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Full Length Review Article

A FUTURISTIC APPROACH- INDUSTRIAL MATHEMATICS

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ABSTRACT

The research paper discusses the growing importance of Industrial Mathematics and its useful applications in the organizations. As we all know that modelling and asymptotic analysis appear in classical applied mathematics, but industrial mathematicians need a wide and broad knowledge of mathematical ideas, algorithms and computer. They need an understanding of the problems in industry, actually they have to understand and speak the language spoken in the industries. Industrial mathematics is a mathematical modelling and scientific computing of industrial problems. In present scenario, the Industry Manager has wide range of responsibilities. To manage them effectively, Industrial Mathematics has emerged and has gained popularity for evaluating new tools and technologies designing new products, restricting the production process, forecasting sales and staffing needs and designing jobs so that staff can progress to position of leadership, overlaying all of these activities is constant attention to high quality in the products delivered to customers and work done for the industry.

INTRODUCTION

In the era of globalization an Industry Manager has wide range of responsibilities. One has to monitor existing work for his customers and assign new work to their staff, because of the technical nature of the work a manager has to devote considerable time to making sure his / her unit has the human resources, training, equipment and technology needed to provide customers with high quality products in lively manner. While managing these day-to-day operations, much of the time has been spent on strategic issues: evaluating new tools and technologies designing new products, restricting the production process, forecasting sales and staffing needs and designing jobs so that staff can progress to position of leadership, overlaying all of these activities is constant attention to high quality in the products delivered to customers and work done for the industry. The interface of mathematics is the real world is a fast growing discipline within mathematical sciences and is characterized by the origin of the problems, which originate from the industry. In this contest a new discipline "Industrial Mathematics" has emerged and has gained popularity in the world. Industrial mathematics is a mathematical modelling and scientific computing of industrial problems. Of course, modelling and asymptotic analysis appear in classical applied mathematics, but industrial mathematicians need a wide and broad knowledge of mathematical ideas, algorithms and computer.

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They need an understanding of the problems in industry, actually, they have to understand and speak the language spoken in the industries. The main objectives of industrial Mathematics are to transform the technical, organizational and economic problems originally posed in a non-mathematical language into mathematical problems, to solve these problems by applying mathematical techniques or by approximate methods of analytical or numerical nature, to reinterpret the results in terms of original problems. Industrial mathematicians are bridge builders. They build bridges from the field of mathematics in the practical world: for that they have to know problems from some companies and ideas and methods from mathematics. They have to be generalists, not specialist.

Research Objectives

- To study the significance of Industrial Mathematics in the present organization structure.
- To study the problems on which techniques of Industrial mathematics are applicable.
- To do the comparative study of applied and industrial mathematics.
- To study the role of industrial mathematics in developing and developed nations.

Issues and problems in industrial mathematics: If you enter the world of the Industry, you never know what kind of problems you will encounter and which kind of mathematical

method you will apply. Here I suggest some problems in industry and mathematical methods to solve them, but the list is not exhaustive and final:

- Problems where signals and images have to be processed or solved by applying Bayesian statistics, time series analysis, wavelets, energy functional etc.
- For problems of optimizing the Transport or in storage of industrial good new methods of combinatorial optimization are used.
- In problems of predicting the outcomes of complicated systems, which do not allow to understand the mechanism behind the methods of adaptive systems theory, of learning of neural networks etc. are used.
- Problems where complicated multiphase flow happens in porous media, forming fronts and drops are solved by the methods of homogenization, level set methods, front tracking algorithms etc.
- Problems of interaction of flexible structure (Fibres, paper sheet) within a flow round require multigrain methods etc.
- Problems of optimizing the properties (elasticity, beat conductivity etc.) for compound materials are dealt with the methods of homogenization and regularization of inverse problem of optimal shape design.

Comparative study of applied and industrial mathematics

From the above discussion it is obvious that industrial mathematicians have to be generalists, they have in know a large variety of mathematical concepts and methods. They have to know modern mathematics. They should know more advanced method than scientists and engineers. Industrial mathematics is not a new subject in itself like statistics, engineering mathematics etc. actually, it is another kind of activity of getting problems, looking at problems, solving problems, interpreting and using solutions. It is a new discipline different from pure and applied mathematics. In his article "Applied Mathematics is Bad mathematics and mathematics tomorrow". Halmos compares the picture of real world provided by applied mathematics with police photograph of a wanted criminal, and that of pure mathematics with a portrait by Picasso. Main differences are summarized as given below:

- Applied mathematicians do not accept a difference between pure and applied, while pure mathematicians do. Industrial mathematics makes the use of both pure and applied mathematics whichever is suited to the problems in industry. This is the first difference between applied and industrial mathematics.
- Most of applied mathematics is 'applicable' mathematics-mathematics, which hopes or expects to be applied, busy still has not been applied whereas industrial mathematics has its industrial applications, it treats problems posed by industry and questions of technical, organization of economic nature which are posed by companies. This is the second main difference between applied and industrial mathematics.
- Thus form the points of human creativity, industrial mathematic is one of the most exciting, adventurous and joyful activities mathematician can find.

In spite of being different from pure and applied mathematics, it needs both. Industrial mathematics stand on the shoulders of mathematics and industrial mathematicians use ideas of others, than they invent the new ones. Mathematics is also profited from industrial mathematics, mainly by offering new challenging problems, better chances for young mathematicians, higher prestige in outside mathematical community.

Scope of industrial mathematic in developed nations

There is the European consortium for mathematics in industries (ECMI), which organizes education and research in industrial mathematician from several European Universities, among which are Eindhoben (Netherland), Firenze (Italy), Glasgow (Scotland), Kaiserslautern (Zermany), Linz (Austria), Oxford (England), There is a division of industrial mathematics at CSIRO in Australia, an institute for industrial mathematics in Israel, IMA in Minneapolis and some more in USA. At global level there is an international council of industrial and applied mathematics (ICIAM) which was established in 80's to promote industrial and applied mathematics internationally, to promote interaction between member societies, and to co-ordinate planning for periodical international meeting on industrial and applied mathematics. It comprises the representatives of the member societies of different countries, ICIAM has organizes six international conferences in 1987(Paris), 1991 (Washington D.C.), 1995 (Hamberg), 1999 (Edinburgh), 2003 (Sydeny) and 2007 Jurich. During the last decade ECMI was quite successful. It has now centers in more than 10 European countries, where a post graduate program in "Industrial Mathematics" is organized. This program has 2 branches: Techno mathematics and Econo Mathematics. Techno mathematics deals with applications of mathematics in technology and focuses on differential equations and its application in mechanics, Electrodynamics, Thermodynamics etc., on signal analysis, image processing and inverse problems and mainly on numerical methods too. Economy Mathematics treats organizational problems by mathematics, on statistics, operations research and economic in equalities in information theory. Both programs differ from classical applied mathematics programs as their use modelling and scientific computing in big way. After completing the program the student should have the following capabilities:

- Proficiency in the formulation of real world situations in to qualitative or quantitative mathematical models and its analysis.
- Experience of the use of mathematical models in the industry and in the handling of mathematical methods for answering practical questions and for solving problems from the real world
- Sufficient knowledge of the mathematics i.e. Relevant for one and two and further reaching knowledge of some special field of interest.
- Knowledge of numerical method and simulation, and experience in the intelligent use of computer
- Background knowledge of computer science and pure mathematics.
- Experience in team work and making a personal contribution to team project.
- Sufficient knowledge of some scientific field where mathematics is used in practice (for eg. Physics, Mechanics, Chemistry, Electro techniques, Economics, industrial engineering) and to be able to communicate with experts in this field; and

- To be able to give oral and written presentation of their scientific work in such a way that not only mathematician but also interested lay man get the main messages.

Scientific cooperation with industries is an essential component of teaching of industrial mathematics. Without linkage with industries, the teaching of industrial mathematics is just to swim without water, the literature is full of examples of scientific cooperation, the term proceeding volumes of ECMI conferences and a series of book by Friedman (1) are referred , these contain various problems rally posed by industries; but even there we find two categories ; problems , whose solution is academically exciting but of minor industrial interest and those which are of burning interest for the company and for which the company pays , in academic world the value is measured by the number of good publications, while in industry it is measured by the price paid for it. Industrial mathematician are squeezed between two criteria. The well- known particle methods have found applications in space flight simulation, in granular flow and even in the simulation of traffic flows on highways.

There is a general strategy which seems to become more and more important: to combine analytical or asymptotic with numerical methods to get results cheap as possible but as precise as necessary. Ray tracing has some features of particle methods. Since early eighties, in industrialize nations a systematic effort is being made to re-establish linkages between mathematics and real world problems. There are some new areas of mathematical knowledge, which has been invented during the industrial and technological revolution, and these have been termed as industrial mathematics. Some of these areas are Fractal Geometry, Wavelets Theory, ordinary and partial Differential equation, variation inequalities, finite elementary methods, inverse problems, fatigue analysis damage estimation, optimization techniques and quality control, images processing, Fourier analysis via Computers, Information and Coding Theory, Modeling of Semi-conductor Devices in Paper Industries, Textile Industries, Steel Industries, Drug Designing and Software Development. Beside these fields any other part of mathematical sciences having significant place in the steps of the world in industrial mathematics can be included in Industrial mathematics. In cooperation with industry, the following procedure is being adopted by the chairman of Industrial mathematics department in the leading universities of western world which has proved to be useful and suitable:

- In a first meeting the problem is presented by the prospective industrial partner. Sometimes it is obvious that another academic institution is more specialized for treating the problem. In this case, department will help to establish the contact.
- After deciding that the problem fits into the framework of their expertise, usually the preparatory phase starts: a mathematical models for the problems is formulated in close interaction with the industrial specialist and the plan for treating the problem is developed.

However, the problems which contain the research element are given preference. In the Preparatory phase, the cost and the duration of the prospective project are also discussed and fixed.

- Before starting the actual project phase, a contract is made specifying the targets and the techniques. Usually, this leads to the development of project-specific software.
- At the end of the project, the developed software is installed at the company. Usually the scientific paper which results from a project is discussed with the industrial partner before publication.

It is important for the success of the project that on both sides there is a well defined person responsible for the interaction between the industry and the company. In particular, this includes the regular reports of the project from university side and the supply of necessary data from the company.

Role of industrial mathematics in developing and developed nations

The situation of industrial mathematics in third world industries' is different from that in Europe, Australia and USA. The institute of Industrial Mathematics (ITWN) University of Kaiserslautern, Germany, trained more than 50 third world students in two years' program in industrial mathematics. After training they went to their home countries and tried to apply their new knowledge, but unfortunately 30 of them returned to Germany in 1996. The following picture emerged on their reporting of their experiences.

- Managers of companies in the third world countries are even less aware of the role of science and especially of mathematics than their "western" colleagues. This opinion originates from the fact that some companies have their research labs in Europe or the USA, doing production only in their home country. Moreover, it is a general belief that mathematics is only useful for hi tech companies, if their production or products are not hi tech, they do not consider mathematics as a valuable tool. But what is high tech? There was a kind of definition by David, who wrote the famous report of the NSF in the USA about the support of mathematics. "When we entered the area of high technology we entered the era of mathematical technology". Challenging a word of David Hilbert we may say: any technology is as much "high technology" as is mathematics in it. The consequences of these statements simply are that one may change every product into a hi-tech product by investing more science and especially more mathematics in its production. Actually, mathematics for basics technology in textile, furniture, glass, metal and food processing has become very popular, the same holds for the simulation of environmental event as avalanches, pollution, breaches in dams etc.

Conclusion

After discussing so far, we can conclude the fact that in the era of globalization an Industry Manager has wide range of responsibilities to be fulfilled and tasks to be done. One has to monitor various things at a time such as existing work for his customers and assigning new work to their staff, because of the technical nature of the work a manager has to devote considerable time to making sure his / her unit has the human resources, training, equipment and technology needed to provide customers with high quality products in lively manner.

For all the above questions, the Industrial mathematics is the best answer and can be effectively used by the managers. In this contest a new discipline "Industrial Mathematics" has emerged and gained popularity in the world.It is a mathematical modelling and scientific computing of industrial problems to get the maximum output. In present scenario, the managers need to be generalists, not specialists.

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