The Growing Demand for Manufacturing Simulation in Malaysia

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Abstract

This paper presents the problems and issues facing manufacturing companies in Malaysia, and analyses the reasons behind the growing demand for simulation. Such a demand can be mainly attributed to the companies' search for methods to increase productivity, the emergence of manufacturing-oriented simulation software which requires no or little programming, and the graphical capability and availability on PC. The paper also offers guidelines based on the authors' consulting and training experience to managers and engineers who are, or will be, engaged in manufacturing simulation.

Keywords

Simulation, Malaysia, manufacturing, modelling, interactive, process, applications

1 Introduction

As Malaysia is fully geared towards the industrialised status along Vision 2020, many changes will take place. New products will be manufactured, new industrial sectors will be started up, new technologies will be exploited. The traditional "gut-feeling" method of management is getting more and more difficult to fit into this changing world.

On the other hand, there will be a shortage of labour, and the costs will rise. In order to meet the dynamic market demands, the Malaysian industry has to manufacture cost effective, technologically advanced, high quality products more rapidly than its competitors.

Computer simulation is a tool to help us cope with changes. It quantitatively represents the real world, simulates its dynamics on an event-by-event basis, and generates detailed performance report. With simulation applied to manufacturing systems, one can identify the potential problems, take preventive measures, evaluate improvement suggestions, and stimulate ideas for higher productivity.

2 Manufacturing Simulation

Manufacturing simulation is defined as "the dynamic representation of a manufacturing facility by a computer model, so that the impacts of changes can be evaluated to support the decision making process". Simulation enables various scenarios to be tested without large investment on setting up a pilot line or disrupting the production. It eliminates the common problem in manufacturing industry: bottlenecks.

The development of simulation software has been evolved progressively over the last three decades, and many systems have been developed by industry and academia to deal with various industrial problems. In brief, four generation of simulation software products have evolved, these being[1]:

- ***1st Generation (late 1960s)*** - Programming in high level languages (H.L.L) such as FORTRAN. The modeller was obliged to program both the model logic and the code to control the events and activities, or 'simulation engine', in the model.
- ***2nd Generation (late 1970s)*** - Simulation languages that have commands like event control "engine", statistical distribution generation, reporting, etc. A model in the simulation language was compiled and then linked with the supplied subroutines to produce an executable model. Examples are GPSS(IBM), SIMAN(Systems Modeling), See Why(AT&T 1979), AutoMod(ASI).
- ***3rd Generation (early 1980s)*** - Simulation language generators that are front-end packages that generate the code in a simulation language. The generated code is complied and then linked to produce an executable model. It reduced the model development time, but still require the modeller to master all aspects of the simulation mechanism. Examples are EXPRESS(AT&T), ARENA(Systems Modeling).
- ***4th Generation (1986 to present)*** - Interactive simulation packages that enable "what you see is what you get", allow models to be modified at any time, speed up 'what-if' analysis. The simulation models can be built very quickly by industrial managers and engineers, thus encouraging those people with knowledge and first hand experience of the problem to build the model themselves. The example is WITNESS (AT&T)

3 Simulation Applications

Simulation has been widely applied in the USA, Europe and Japan since the 1980s. A survey showed that simulation modelling is used at all levels of management in the 500 largest corporation in the United States. Another survey sponsored by the Department of Trade and Industry of the UK found that where simulation has been used, capital costs were saved between 5% and 10%. In 1991, the benefit of simulation to UK industry has been estimated to be as much as 300 millions of sterling pounds. Simulation is also used to improve health care by improving the various processes in the emergency room area so as to raise the quality of health care provided[9]. Worldwide experiences[10] have shown the following potential benefits in using simulation systems:

- 5 to 10% savings in capital costs
- 5 to 25% resource utilisation increases
- 15 to 30% improvement in staff levels
- 25 to 45% reductions in throughput times
- substantial stock and work in progress reductions
- identification and elimination of bottle-necks

In the past few years, Japan has become the fastest growing market for simulation, where most large corporations have adopted simulation technology to improve their already impressive manufacturing capabilities. More and more people in Malaysia have been attracted to manufacturing simulation, as can be seen from the publications on this subject, which ranges from presentations on technical conference[1], simulation workshops[2], to articles on popular newspapers[3].

In practice, manufacturing simulation has been playing increasingly important part in productivity improvement. As an indication, national institutions such as SIRIM, UTM, USM, MIMOS, have been establishing expertise in manufacturing simulation, and offering training, courses and consultancy to industry. Another example is the popularity of WITNESS, a visual interactive simulation software by AT&T. More than 20 systems have been installed and a WITNESS user group was formed in February 1995 to promote information exchange among users.

Many manufacturing companies here have gained great benefits from applying the simulation technology, such as Motorola, National Semiconductor, Siemens, etc. Some multi-national companies even set up regional simulation support to promote applications of manufacturing simulation in their manufacturing sites in this region. There are a number of reasons for this increased interest in manufacturing simulation here:

- Companies are actively looking for methods to increase productivity, to improve quality and to reduce cost. Manufacturing simulation is a natural choice by managers as an experimental tool to test various management decisions, evaluate investment returns, and identify improvement opportunities.
- More and more companies are adopting automation systems to drive for high end manufacturing environment and to overcome the ever increasing labour shortage problem. Simulation is an inexpensive insurance against costly mistakes.
- Many simulation software are available on personal computers. In addition some simulation systems have been developed specially for modelling manufacturing systems.
- The adding of very elaborate graphics, easy-to-learn and easy-to-operate model building environment such as WITNESS and others. These capabilities have greatly increased the popularity of the PC based simulation systems.

4 Applications of Manufacturing Simulation Technology

Nearly all manufacturing companies want to achieve better production performance such as high throughput (i.e. output), short lead time, low work-in-process (WIP), and high resource utilization. Through manufacturing simulation, industrial managers and engineers can evaluate behaviour of a manufacturing process under different sets of conditions; carry out 'what-if' scenario analysis in order to identify better physical configuration (layout) and operational policies. Generally speaking, manufacturing simulation has been applied in the following forms:

4.1. Design and Evaluation of New Manufacturing Processes

Typical simulation applications in designing for new manufacturing processes include evaluating various options in terms of equipment selection and layout, establishing critical operational parametres and their boundary conditions, against which the design can be tested and modified if necessary, and synchronising operations to achieve an optimum system performance.

Evaluating the system design is particularly important for high level of automatic operations, where the processing rate is high, control logic is complicated, capital is intensive, and the implemented system is very difficult and costly to change. For example, the loading, unloading and transfer of material between automated machines, and conveyor's speed must be carefully synchronised using simulation before its implementation.

4.2. Performance Improvement of Existing Manufacturing Processes

Problems facing many companies are the difficulty to assess the improvement potential of suggestions, and achieve the improvement in a short time. In the continuous improvement process, manufacturing simulation has been proved to be a very effective tool. Experiments can be performed on a simulation model rather than the actual system, such that when system improvements are studied, the actual system need not be disturbed. Examples are:

- Layout change: A local application can be found in [4], where machines and storage area on the plant floor are re-organised to cope with the rapid growth of production demand. Simulation can be used to evaluate machine grouping, layout, and process structure.
- Assessing impact of local automation on the rest of manufacturing operation. By using simulation, the whole production line can be balanced when a new machine or process is introduced into the line.
- Efficiency diagnosis: By using simulation, managers can 'play back' the past production under the existing or changed operational conditions. This will enable them to pin out 'bugs' and work out corrective action plans.

4.3. Establishment of Optimum Operational Policies

Manufacturing simulation can be used to study impact of various operational policies on the production performance. Typically,

- Product mix and batch size. In [5], simulation is used together with Design of Experiment (DOE) to optimise the product mix and batch size against the set-up time, in order to increase production output.
- Labour allocation: for instance, one operator looks after one machine, or a team of several operators looks after several processes or machines. Such policies would have a significant impact on production performance.
- Impact of management policies: For instance, push type production vs pull type production. Manufacturing simulation is used to help managers design pull mechanism (e.g. pre-determined buffer size, triggering level etc.) and set up procedures to support the transition from push type to pull type production, as described in [6].

4.4. Analysis Tool for Production Planning and Scheduling

Simulation models can be developed and run on the basis of the finite capacity information and the production plan, on which the production plan and schedules can be generated. The schedules can serve as the base for detailed analysis, bench-mark for actual production and operational instructions. One of the simulation based scheduling system has been successfully used for years in Singapore[7].

To sum up, manufacturing simulation is performed (i) to improve our understanding of how the system operates; (ii) to minimize costs associated with experimenting on the real system; and (iii) to minimize the risk of error when dealing with the actual system.

Industrial experiences also show that simulation is an excellent vehicle for communication among various user groups in a company. This is because simulation provides us with a logical and often even a graphical description of the system under investigation. In this way, ideas can be presented to the design team and to management much more effectively through simulation. Other applications include Activity Based Costing[8].

5. Issues in Adopting Simulation Technology

Like any other new technology, one has to be cautious in adopting simulation technology. From our experience, there are several factors contributing to a successful application of manufacturing simulation technology, as described below.

5.1. Project Management

- ***Management commitment***. The simulation application involves many functional departments, such as industrial engineering, production management, material supply, information systems, finance, and the initial investment is relatively high, management commitment is essential.
- ***One engineer/manager to drive the project***. As a new technology, simulation may be perceived by some as a low priority task and others as a luxury. Engineers and managers are busy at dealing with daily problems without realising that these problems could be strategically tackled by simulation. Therefore, there must be one engineer/manager in an organisation to drive simulation applications.
- ***Clearly defined business objective***. Business objective is the most important issue for a project. They are used to determine the outcome, scale, people involvement of a project and to justify the need of the project. A project may be unnecessarily lengthy and fruitless without a clear object. In simulation, there is one more implication, for a model valid for one purpose may not be valid for another.
- ***Team work***. Team work is essential for successful modelling. For example, engineering documents may not reflect reality so well as some would like to believe. Many unwritten requirements and procedures would invalidate the model. They can only be acquired by maintaining close communication with the management, 'experts', end users and manufacturing processes if possible.

5.2. Selection of Manufacturing Simulation Software

Today there are dozens of simulation software commercially available, for which a general guideline for software evaluation is complied as follows, which has classified selection criteria into four categories:

- ***Meet User Requirement:*** A simulation software must be able to build simple and complicated model of the user's manufacturing process in the same software environment. There are two ways to find out, the first is to see whether there are successful *local* application cases in similar environment; and secondly is to ask the vendor to demonstrate the *model building* of user's environment

- ***User-Friendliness***: A simulation software must be easy for engineers and managers to learn, to build model, to modify and debug models. The typical criteria is that the process flow logic, graphics and user-defined report format should not be separately defined. The input, edit, verification, execution of flow *logic and graphics* are in the same window.
- ***Cost & Platform***: One should consider the *Total Cost* of
  - all required modules in the software
  - additional hardware
  - estimated manpower to learn and use the software/hardware
- ***Vendor's Technical Competence:*** It includes local support, product track record, vendor's stability. As simulation is a technology rather than only a software, it is very important that the local representative has extensive *project experience* using the supplied software

7. Conclusions

Malaysia is recognised as a manufacturing base of world-class ability. In order to sustain our competitiveness against countries such as Indonesia, China and Vietnam, we must improve the efficiency, quality, and productivity of the manufacturing industry. In order to aboard the vehicle of industrialised nations, we need to further develop our expertise in manufacturing management. In a word, we will continually put in time and effort to learn new and better ways of maintaining a competitive edge.

Computer simulation, as a scientific "crystal ball" to exam the effect of changes, is the technology we have to master. The national institutions have played the educational roles. The pioneering practitioners have enjoyed the benefits. More and more companies are realising the potential of manufacturing simulation and join us to forecast the "future" of manufacturing.

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