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Statistics in Engineering Education ***

Rezime: U ovom radu je prikazan subjektivni pristup i istraživanje obrazovanja satističkih metoda na mašinskim fakultetima zemalja Evropske unije, kao osnova za postizanje svetskog nivoa kvaliteta i konkurentnosti proizvoda i usluga na svetskom tržištu. Sugestije za poboljšanje statističkog obrazovanja su prikazane sa ciljem da se prevaziđe postojeći jaz između inženjera i naučnika koji se bave primenjenom naukom, sa jedne strane i matematičara sa druge.

Ključne reči: statističke metode, poboljšanje kvaliteta, odlučivanje na osnovu podataka, prikupljanje podataka

Summary: This paper presents a subjective view and a research of the education of the statistical methods in Mechanical Engineering Faculties in EU countries, as a base for achieving world class quality in good and services. Suggestions for an improvement of the statistical education were presented in order to overcome the existing gap between engineers and scientists on one side and mathematicians on the other.

Keywords: Statistical methods, quality improvement, data driven decision making, data collection

1. INTRODUCTION

Since mid 1980-ties, a statistical method has been increasingly applied in business and industry, primarily in USA [3]. This trend dates in Japan much earlier, i.e. from the beginning of 1950-ties. Expansion of application of statistics is reflected in the field of computer sciences, by application of the

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methods and even more in design of program packages for data analysis, such as SPSS, STATISTICA, MINITAB, with specialized modules for different fields of application.

Today, application of statistical methods in industry, are generally concentrated on quality improvement and control, trough methods for robust product and process designs and optimization, quality control during the process and service, reliability of processes and products etc. From business point of view, statistical methods are widely in use for forecasting, data mining, and marketing research and analysis.

In modern world of industry, business and science, statistical methods are in iterative use during the all phases of development and research, leading to more and more necessary data driven decision making.

2. INFORMATION RECEIVED FROM INDUSTRY

As a consequence of growing industrial needs, in the 1980s, several authors stressed the necessity of introducing changes into the statistical education of engineering students at universities. This is particularly referred to the USA. Directly annualizing the needs of the economy, through independent students practice, the selected universities changed statistics courses and teachers started to focus on much more practical and useful areas of statistics.

Europe lagged behind for almost a decade and started only in the new millennium attempts towards introducing use of statistics in industry and business.

Analysis provided by Romano Prodi, about the state of EU economy to Special European Council in Lisbon 2000, presented state of competitiveness deficit of EU [1].

Therefore EFQM, as well as a certification of ISO 9000 standards are just a gimmicks, since they are not a proof of customer satisfaction [2].

Consequently, in 2000 ENBIS founded with one of the main goals to introduce statistics as one of the vital factors for the economic and technical development and improved competitiveness of European industry and business [4].

Preliminary screening in needs for achieving improvements in quality levels in industry and business are explored by two methods, from the two different sources, from EFQM and EURobust [5][6].

The first method, resulting from the demand of the economy, is introduction of quality control management throughout the European Union, well-known for its quality and prestige, abbreviated as EFQM, set up at 1991, and being awarded annually since 1992. The Figure 1. below shows finalists, awards and recognitions awarded in the period 2000-2005.

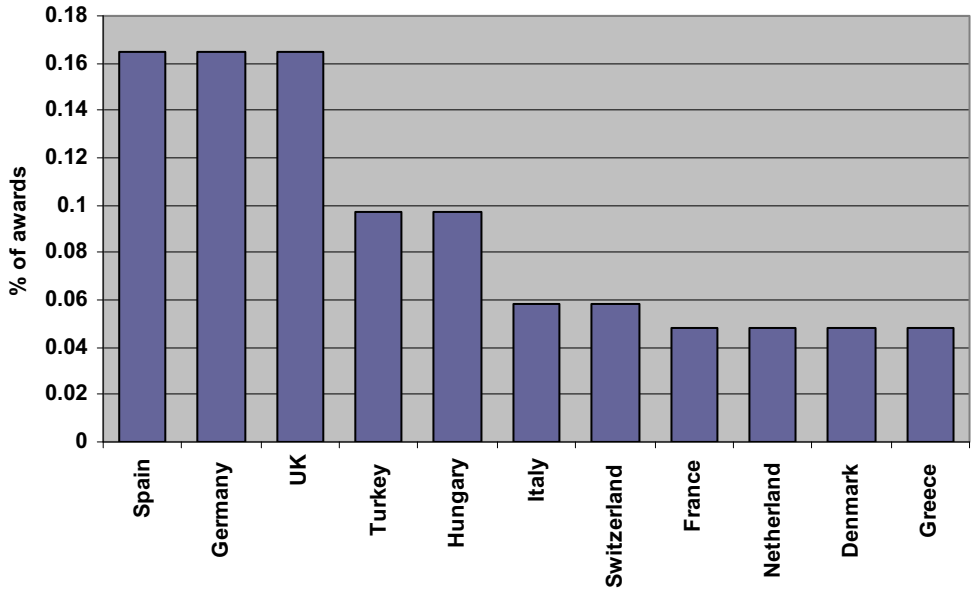

Figure 1. European Quality Award 2000-2005

The second method was realized through the European Project EURobust, aimed at examining the application of robust design methodology (RDM) in companies across five European countries: Netherlands, Germany, Ireland, Spain and Sweden. EURobust Project was first time implemented in 2003.

The Project objective was to study application of statistical tools and industry techniques in the real practice in the leading companies. It is interesting that plenty of information came from industry, both from companies and from relevant manager profiles.

The analysis of data showed that the collected data may be divided into two 50% strata: first, data on quality control and second, statistical data. The part of data concering statistics had to be subjected to ANOVA methodology as well, but even simple countings within the stratum proved to be interesting. The Figure 2. below shows elementary processing of the collected data, from which it may be concluded that industry demands refer solely to more advanced statistical packages and theories.

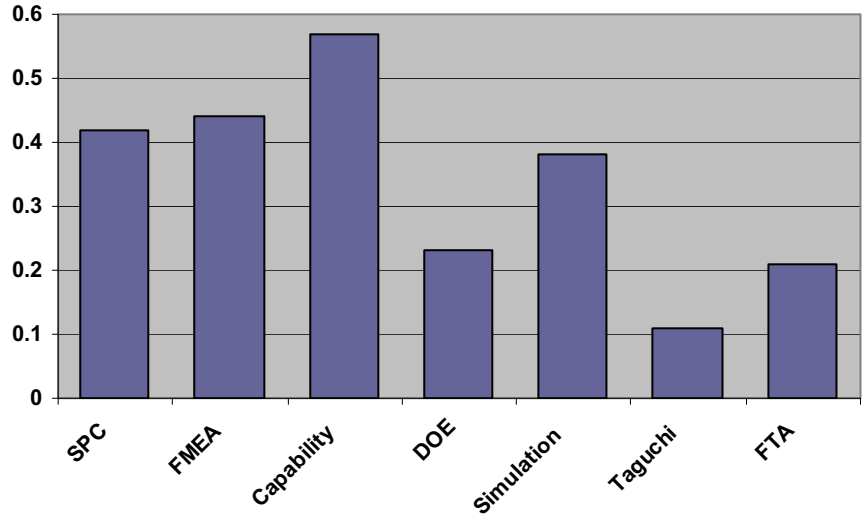

Figure 2. Use of the Statistical Tools in EU Industries

3. INFORMATION RECEIVED FROM UNIVERSITY

3.1. On data collection

Development of data collection methodology has proved to undergo significant changes, depending on the quantity of the collected data. The originally designed questionnaire methodology was soon abandoned due to a minimal response to the sent questionnaires. Most universities kindly referred to their existing web locations.

Therefore, after all, all known official web locations had to be visited. The search engine Google was used, with incremented key words given in the following sequence:

university,

mechanical engineering,

statistics

The data was collected from 347 different web locations, while observing the following sampling principles:

- Uniformity of web locations in the EU countries,
- Collected data on original statistical subjects,
- Courses were not divided by classes, main and academic,
- Minimum 45 academic classes per subject, per one term.

Each of these principles called for retroactive search as it was changing the data collection methodology itself. It proved that some EU countries had quite few faculties of mechanical engineering, especially those with additional demands. Interestingly enough, newly admitted EU countries frequently have a larger number of mechanical engineering faculties, teaching statistical subjects as well. Germany, France and UK particularly stand out in the number of these schools. It is interesting to mention that in the above-mentioned countries these subjects are taught, irrespective of the class of studies and the curriculum commonly includes over 70 classes in one term. The data was collected in about 10 months.

3.2. Obtained results and observations

It has proved that there is no single strategy of studying statistical subjects in the EU. Each school has developed its own strategy for statistical education of engineers. Within the obligatory subjects for certain departments of mechanical engineering schools, the following areas are found to be taught in about 100% sample:

- Continuous probability distributions,
- Discrete probability distributions,
- Probability.

Considering the fact that these areas are part of the elementary technical culture, the obtained result was expected. The Figure 3. shows the essence of courses concerning statistical education at mechanical engineering faculties in the EU countries.

More advanced statistical techniques, from Nonparametric Test to DOE, are rarely taught in any class of studies, although industry sector is showing strong demand for learning these techniques (see Figure 1).

4. CONCLUSION

EU countries do not have uniform strategy of statistical education of mechanical engineers. Demands of the industry are significant and include demand for mechanical engineers able to use advanced data mining techniques as well as advanced statistical decision-making techniques in all phases of design, production and servicing.

The problem of statistical education results from the heritage of mathematical education and close reliance of statistics on mathematical foundations, more then on real needs of industrial and business practice and scientific approaches.

Therefore, it is necessary to teach students first elementary probability and statistics and only then introduce more sophisticated statistical techniques. The courses need to be modified and brought to the level of immediate applicability,

as it was done in the USA with certain statistical tools and theories. This is particularly true for the Sample Theory, as well as all types of testing.

Engineers should first understand:

- that statistics should be included in all phases,
- how to collect the data for statistical processing,
- how to recognize and understand problems from which data is collected,
- to what extent the data is limiting and excellent,
- main statistical theories, complex statistical theories and software tools for processing of the given data,
- manner of making appropriate decisions based on the processed data.

According to the above-mentioned research, about 20% of undergraduate students from certain mechanical engineering departments in the EU have such education. Their contribution in the relevant industries is particularly notable given the development of the EU countries.

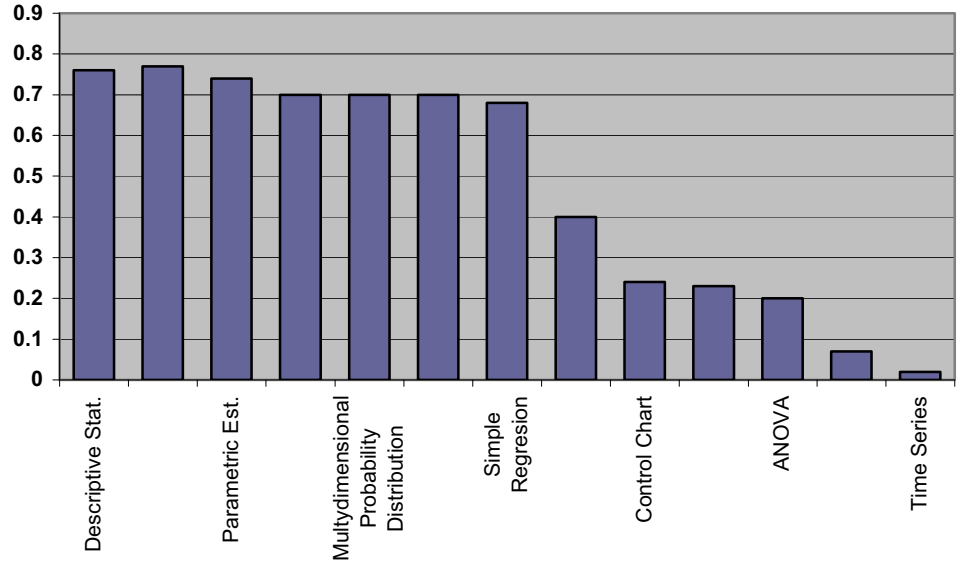

Figure 3. Course essencies in statistical education at Mechanical Engineering Faculties of EU countries

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