«Operational Research»

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Instituto Superior Técnico

Department of Chemical and Biological Engineering
Area of "Process and Project Engineering"

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Operational Research

- Which timetable will it have ?
- What is it ?
- How will we treat it ?
- How will it be assessed ?
- Bibliography

· Which timetable will it have ?

Theoretical (T) or practical (P) classes:

(T or P) Tuesday, 10 h–12 h, Q4.4

(T or P) Thursday, 08 h–10 h, C-12

· What is it ?

(1) op·er·a·tions research (noun)

Abbreviation: OR – Mathematical or scientific analysis of a process or an operation, used in making decisions.

In BOOKSHELF: The American Heritage Dictionary of the English Language, 3rd Ed.. Copyright © 1992, Houghton Mifflin Comp.. Selected Illustrations from the Concise Columbia Encyclopedia. Copyright © 1991, Columbia University Press.

(2) operations research

Operations research, also known as operational research, deals with a broad range of mathematical applications that describe complex systems (see SYSTEMS ENGINEERING). The field originated in

World War II, when British scientists were asked to analyze air-defense[1] strategy, logistical problems, and other aspects of military operations. Operations research is now a common management tool (see INDUSTRIAL MANAGEMENT and MANAGEMENT SCIENCE) and is applied to such areas as production scheduling, inventory policies, transportation systems, and health-care delivery.

Operations researchers approach a problem by constructing a model (idealized representation) of the system. The model may be expressed in mathematical equations, or it may result from simulating on a computer the behavior[2] of the system. The model describes the structure of the system and the constraints placed on actions of the decision-maker. Often the problem has a clearly stated objective, such as to choose the mix of products that will maximize profits, or to design a customer-service facility that will minimize customer waiting time.

[1] American English *defense;* British English *defence.*
[2] AmEng *behavior;* BrEng *behaviour.*

Many mathematical techniques are used to find the best way to achieve such stated objectives, once the model has been given, and these techniques form active fields of mathematical study. Much of the art of operations research, however, lies in actually formulating problems and constructing and testing models.

Several areas of mathematics are closely linked to operations research. One such area is optimization, which studies ways of maximizing or minimizing a function subject to stated constraints. Linear programming[3] is one of the most common optimization methods. It provides an effective way to maximize a linear function of several variables subject to linear constraints on those variables (constraints in the form of linear equations or inequalities). For example, an oil refinery has available several types of crude oil that can be blended and

[3] Notice, however, that LP is the most typical part of OR !

processed in different ways to produce different mixes of refined products.

Linear programming can be used to find the blend that maximizes the profit on the refined products subject to constraints such as the limited availability of each type of crude and contract obligations to produce at least certain amounts of some refined products. Optimization methods are regularly used to control continuous-production facilities such as oil refineries.

Other mathematical fields related to operations research include game theory, decision theory, and queuing theory[4], and the study of graphs, flows, and networks. GAME THEORY analyzes competitive situations in which several opponents pursue conflicting goals. DECISION THEORY adds to game theory the availability of statistical information about the opponent's strategy. QUEUING THEORY is a

[4] This is another typical part of OR.

branch of the theory of PROBABILITY that studies arrival-service-departure systems such as turnpike[5] tollbooths, telephone exchanges, and typing or maintenance pools.

As a field of applied mathematics, operations research seeks effective computational procedures. The development of modern, high-speed COMPUTERS has contributed greatly to the effectiveness of operations research as a standard tool of management and engineering.

David S. Moore

Bibliography: **Bronson, R., Schaum's Outline of Operations Research (1982);** Feichtinger, Gustav, and Kall, Peter, Operations Research in Progress (1982); **Hillier, Frederick, S. and Lieberman, Gerald J., Introduction to Operations Research, 3d ed. (1980);** Taha, Hamdy A., Operations Research: An Introduction, 4th ed. (1987)

[5] *turnpike:* estrada com portagem; cfr. *turnstile*, torniquete (?).

In **"Grolier"** (*The Software Toolworks Multimedia Encyclopedia*, 1992 Edition, encyclopedia text and artwork © 1992 Grolier, Inc., etc.)

(3) (*In* Ravindran *et al.*, 1987) According to the *Operational Research Society of Great Britain*: OR is the application of the methods of science to complex problems arising in the direction and management of large system of men, machines, materials and money in industry, business, government, and defense. The distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically.

According to the *Operations Research Society of America*: OR is concerned with scientifically deciding how to best design and operate

man-machine systems, usually under conditions requiring the allocation of scarce resources.

(4) (See also Hillier & Lieberman, 1995)

(…)

· **How will we treat it ?**

It is a quantitative, numerical, computational subject.

We will try to make it applied and applicable, through

- Existing software
  Specific programs (Lindo, QSB [Quantitative Systems for Business], H&L OR Courseware, etc.)
- Excel or similar
- Course programs in the Internet

· **How will it be assessed ?**

Final exam (open book), on PC.

Other solutions can be used, such as combination with practical works.

· **Bibliography**

(See the Internet)

- Course notes (various)
- Frederick S. HILLIER, Gerald J. LIEBERMAN, 2005 (’01, 1995, ’90, ’86, ’80, ’74, ’67), "Introduction to Operations Research", 8.th ed., McGraw-Hill, xxv+1062 pp.

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