serious clashes in the professional and academic competences of the Master’s degree students. The English-language course could serve as one of the tools to even out this diversity. Based on the engineering subjects curriculum, it could help achieve two goals simultaneously: improve the students professional expertise and enhance their communicative competence.

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