TERMINOLOGY

The British/Europeans refer to "operational research", the Americans to "operations research" - but both are often shortened to just "OR" (which is the term we will use). Another term which is used for this field is "management science" ("MS"). The Americans sometimes combine the terms OR and MS together and say "OR/MS" or "ORMS". Yet other terms sometimes used are "industrial engineering"("IE"), "decision science" ("DS"), and “problem solving”. In recent years there has been a move towards a standardization upon a single term for the field, namely the term "OR".

THE ORIGINS OF OPERATIONS RESEARCH

The formal activities of Operations Research (OR) were initiated in England during World War II when a team of British scientists set out to make decisions regarding the best utilization of war material. Following the end of the war, the ideas advanced in military operations were adapted to improve efficiency and productivity in the civilian sector. Today, OR is a dominant decision making tool.

WHAT IS OPERATIONS RESEARCH?

Operations
The activities carried out in an organization.

Research
The process of observation and testing characterized by the scientific method. Situation, problem statement, model construction, validation, experimentation, candidate solutions.

DEFINITION OF OR

Defining OR is difficult task as its boundaries and content are not yet fixed. It can be regarded as use of mathematical and quantitative techniques to substantiate the decision being taken. Further, it is multidisciplinary which takes tools from subjects like mathematics, statistics, engineering, economics, psychology etc. and uses them to score the consequences of possible alternative actions. Today it has become professional discipline that deals with the application of scientific methods to decision-making.
Few other definitions of OR are as follows:

- “OR is concerned with scientifically deciding how to best design and operate man-machine system usually requiring the allocation of scarce resources.”
  
  – Operations Research Society, America

- “OR is essentially a collection of mathematical techniques and tools which in conjunction with system approach, are applied to solve practical decision problems of an economic or engineering nature”.
  
  – Daellenbach and George

- “OR utilizes the planned approach (updated scientific method) and an interdisciplinary team in order to represent complex functional relationships as mathematical models for the purpose of providing a quantitative analysis”.
  
  – Thieraub and Klekamp

- “OR is a scientific knowledge through interdisciplinary team effort for the purpose of determining the best utilization of limited resources.”
  
  – H.A. Taha

- “OR is a scientific approach to problem solving for executive management”.
  
  – H.M. Wagner

**Scope of Operations Research**

The scope of OR is not only confined to any specific agency like defence services but today it is widely used in all industrial organisations. It can be used to find the best solution to any problem be it simple or complex. It is useful in every field of human activities, where optimisation of resources is required in the best way. Thus, it attempts to resolve the conflicts of interest among the components of organization in a way that is best for the organisation as a whole. The main fields where OR is extensively used are given below, however, this list is not exhaustive but only illustrative.

(i) **National Planning and Budgeting**

OR is used for the preparation of Five Year Plans, annual budgets, forecasting of income and expenditure, scheduling of major projects of national importance, estimation of GNP, GDP, population, employment and generation of agriculture yields etc.

(ii) **Defence Services**

Basically formulation of OR started from USA army, so it has wide application in the areas such as: development of new technology, optimization of cost and time, tender evaluation, setting and layouts
of defence projects, assessment of “Threat analysis”, strategy of battle, effective maintenance and replacement of equipment, inventory control, transportation and supply depots etc.

(iii) Industrial Establishment and Private Sector Units
OR can be effectively used in plant location and setting finance planning, product and process planning, facility planning and construction, production planning and control, purchasing, maintenance management and personnel management etc. to name a few.

(iv) R & D and Engineering
Research and development being the heart of technological growth, OR has wide scope for and can be applied in technology forecasting and evaluation, technology and project management, preparation of tender and negotiation, value engineering, work/method study and so on.

(v) Business Management and Competition
OR can help in taking business decisions under risk and uncertainty, capital investment and returns, business strategy formation, optimum advertisement outlay, optimum sales force and their distribution, market survey and analysis and market research techniques etc.

(vi) Agriculture and Irrigation
In the area of agriculture and irrigation also OR can be useful for project management, construction of major dams at minimum cost, optimum allocation of supply and collection points for fertilizer/seeds and agriculture outputs and optimum mix of fertilizers for better yield.

(vii) Education and Training
OR can be used for obtaining optimum number of schools with their locations, optimum mix of Students/teacher student ratio, optimum financial outlay and other relevant information in training of graduates to meet out the national requirements.

(viii) Transportation
Transportation models of OR can be applied to real life problems to forecast public transport requirements, optimum routing, forecasting of income and expenses, project management for railways, railway network distribution, etc. In the same way it can be useful in the field of communication.

(ix) Home Management and Budgeting
OR can be effectively used for control of expenses to maximize savings, time management, work study methods for all related works. Investment of surplus budget, appropriate insurance of life and properties and estimate of depreciation and optimum premium of insurance etc.
Phases of OR Study

OR is a logical and systematic approach to provide a rational basis for decision-making. The phases of OR must be logical and systematic. The various steps required for the analysis of a problem under OR are as follows:

Step I. Observe the Problem Environment
The first step of OR study is the observation of the environment in which the problem exists. The activities that constitute this step are visits, conferences, observations, research etc. with the help of such activities, the OR analyst gets sufficient information and support to proceed and is better prepared to formulate the problem.

Step II. Analyse and Define the Problem
In this step not only the problem is defined but also uses, objectives and limitations of the study that are stressed in the light of the problem. The end results of this step are clear grasp of need for a solution and understanding of its nature.

Step III. Develop a Model
The next step is to develop model, which is representation of same real or abstract situation. OR models are basically mathematical models representing systems, process or environment in form of equations, relationships or formulae. The activities in this step is to defining interrelationships among variables, formulating equations, using known OR models or searching suitable alternate models. The proposed model may be field tested and modified in order to work under stated environmental constraints. A model may also be modified if the management is not satisfied with the answer that it gives.

Step IV. Selection of Data Input
It is a established fact that without authentic and appropriate data the results of the OR models cannot be trusted. Hence, taping right kind of data is a vital step in OR process. Important activities in this step are analysing internal-external data and facts, collecting opinions and using computer data banks. The purpose of this step is to have sufficient input to operate and test the model.

Step V. Solution and Testing
In this step the solution of the problems is obtained with the help of model and data input. Such a solution is not implemented immediately and this solution is used to test the model and to find its limitations if any. If the solution is not reasonable or if the model is not behaving properly, updating and modification of the model is considered at this stage. The end result of this step is solution that is desirable and supports current organisational objectives.
**Step VI. Implementation of the Solution**

This is the last phase of the OR study. In OR the decision-making is scientific but implementation of decision involves many behavioural issues. Therefore, implementation authority has to resolve the behavioural issues, involving the workers and supervisors to avoid further conflicts. The gap between management and OR scientist may offer some resistance but must be eliminated before solution is accepted in totality. Both the parties should play positive role, since the implementation will help the organisation as a whole. A properly implemented solution obtained through OR techniques results in improved working conditions and wins management support.

**Features / Characteristics of OR**

The significant features of operations research include the followings:

(i) **Decision-making.** Every industrial organisation faces multifacet problems to identify best possible solution to their problems. OR aims to help the executives to obtain optimal solution with the use of OR techniques. It also helps the decision maker to improve his creative and judicious capabilities, analyse and understand the problem situation leading to better control, better co-ordination, better systems and finally better decisions.

(ii) **Scientific Approach.** OR applies scientific methods, techniques and tools for the purpose of analysis and solution of the complex problems. In this approach there is no place for guess work and the person bias of the decision maker.

(iii) **Inter-disciplinary Team Approach.** Basically the industrial problems are of complex nature and therefore require a team effort to handle it. This team comprises of scientist/mathematician and technocrates. Who jointly use the OR tools to obtain a optimal solution of the problem. The tries to analyse the cause and effect relationship between various parameters of the problem and evaluates the outcome of various alternative strategies.

(iv) **System Approach.** The main aim of the system approach is to trace for each proposal all significant and indirect effects on all sub-system on a system and to evaluate each action in terms of effects for the system as a whole. The interrelationship and interaction of each sub-system can be handled with the help of mathematical/analytical models of OR to obtain acceptable solution.

(v) **Use of Computers.** The models of OR need lot of computation and therefore, the use of computers becomes necessary. With the use of computers it is possible to handle complex problems requiring large amount of calculations.
Limitations of Operations Research

OR has some limitations however, these are related to the problem of model building and the time and money factors involved in application rather than its practical utility. Some of them are as follows:

(i) **Magnitude of Computation.** Operations research models try to find out optimal solution taking into account all the factors. These factors are enormous and expressing them in quantity and establishing relationships among these require voluminous calculations which can be handled by computers.

(ii) **Non-Quantifiable Factors.** OR provides solution only when all elements related to a problem can be quantified. All relevant variables do not lend themselves to quantification. Factors which cannot be quantified, find no place in OR study. Models in OR do not take into account qualitative factors or emotional factors which may be quite important.

(iii) **Distance between User and Analyst.** OR being specialist’s job requires a mathematician or statistician, who might not be aware of the business problems. Similarly, a manager fails to understand the complex working of OR. Thus there is a gap between the two. Management itself may offer a lot of resistance due to conventional thinking.

(iv) **Time and Money Costs.** When basic data are subjected to frequent changes, incorporating them into the OR models is a costly proposition. Moreover, a fairly good solution at present may be more desirable than a perfect OR solution available after sometime. The computational time increases depending upon the size of the problem and accuracy of results desired.

(v) **Implementation.** Implementation of any decision is a delicate task. It must take into account the complexities of human relations and behaviour. Sometimes, resistance is offered due to psychological factors which may not have any bearing on the problem as well as its solution.