

**DEPARTMENT OF MATHEMATICS AND
INFORMATICS
FACULTY OF SCIENCE
UNIVERSITY OF NOVI SAD**

**MATHEMATICAL INDUSTRIAL
DAYS**

**MATHEMATICAL MODELLING
WEEK**

Novi Sad, July 2005

Mathematical Industrial Days and Mathematical Modelling Week are organized within TEMPUS CD JEP 17017-2002 project. The project is financed by European Union.

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Mathematics, as the language of the sciences, has always played an important role in technology, and now is also applied to a variety of problems in economy, finance and environment.

Modern industry is increasingly becoming dependent on high technology and the need for mathematical expertise in both research and development can only grow.

In order to use mathematical skills effectively real world problems typically solving starts with the phase called mathematical modelling – that involves problem identification, a mathematical formulation and mathematical/numerical analysis to reduce the problem to its simplest form for computation.

The usefulness of mathematical modelling and applied mathematics does not end with big companies and high technology products or sophisticated financial markets and financial instruments. Smaller companies, without research departments may not recognize that their problems might be formulated and solved using mathematical modelling. Therefore the interaction between researchers and industry is a necessary condition for successful application of mathematics in solving real world problems.

European universities gathered in European Consortium for Mathematics and Industry have a long tradition of organizing joint meetings of industry and mathematicians. The idea dates back to 1968 when the first Study Group with Industry was organized at Oxford University. Some of the most well known companies like Siemens, Lego etc. use these meeting as a place to present their problems and benefit a lot from interaction with the up-to-date mathematical knowledge. At the same time researchers benefit from opening new research areas stimulated by the real world which is particularly interesting for applied mathematicians.

Mathematical Industrial Days are the first event of this kind in Serbia and Montenegro. The idea is to gather together various companies – from agricultural cooperations to banks, and researchers from Universities. In two days company representatives will present their problems and mathematicians will listen and ask questions. Afterwards, it is expected that some of the presented problems will be

solved in close cooperation of smaller groups of interested researchers and companies.

We hope to achieve two goals. The first one is to inform the industry in Serbia and Montenegro and the general public that applied mathematics can contribute a lot to technological development of the country and therefore lead to a better society. Our second goal is to solve some of the presented problems to mutual benefit of researchers and industry.

We gladly acknowledge the financial support from EU through Tempus CD JEP 17017-2002 project, expertise of our academic partners University of Lappeenranta in Finland, Technical University of Dresden in Germany, University of Zielona Gora in Poland and European Consortium for Mathematics in Industry. Department of Mathematics and Informatics provided facilities for this event while the Ministry of Science and Environmental Protection of Republic of Serbia supported the event.

Matematika je, kao jezik nauke, oduvek imala veoma važnu ulogu u razvoju tehnike, a danas se primenjuje i u raznim problemima iz ekonomije, finansija i očuvanja životne sredine.

Savremena industrija je sve više zavisna od visokih tehnologija i potreba za matematičkom ekspertizom u razvoju i istraživanjima može samo da raste.

Da bi se u realnim problemima matematička znanja efikasno koristila sprovodi se proces matematičkog modeliranja, što uključuje identifikaciju problema, matematičku formulaciju i zatim matematičko – numeričku analizu kojom se određuje model najjednostavniji za efikasna izračunavanja.

Matematičko modeliranje nije korisno samo velikim kompanijama koje koriste visoku tehnologiju ili posluju na sofisticiranim finansijskim tržištima sa dobro razvijenim finansijskim instrumentima. Mala preduzeća, koja nemaju odeljenja za razvoj i istraživanje, često nemaju ni saznanja o tome da se njihovi problemi mogu

matematički formulisati i rešiti. Zbog toga je neophodna interakcija između privrede i istraživača da bi se matematika primenila na realne probleme.

Evropski univerziteti koji čine Evropski konzorcijum za matematiku u industriji imaju dugu tradiciju susreta matematičara i privrede. Počeci datiraju iz 1968. godine kada je organizovana prva Studijska grupa za industriju na univerzitetu u Oksfordu. Neke od najpoznatijih kompanija kao što su Lego, Siemens itd koriste ove studijske grupe da bi prezentovali svoje probleme i koristili najnovija matematička saznanja. U isto vreme matematičari, na osnovu takvih problema otvaraju nove pravce istraživanja u matematici.

Matematičko industrijski dani su prvi događaj ove vrste u Srbiji i Crnoj Gori sa idejom da se okupe različita preduzeća - od poljoprivredne zadruge do banaka i istraživači. U toku dva dana predstavnici preduzeća će izložiti probleme, a matematičari će slušati i diskutovati o mogućim modelima proveravajući realnost svojih ideja. Nakon toga očekujemo da će neki od prezentovanih problema rešiti manje grupe zainteresovanih istraživača u tesnoj saradnji sa preduzećima.

Nadamo se da ćemo ovim skupom postići dva cilja. Prvi je da informišemo privredu i širu javnost u Srbiji i Crnoj Gori o mogućnostima primene matematike i tehnološkom i ekonomskom napredku koji društvo u celini može ostaviti na taj način. Drugi cilj nam je da rešimo prezentovane probleme na obostrano zadovoljstvo privrede i istraživača i započnemo trajnu saradnju privrede i matematike.

Sa zadovoljstvom ističemo finansijsku podršku Evropske unije kroz projekat Tempus CD JEP 17017-2002, stručnu pomoć naših akademskih partnera - univerziteta u Lapenranti - Finska, Drezdenu – Nemačka i Zielonoj Gori – Poljska i Evropskog konzorcijuma za matematiku u industriji. Departman za matematiku i informatiku Prirodno-matematičkog fakulteta u Novom Sadu je omogućio tehničke uslove za održavanje ovog skupa, a Ministarstvo za nauku i zaštitu životne sredine Republike Srbije je podržalo skup.

Mathematical Industrial Days, July 1-2, 2005

Friday, July 1st 2005

13:00	Registration and Welcome Reception	
15:00	Opening Ceremony – Aleksandar Sedmak, Assistant Ministry, Ministry of Science and Environmental Protection, Republic of Serbia	
15:15	Matti Heilio, University of Lappeenranta, Finland	Mathematics and Industry. Views from Finland and European collaboration
15:45	Laura Fodor Agošton, Executive Manager, Panonska banka AD Novi Sad	Credit risk – methodology and problems
16:15	coffee break	
16:45	Dragica Mihajlović, Executive Manager, Panonska banka AD Novi Sad	Operational risk
17:15	Jorgić Branislav, Jorgić Broker AD, Belgrade	Ratings of companies – standardization of financial instruments
17:45	coffee	
18:15	Belgrade Stock Exchange, Belgrade	Correlation between share prices and Belexfm index at Belgrade Stock Exchange
20:00	Dinner	

Saturday, July 2nd 2005

10:00	Janović Petar, Fabrika akumulatora AD Sombor	Production of car batteries
10:30	Lalić Dragan, Takarič Bernat, Water Factory, Zrenjanin	Problems in water supply technology in Zrenjanin
11:00	coffee break	
11:30	Živko Čonić, Agricultural cooperative Ravangrad, Sombor	Optimal plan of agricultural production
12:00	coffee break	
12:30	dr D. Kozarski, dr V. Till, dr S. Stojanović, Institute of Radiology, Novi Sad Central Hospital	Applied mathematics in radiology
13:30	Lunch	

Matematičko – industrijski dani
1-2. juli 2005.

Petak, 1. juli 2005.

13:00	Registracija učesnika	
15:00	Otvaranje – Aleksandar Sedmak, pomoćnik ministra, Ministarstvo za nauku i zaštitu životne sredine Republike Srbije	
15:15	Matti Heilio, University of Lappeenranta, Finland	Matematika i industrija. Pogled iz Finske i evropska saradnja.
15:45	Laura Fodor Agošton, izvršni direktor Panonska banka AD Novi Sad	Problemi u odredjivanju kreditnog rizika
16:15	kafe pauza	
16:45	Dragica Mihajlović, izvršni direktor, Panonska banka AD Novi Sad	Operativni rizik
17:15	Jorgić Branislav, Jorgić broker AD, Beograd	Rejting organizacija – utvrđivanje standarda za rangiranje HoV
17:45	kafe pauza	
18:15	Beogradska berza, Beograd	Korelacija izmedju cena akcije i indeksa Beogradske berze
20:00	Večera	

Subota, 2. jul 2005.

10:00	Janović Petar, Fabrika akumulatora AD Sombor	Proizvodnja akumulatora
10:30	Lalić Dragan, Takarič Bernat, JP Vodovod, Zrenjanin	Odredjivanje karakteristika vodovodne mreže i režima rada pumpnih agregata na izvorištu vodovoda
11:00	kafe pauza	
11:30	Živko Čonić, Poljoprivredna zadruga Ravangrad, Sombor	Odredjivanje optimalnog plana setve
12:00	kafe pauza	
12:30	dr D. Kozarski, dr V. Till, dr S. Stojanovic, Institut za radiologiju, Klinički centar Novi Sad	Primenjena matematika u radiologiji
13:30	Ručak	

Mathematical Modelling Week

The purpose of the Modelling Week is to offer students an intensive workshop which combines non-trivial mathematical challenge, real world problem solving, introduction to questions from corporate R&D or other development tasks in modern society.

Students are divided into teams of five or six. Each team is assigned to a modelling problem. The cases originate from industry, commerce, different organizations or branches of society. The problems are brought in and presented by the problem owners (or supervisors from universities replacing the industrial representatives). The students are allocated to teams on the basis of their areas of interest and mathematical expertise. The teams are guided by academic staff members called "group instructors". The week starts with the instructors giving a brief outline of the problem, the industrial context and the relevance of the problem. The team questions the problem owner about the problem and the expectations. To identify and understand the "real" problem may take some time. The students must formulate a model and recognize the typically non-unique mathematical problem. The analysis follows leading to analytical studies and efforts to find techniques for numerical solutions. Mathematical descriptions (models of the given problem) have to be written down and evaluated. In most cases computer programmes are developed using MATLAB or other software tools. The results of these computer simulations are then checked. The team has to ask themselves if the results provide a satisfactory answer with practical value to the original problem. Perhaps the model has to be changed or refined and an iteration process starts until the results satisfy the team and the instructor.

Typically the group arrives at an approximate solution. At the end of the week the student groups have to present their findings in public. The team prepares the final presentation of the results. Each team has 20 minutes to present their results and convince the participants of industry and commerce of the validity and usefulness of their solutions. The students must think carefully to discover ways to 'sell' their results.

Further they are assumed to produce later a written report, a short article that will be published in the proceedings of the Modelling Week. This Modelling Week will be organized in ECMI style described above as a part of Tempus CD JEP 17017-2002 project. The instructors will be from Technical University of Dresden (ECMI node), Lappeenranta University of Technology (ECMI node), Zielona Gora University (cooperation with ECMI group) and University of Novi Sad (cooperation with ECMI group). The target group are students from South-East Europe but students from other universities are also welcome. The Modelling Week will be organized together with Mathematical Industrial Days and therefore students will have a chance to meet with real problems coming from local industry, financial sector and nongovernmental organizations.

In order to work successfully students must possess some level of mathematical knowledge and therefore participants should be senior undergraduate or postgraduate students.

Problems for Mathematical Modelling Week

Hardware in the loop simulation in mechatronic design

Real time simulation methods and computational power makes it possible to connect a simulation model as a component in a real machine system. Examples could be the design of a car tire suspension or a manipulator arm of a crane. In the design process mechanical properties and performance of the components must be studied, alternatives selected etc. HIL Simulation means the following: Replace the real component by a simulation device, for example "virtual hydraulic system", that produces a mechanic response to a given input that is identical to the response of the real hydraulic component. HIL-simulator mathematical model + mechanical actuator, that will respond to the control signal.

In this project we build a model of a relatively simple mechanical device. We study the systems behavior when part of the mechanism is replaced by a computational model mimicking the actual mechanical part. In addition to the model building the task is to study the effect of the inevitable errors and deviations between the simulation model and the real component.

Instructor: Prof. Dr. Matti Heilio, University of Lappeenranta, Finland

Students:

Guberović Rafaela
Harčinović Ulfeta
Backović Danilo
Ristić Katica
Jovanović Irena
Shabani Armend
Ilić Aleksandar

Lake fish harvesting model

Consider the harvesting of few species of fish living in lake. We have collected some data concerning year fish harvesting but we are unable to construct an empirical model, i.e. fit directly the data with suitable function. We know that some of species of fish might compete for common resources. But in some cases one species is the primary food source for the other. Fishing company is interested in a prediction of further harvests.

Instructor: Prof. Dr. Wojciech Okrasinski, University of Zielona Gora, Poland

Students:

Perić Zoran
Miladinović Marko
Gajević Danica
Vujošević Janičić Milena
Bakota Tibor
Rakić Aleksandra

Optimal crop distribution in Vojvodina

We consider a production of cereals (wheat and maize) and a production of industrial crops (sugar beet, sunflower and soybean) in Vojvodina. Farmers, agronomists, and other agricultural specialists make a lot of decisions.

We are interested in crop distribution. On the one hand, the farmer wants maximization of the total gross margin, minimization of the total risk and minimization of the total labour. On the other hand, there are a lot of constraints (rotational constraint, policy constraint, market constraint).

We selected a limited period of 5 years (1999-2003) and collected data on crop distribution and gross margins.

Try to find the optimal crop distribution in Vojvodina.

Instructor: Dr. Zorana Lužanin, Assoc. Prof., University of Novi Sad, Serbia and Montenegro

Students:

Radovanović Dragica

Aleksić Tatjana

Marković Marjan

Denes Attila

Tomašević Jelena

Vla Katarina

Pap Zoltan

Stock Option Pricing

A stock option is a security that gives the holder the right (but not the obligation) to buy (if the option is a "call option") or to sell (if the option is a "put option") the underlying stock by a certain date for a certain price. This so called exercise price must be distinguished from the price of the option itself. Although the option price is fixed by the emittent of the option, it is affected by several factors. There are some models and formulas known for the pricing of options. The most famous is the so called Black-Scholes model.

The problem is to determine the pricing model for some selected options and - if possible - to develop a suitable approach for forecasting the option price in dependence on the history of the underlying stock.

Instructor: Dr. Jan Rudl, Technical University of Dresden, Germany

Students:

Vilotijević Vera
Hajdu Andrea
Milovanović Zorica
Bašić Milan
Braha Naim
Račić Sanja
Ivana Manić