# Industrial Applications of Mathematics- A Review

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***Abstract***— Industrial Mathematics is a emerging field within the mathematical sciences. It is characterized by the origin of the problems which it engages and are associated with industry. For example Research and Development, finances, manufacturing, software and information technology and communications to list a few. In this review we aim to explore a better understanding of industrial models and processes through mathematical ideas and computations.

***Keywords***-*Business Analytics,Systems Biology, Manufacturing.*

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## I. Introduction

Mathematics is the most versatile of all the sciences. It is uniquely well placed to respond to the demands of a rapidly changing economic scenario of developing society. The systematic application of mathematics and computing to the most challenging industrial problems will be a vital contributor to business performance. Mathematics now has the opportunity more than ever before to solve quantitative understanding of industrial strategy and processes across all sectors of industry [1]. Companies that take best advantage of this opportunity will gain a significant competitive advantage. Mathematics truly gives industry the edge for better economic growth. Mathematics finds applications in various fields like

- Business Analytics
- Computer Systems, Software and Information Technology
- Systems Biology
- Oil Discovery and Extraction
- Mathematical Finance
- Manufacturing
- Communications and Transportation
- Modeling Complex Systems

In this review article we are mainly focused on the applications of mathematics to Business analysis, systems biology and manufacturing sector.

## II. BUSINESS ANALYTICS

Business Analytics (BA) may be defined as "a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions" [2]

The software industry is making a big bet that the data-driven decision making … is the wave of the future. The drive to help companies find meaningful patterns in the data that engulfs them has created a fast-growing industry in what is known as "business intelligence" or "analytics" software and services. Major technology companies—IBM, Oracle, SAP, and Microsoft—have collectively spent more than $25 billion buying up specialist companies in the field. [Lohr, 2011-a]

"Business analytics" has become a popular and emerging field that includes well-established fields of applied mathematics such as operations research and management science. However now a days its scope is widened by the application of the immense databases to business executives.

The new opportunity, both for businesses and for students hoping to enter industry, lies in the development of algorithms and techniques to handle large amounts of structured and unstructured data at a cheaper cost. Corporations are adopting business intelligence (i.e., data) and analytics (i.e., quantitative methods) across the enterprise, including such areas as marketing, human resources, finance, supply chain management, facility location, risk management, and product and process design.

An exciting area of applied mathematics called Operations Research combines mathematics, statistics, computer science, physics, engineering, economics, and social sciences to solve real-world business problems [3]. Numerous companies in industry require Operations Research professionals to apply mathematical techniques to a wide range of challenging questions. It has been successful in providing a systematic and scientific approach to all kinds of government, military, manufacturing, and service operations.

## III. SYSTEMS BIOLOGY

Pharmaceutical researchers have undertaken many initiatives and technologies to stem the rising costs of drug discovery and development. Biomarkers, adaptive trial designs, modeling, trial simulations, predictive metabolism, data mining, and disease models have reshaped the way in which researchers approach discovery and development. Quantitative pharmacology, which leverages model-based approaches, operates at both cultural and technical levels to integrate data and scientific disciplines. [Allerheiligen 2010] [4]

The completion of the Human Genome Project in 2000 ushered a new era of individualized medicine and targeted drug discovery. However, only a few uncommon diseases or disease variants result directly from individual mutations in the human genome. Most common disorders such as diabetes and cancer arise from the malfunctioning of complicated networks of genes. The idea of treating such diseases by fixing one gene is beginning to look as naïve as the idea of fixing an engine by replacing one screw. Earlier, doctors require a whole sequence of interventions, in targeted amounts, at particular times and in particular places in the gene network. As the complexity of gene networks is becoming more apparent, mathematical methods for their analysis is gaining more importance [5].

Molecular dynamics simulations start at the most fundamental level, using the principles of quantum mechanics. Recent advances in algorithms, software, and hardware have made it possible to simulate molecules containing tens of thousands of atoms for up to a millisecond—the time scale at which many important biological processes happen.

Other mathematical models go in the opposite direction and operate on the level of the whole organism. These models are used, for example, to predict how a population of patients—each one with his or her unique physiology—might respond to a proposed public health intervention. Eventually, whole-patient models may become integrated with genomic data to make truly individualized medicine possible.

The mathematical and computational techniques behind these models include network science, deterministic and stochastic differential equations, Bayesian networks and hidden Markov models, optimization, statistics, control, simulation, and uncertainty quantification.

Kohzanov studied the problem of population dynamics using mathematical modeling [6]. Mathematically, it reduces to studying the solvability of a nonlocal boundary value problem for quasilinear ultra-parabolic equations with astronomical time t and biological time (age) a.

Nikolaev et al described the modeling of the dynamics of renewing zone structure in biological tissues in the formalism of parameterized L-systems on an example of the shoot apical meristem [7]. He studied the influence of the ratio of the characteristic times of the cell cycle and diffusion of morphogens on the stability of some spatially distributed molecular-genetic control system. and showed that cell division is a perturbing factor for the system regulating the renewing zone structure.

Sadovskii and Senashova studied the model of a spatially distributed two-species population which interact according to the predator-prey pattern [8]. Each species is distributed over two stations. The migration of individuals between the stations are purposeful and maximize the breeding coefficient for each species. In addition, each species pursues its reflexive strategy of behavior to determine the optimal migration flow.

## IV. MANUFACTURING

Applied mathematics continues to be an integral part of manufacturing in many different ways: designing prototypes, optimizing designs, verifying the designs, production and inventory planning, and managing supply chains [9].

Multidisciplinary design optimization (MDO) provides procedures and analytic and computational tools for coordinating efforts of design teams from multiple disciplines. Multidisciplinary design optimization (MDO) is a field of research that studies the application of numerical optimization techniques to the design of engineering systems involving multiple disciplines or components.

Simulation-based design of complex systems in aerospace and automotive systems, for example, relies on computer analysis (including computational fluid dynamics and finite-element analysis). One of the major challenges still facing the computer-aided design (CAD) industry is to unify design, analysis, and verification into one seamless process. Too often, design engineers and verification engineers use different algorithms, different software and different file types. This creates a bottleneck, as the CAD files have to be converted from one form to another. Isogeometric analysis is a promising new technique used to create three-dimensional virtual models that can be plugged directly into physical differential equations.

In spite of the fact that mathematics is an important tool to solve complex industrial problems, the acceptance is not as wide spread as expected. Industrial mathematicians are working only in large companies like Philips, IBM and AT &T etc. With the passage of time more and more groups are hiring qualified mathematician to solve their manufacturing problems.

The goal of production planning is to deliver a build schedule that makes efficient use of resources while fulfilling as much demand as possible. The build schedule needs to take into account the flexibility of production resources, the stochastic nature of supply and demand within the supply chain, and the timing of new product releases and production facility improvements. Planning processes that rely on heuristic, manual decision-making are not adequate in industries with complex mixtures of products and manufacturing processes. Better decision algorithms, improved data management, and an automated and integrated planning process are needed.

## V. CONCLUSION

The role of mathematics as a main tool for development of science and technology has always been quite clear. Mathematics has emerged as a central science which finds applications in almost all fields of science, engineering, business and industry. There is a need for more profound analysis of basic mathematics to answer the needs of computation of highly nonlinear phenomenon whose complexity cannot be solved on pen and paper.

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