GNITED MINDS
Journals

Journal of Advances in Science and Technology

Vol. 10, Issue No. 21, February-2016, ISSN 2230-9659

A COMPARATIVE STUDY OF MATHEMATICAL MODELING FOR SOME INDUSTRIAL SYSTEM: BEHAVIOUR AND AVAILABILITY ANALYSIS

AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

A Comparative Study of Mathematical Modeling for Some Industrial System: Behaviour and Availability Analysis

Amit Kumar*

Research Scholar

Abstract – Mathematics is the most versatile of all the sciences. It is uniquely well placed to respond to the demands of a rapidly changing economic landscape. Just as in the past, the systematic application of mathematics and computing to the most challenging industrial problems will be a vital contributor to business performance. The difference now is that the academic community must broaden its view of mathematics in industry and its expertise must be managed in more imaginative ways.

An analysis of a problem requires the formulation first. Originally, problems can solve using statistical methods. Afterward this can do on; Laplace transform technique was used to solve the problems. There are many techniques of predicting the reliability of a system. The paper contains about the system model concept to produce mathematical model and analyze industrial system.

This paper describes how some industrial problems can be solved using relatively simple mathematical models. Models can be used also to provide insight into how industrial system components interact. Finally, some models that address industrial problems, such as inventory models, linear programming, network flow, decision analysis, queueing models, and simulation are examined.

---------------------------♦-----------------------------

INTRODUCTION

Mathematics now has the opportunity more than ever before to underpin quantitative understanding of industrial strategy and processes across all sectors of business. Companies that take best advantage of this opportunity will gain a significant competitive advantage: mathematics truly gives industry the edge.

Academic mathematics is insufficiently connected to mathematics outside the university. One of the greatest—and most difficult—opportunities for academic mathematics is to build closer connections to industry.

Academic mathematical science must strike a better balance between theory and application. At one extreme, a narrowly inward-looking community will miss both the opportunities that arise outside the mathematical sciences and the opportunities that are part of scientific and technological developments. At the other extreme, an exclusive concern with applications and collaborative research would severely limit the mathematical sciences and deprive the scientific community of the full benefits of mathematical inquiry. At present, the balance is tilted too far towards inwardness.

A narrow vision of mathematics in academic departments translates into a narrow education for graduate students, most of whom are oriented toward careers only in academic mathematics.

In the present scenario of spirited market to cut down manufacture costs and improve productivity and delivery performance of manufacturing systems of processing industries are the key objectives of manufacturing. Process Industries must provide continuous and long term production to meet the ever increasing demand at lower costs. The Reliability and Availability analysis of procedure Industries can advantage in terms of higher production, lower maintenance costs. The availability of complex systems and continuous process industries can be enhanced by considering maintenance, inspection, repairs and replacements of the parts of the failed units.

Since, we are living in probabilistic environment, so we need the knowledge of probability. Probability is necessary for mathematical study of reliability. Thus before proceeding further, we introduce first the fundamental idea of dependability.

The systems approach has beginnings far back in history. But as modern systems analysis has broadened, it has already begun to be controversial and misunderstood. The systems approach has quickly attracted overly zealous proponents and, as often, misinformed detractors. Substantial disagreement exists among the professionals as to how useful the approach is for the bigger problems of society, or for smaller ones when they are more "social" than "technological." This confuses the nonprofessional as to what the approach really is. It impedes its appropriate application. Some hail it as magic, a new all-powerful tool that can demolish any tough problem, engineering or human. Of course, there are always the doubters, the mentally lazy or ignorant who are annoyed with the entry of something new. And there are some aerospace engineers who have used the systems approach but only for narrow problems in their specialized field. They often do not realize they must extend their team capabilities considerably to handle complex social-engineering problems. Some experienced systems engineers go to the other extreme, certain the discipline is inappropriate for "people" problems. In this viewpoint, they are sometimes joined by experts schooled in the more unpredictable behavior of man. Some of these more socially trained individuals are concerned that the systems approach's disciplines cannot be applied successfully to the real-life problems of the human aspects of our civilization.

Early modern industrial engineering modeling tools were developed by Taylor, the Gilbreths, and Gantt. They proposed procedures to improve operations and check the progress of multiple work activities. The early project management techniques included project evaluation and review technique and the critical path method. These are still used today to help manage large projects. Early mathematics (computations, statistics, and accounting) has been applied to operations problems, in administration and in managing technical activities, by public administrators, engineers, and managers. The focus of this contribution is on the use of mathematics to solve industrial problems. We discuss many areas of mathematics as well as the variety of industrial problems to which mathematics has come to aid. What does it mean to model a particular system? First one needs to abstract the essence of a situation and then represent it mathematically. This representation is then mathematically manipulated to provide some useful information. Finally, the knowledge gained from this information should be translated into an action for the system, situation, or problem at hand. A nice overview of modeling as well as developing modeling skills is provided in Powell (2001).

PERSPECTIVE FROM INDUSTRY

From the point of view of industry, mathematics is an enabling technology. It provides a logically coherent framework and a universal language for the analysis, optimization, and control of industrial processes. Because it is an enabling technology, its contributions are rarely visible in the final product that industry delivers. Nevertheless, the economic impact is real, and many companies – old, as well as new – have achieved a competitive advantage through the judicious use of mathematics.

While mathematics presents industry in the 21st century with major opportunities, it faces significant structural challenges in the industrial environment. A strong pressure to organise research and development around well-defined projects, combined with an increasing trend to outsourcing, has led even large companies to significantly reduce their investment in the mathematical sciences. Because project-oriented workflows tend to rely more on established practices than on innovative enabling technologies, the role of mathematics research that might overcome or alleviate technical problems has been diminished, resulting in short-term vision and a loss in economic potential. Nonetheless, strongly innovative companies that properly exploit mathematics can rapidly gain a commercial edge over their competitors. This is illustrated dramatically by the success of start-up companies selling custom-designed software.

The claim of the present report is that the time has come to reinvigorate the synergy of mathematics and industry. Industry faces new challenges; mathematicians are ready to respond and can make significant contributions.

- Engineering systems and manufacturing processes are becoming increasingly complex; design optimization, time-to-market, and cost effectiveness have become major concerns.

- The ubiquity of powerful microprocessors and the advent of inexpensive data storage have led to an ever-expanding capability to collect data. But the useful integration of such data in an industrial context requires that they be processed, preferably in real time, and transformed into information and knowledge.

- Mathematical concepts and methods play a growing role for biotechnology and medical technology. An avalanche of data and information at molecular and cellular levels has launched a technological revolution. Better quantitative understanding of biochemical and biophysical processes is initiating innovative technologies producing drugs, biological materials or artificial tissues. Mathematical tools enable the design of new compounds and processes with prescribed functional properties.

- Societal concerns have led to regulatory actions that reflect more stringent requirements for the safety and reliability of products; they demand new methods for validation, verification, and the quantification of uncertainties.

- Globalisation, awareness of resource limitations, increasing sensitivity to anthropogenic effects on the environment, and general concerns about sustainability impose constraints on industry, as well as on society as a whole. They force industry to continually analyse and evaluate its activities in a broader social context, beyond the bottom line.

The traditional reductionist methods of the physical sciences and engineering are no longer adequate to answer many of the questions raised in an industrial environment. Today's problems are complex and nonlinear, they involve phenomena on multiple length and time scales, and their analysis can extend well beyond the realm of textbook mathematics. Industry requires access to qualified mathematical scientists who appreciate and understand its needs, who have been trained to capture the essence of an industrial problem in mathematical terms, who can apply methods of contemporary mathematics, and who are familiar with the latest advances in scientific computing and numerical algorithms. Only such people can produce the transformative new ideas that drive future innovations.

SYSTEMS PHILOSOPHY

The methods of systems thinking provide us with tools for better understanding these difficult management problems. The methods have been used for over thirty years (Forrester 1961) and are now well established. However, these approaches require a shift in the way we think about the performance of an organization. In particular, they require that we move away from looking at isolated events and their causes (usually assumed to be some other events), and start to look at the organization as a system made up of interacting parts.

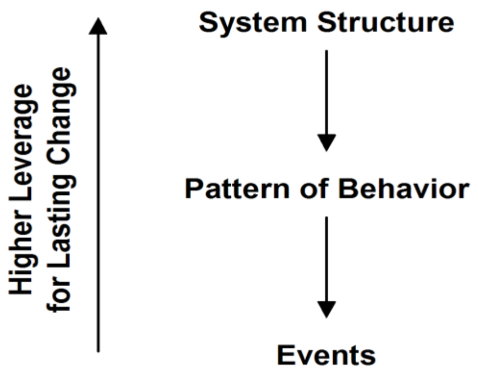

Figure 1 :System behavior and causal loop diagrams

We use the term system to mean an interdependent group of items forming a unified pattern. Since our interest here is in business processes, we will focus on systems of people and technology intended to design, market, produce, and distribute products or services. Almost everything that goes on in business is part of one or more systems. As noted above, when we face a management problem we tend to assume that some external event caused it. With a systems approach, we take an alternative viewpoint—namely that the internal structure of the system is often more important than external events in generating the problem.

PATTERNS OF BEHAVIOR

The systems approach gains much of its power as a problem solving method from the fact that similar patterns of behavior show up in a variety of different situations, and the underlying system structures that cause these characteristic patterns are known. Thus, once we identified a pattern of behavior that is a problem, we can look for the system structure that is known to cause that pattern. By finding and modifying this system structure, we have the possibility of permanently eliminating the problem pattern of behavior.

CONSISTENCY

Reliability contains rich mix together of essential concepts and sensible problems from the real world. In the wider sense, the word 'reliability' has a very significant meaning: Re and liability. It simply means that it is the legal responsibility, not once but again and again. The concept of reliability has been interpreted in many unlike ways in plentiful works out of which a few are listed below:-

(i) Reliability is the essential of the allocation of probabilities of failure free process from the instant of switch on to first failure.

(ii) Reliability is the likelihood that the piece of equipment will operate without failures for a given time underneath given in commission environment.

One of the definitions which have been accepted by most fashionable consistency establishment is given by the Electronics Industries Association (EIA) U.S.A. which states, "Reliability is the probability of an item performing its intended function over a given period of time under the operating conditions encountered;

APPLICATIONS OF RELIABILITY TECHNOLOGY

a) Electrical and electronics manufacturing utmost work has been done which may be seen in the literature. Analysis of systems and reliability optimization are given in the literature.

b) Mechanical engineering applications are contained in Dhillon and Singh's book. It may be seen in literature. Singh applied the technology to process industries which may be seen.

c) The agricultural submission may be seen.

d) Applications to non-conventional liveliness systems.

e) The software reliability is given.

f) In civil and element engineering some work has been done on reliability but not very much. There is scope for work in these fields.

g) In the fields of robotics there is scope for work.

h) In biological sciences, there is good scope for the work.

TECHNIQUES OF PREDICTING THE RELIABILITY OF A SYSTEM

There are many techniques of predicting the reliability of a system. The following methods may be used to analyze and predict the reliability of a system.

- Regenerative Point Technique.
- Supplementary Variable Technique.
- Renewal Theoretic Approach.
- Markow Method.
- Laplace Transform Technique.

Problems solving using all this techniques required very drawn out mathematical calculations, which are exceptionally much time and energy overwhelming.

REGENERATIVE POINT GRAPHICAL TECHNIQUE

The Mean Time to System Failure(MTSF), Availability, Busy period of Server, number of Server's visits and number of Replacement etc. Regenerative Point Graphical Technique

Is very useful as;

1) Valuable results may be found without doing lengthy calculations.

2) Time is saved.

3) Energy is also saved.

4) Various parameters of system can evaluate quickly and easily.

SYSTEM MODELING

Modeling is the process of producing a model; a model is a representation of the construction and working of some system of interest. A model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. On the one hand, a model should be a close approximation to the real system and incorporate most of its salient features. On the other hand, it should not be so complex that it is impossible to understand and experiment with it. A good model is a judicious tradeoff between realism and simplicity. Simulation practitioners recommend increasing the complexity of a model iteratively. An important issue in modeling is model validity. Model validation techniques include simulating the model under known input conditions and comparing model output with system output. Generally, a model intended for a simulation study is a mathematical model developed with the help of simulation software. Mathematical model classifications include deterministic (input and output variables are fixed values) or stochastic.

A FUTURE INDUSTRIAL APPLICATION

A future application falls in the realm of homeland security. Many supply chains are particularly vulnerable to disruptions because of their design characteristics and operating philosophies. Disruption effects on direct targets could be substantial. Long lasting and rippling effects could be felt throughout multiple business sectors because of the increase in business interrelations. A current complex JIT environment creates supply chains that integrate many private and public entities with unclear contingency plans and roles in a disaster. JIT also provides insufficient buffers to absorb unusual system disturbances in supply networks. Since most companies' operations are not flexible enough for essential quick responses, disruptions can create bullwhip and queueing effects. The amplification of demand variability from a bullwhip effect can cause increasing negative economic effects further upstream and downstream. There is a need to understand these systems to probe for weaknesses, predict outcomes, and test policies. The scale and complexities involved pose significant problems. Schmitt and Stecke (2003) have applied novel methods of simulating and modeling to synthesize the huge, dynamic mass of information that flows in supply networks. They are working with Sandia National Laboratories in the development of an "agentbased" model of supply networks of 14,000 manufacturing firms in the Pacific Northwest to assess the economic impact of various disruptions in critical infrastructure. The overall mathematical modeling effort should contribute to the U.S.'s effort and ability to prepare for possible attacks on critical infrastructure such as electric power, telecommunications, and transportation, and improve the effectiveness and efficiency of responses should such attacks occur.

CONCLUSION

Industry faces problems that extend well beyond the envelope of classical topics in mathematics. Many of these problems have a significant mathematical component, and the intellectual challenges they pose fall in many cases within topical areas of current research in the mathematical sciences. Stronger links between mathematics and industry will be beneficial both to the partners and to national economies. They will inspire new mathematics and enhance the competitive advantage of companies. Several countries have developed a variety of mechanisms to facilitate a constructive relationship between mathematics and industry; in these countries, dynamic collaborations already exist. In others, there is an urgent need to create or revitalize the connection.

This is a time of consciousness that science and technology are changing the world rapidly and that scientific discovery and technological development present potential powers even greater than those that have already so profoundly influenced our way of life. It is also a time when the typical citizen demands more be done about a growing list of serious shortcomings of society. It is not surprising, then, to ask whether we can connect the potency the scientific approach is felt to possess with the need for a superior attack on our unsolved problems.

REFERENCES

G. P. Richardson and A. L. Pugh III (1981). Introduction to System Dynamics Modeling with DYNAMO, Productivity Press, Cambridge, Massachusetts.

J. W. Forrester (1961). Industrial Dynamics, The MIT Press, Cambridge, Massachusetts

Keefer, D.L., Kirkwood, C.W., and J.L. Corner (2004). "Perspective on Decision Analysis Applications," Decision Analysis, Vol. 1, No. 1, pp. 4-22.

Powell, S.G. (2001). "Teaching Modeling in Management Science," INFORMS Transactions on Education, Vol. 1, No. 2, http://ite.pubs.informs.org/Vol1No2/Powell/

Stecke, K.E. (2002). "Machine Interference: Assignment of Machines to Operators," Handbook of Industrial Engineering, Second Edition, Gavriel Salvendy, Editor, John Wiley & Sons, New York.

THE SYSTEMS APPROACH Fresh Solutions to Complex Problems through Combining Science and Practical Common Sense Simon Ramo, Ph.D. and Robin K. St.Clair, Ph.D.

Corresponding Author

Amit Kumar*

Research Scholar

E-Mail – rohitkumarjangra1@gmail.com