Systems Modelling and Simulation (2)

Simulation Modelling Applications

Today's discussions General applications in industrial systems

- Manufacturing process and material handling
- Healthcare, service industry, defence, natural systems
- Transport systems, logistics, computer systems performance, communication systems, retail and supply chain management
- Telecommunication and Power Distributions
- Building Services and Safety

Simulation in Manufacturing

Simulation has been used to solve manufacturing systems problems for many years because:

- Motivation to stay competitive
- High levels of Automation
- Initiatives can be tested without disruption to the actual system
- Manufacturing systems can be well-defined
- Manufacturing and material handling systems can be too complex for other analytical techniques

Some questions need to be answered in a competitive manufacturing system…

- When should the next piece of equipment be purchased
- How many people will be needed to meet demand
- Can new orders be accepted without delay
- How will the new plant operate in five years time
- How can WIP, inventory and production cycle times be reduced whilst throughput increases
- When should the capacity of production change
- How should maintenance be planned to minimise disruption
- How can plant layout be improved to reduce material handling, …

Key Components of Manufacturing System

- There are a wide variety of manufacturing systems with various products
- There are common elements that describe most manufacturing operations.
- These common elements would be the basis for any simulation model in this subject area

Key Components of Manufacturing System contd.

Products	Resources	Demand	Control
Types	Layout	Customer	Inventory
Routings	No. of machines	Start date	Rules
Sequence	Downtime	Due date	Production logic
Process Plan	Buffer size	Interarrival	Safety
Process Times	Tools		Process control
Settings	Schedule		
	Capacity		
	MTBF		

Guideline for levels of detail in simulation modelling

- A model is an approximation of the real world *(abstract)*
- Some details will be omitted *(correct choice!)*
- Gradual development *(add details gradually)*
- Accuracy of model is in % of confidence in its results
- *Validation* is an interactive process *(modeller checks the results with the actual system)*

  For example: Total number of products produced at the end of a shift

Downtime

- Sometimes overlooked when conducting simulation projects
- Have significant effect on system performance

- Banks et al (1996) suggest:
  - **Ignore it**
  - **Model it implicitly through changing processing times**
  - **Use constant values for time-to-fail and time-to-repair**
  - **Use statistical distributions for time-to-fail and time-to-repair**

Random Events in manufacturing

Random events in Manufacturing Systems can be associated with variances in:

- Quality of Raw Material
- Processing time
- Setup times
- Time-to-fail and time-to-repair
- Yield
- Transportation time
- Orders
- Shipment

Performance Factors

- Production Throughput
- Production life cycle (time spent in the system)
- Queues behind stations
- Material transportation
- Work-in-process (WIP)
- Resource Utilisation
- Systems specific performance factors (e.g. scrap rate, waiting times, rework-rates, …)

Analysis issues

- Identifying bottleneck(s)
- Staffing levels
- Evaluating the scheduling tasks (changes in capacity)
- Evaluating the control system
- Recovery strategies for random events and surges

Business Process Simulation

- Identifying the right areas to change and improve is paramount to the overall success of any organisation
- Miscalculating the impact of changes can have dire consequences
- There is a need for key decision makers to have a proper understanding of their business processes and being able to visualise and assess the consequences of their decisions

Business Process Modelling

- Methods to express the relationships between various elements
- Strategies and tactics in business activities
- Capturing the complexity of relationships and the behaviour of the system
- Helps to identify problems, test tactics that may improve the system with minimal cost
- Reducing the risk of actual trial and error

Typical usage of Simulation in Business Process

- Financial Planning
- Risk management
- Forecasting
- Mapping processes, tasks and process steps for resource allocation and capability evaluation

Simulation for Logistics and Transport Systems

Major challenges:

- Transport and logistic networks are quite complex and involve large number of entities and resources
- Unfamiliarity with simulation technology in these industries

Logistics and Transport (L&T) problems [Or so-called network Systems]

Simulation can and is used for:

1. Assessment of new designs
2. Evaluation of alternative designs
3. Refinement and redesign of existing operations

Simulation for L & T

Simulation models are built for:

- Strategic planning
- Tactical planning
- Traffic network control
  - **Offline control**
  - **Real-time control**
- Scheduling and dispatching:
  - **Offline scheduling**
  - **Exception handling**
  - **Real-time monitoring**

Simulation for warehouse and Distribution Systems

- Use of DES for large-scale logistics network
- Improve the operations of a warehouse
- Modelling and investigating the operations of an entire supply chain
- Common goal is to:
  1. **Evaluate the performance of value-adding resources**
  2. **Facilities**
  3. **Operations**
  4. **Flow of goods between plants, warehouses and customers**

DES models are designed to:

1. Evaluate strategic decisions:
   - **Warehouse location and allocations**
   - **Warehouse/distribution centres**
   - **Transportation modes analysis**
2. Test Tactical Solutions:
   - **Inventory management policies**
   - **Ordering processes (warehouse-to-warehouse and warehouse-to-customer)**
   - **Service levels**
3. Ongoing assessment of performance
   - **Transport modes**
   - **Operation parameters**
   - **Changes in parts**
   - **Demand fluctuation**

Typical Data requirements

- Number and location of plants
- Number and location of warehouses
- Customers details
- Customer demand on specific warehouse(s)
- Part number and details (supplier/plant/expiry/…)
- Bill of material
- Transportation times and control rules
- Transport between warehouses and plants
- Transport between warehouses and customers

Normally Stochastic in Nature

Tracking and Traceability of Parts

- A major issue in supply chains
- Distributions
- Safety
- Recalls
- Liability
- Potentially costly for suppliers due to penalties imposed by buyers

Information Systems, Telecommunication Networks

- Same rules apply
- Machines and nodes with specific capacity and processing time
- Interrelationship between components of a IS or Communication network
- Downtimes and Meantime between failures

Building Services and Safety

- Key factors in layout design
- Overall usage of space (utilisation especially in industrial estates and business environments)
- Evacuation planning
- Design of exit and fire routes
- Corridors and passage ways
- Capacity planning of stairs and escalators
- Optimising usage of lifts
- Measuring comfort as performance indicator against capacity …

Finally…

- Application of simulation in various industries
- Not necessarily all was discussed
- Requires good understanding of simulation and how and when it can be applied
- Good sense of the system and its main elements and parameters is essential