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Computerised model for materials handling in a large mineral processing based organization

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ABSTRACT

Integrated Information Technology applications related to Materials Handling have been advocated for a long time. For many large organizations, the challenges have been to monitor material flow, traceability of material, accurate weighment and ensuring that the transportation of the material is as per schedule and at optimum cost. It is important that the Suppliers/Transporters payments are to be made timely. The objective of the paper is to address the above mentioned issues in this area on how a computerised model implemented over a Wide Network can improve productivity. The challenges lie in improving operations involving diversified users spread over large areas, operating on machines with different configurations, affecting the overall system objectives. The system will be useful in standardisation of operations, having information on material flow at finger tips and automatic recording of weighment apart from generating various MIS reports for production Planning/Scheduling. It will help users in taking on-line decisions. The System will also aid in reducing bill processing cycle time thus leading to financial benefits and better organizational image. The above model with minor refinement can be used in any Mineral Processing Organization.

OVERVIEW

Material Handling is the function of moving the right material to the right place, at right time, in the right amount, in sequence to minimize cost and improve productivity. The objective of the organization is to dramatically improve operations, performance and quality and exceed customer expectations [JMC].

Material handling has been a concern to the management as it has a very significant bearing on the operations. Material handling costs an

average 50% of the total operation costs. In some industries as Mining, the cost increases to approx imately 90% of the operations cost.

The objective of the model is to address the problems faced by the organization in this area. Computerised Integrated Material Handling Systems have been advocated since long but the 'big picture' of total integration was not there. The business logic in the 1970's era was essentially to provide a particular good or service at the least cost. This was achieved by the companies mainly through vertical integration and exploiting the experience curve effect for achieving low relative costs, [JMC]. The business logic of to 70's do not hold good for the 1990's and beyond. In a fiercy competitive market of today, the business model which emerges calls for a company strategy to be based on three intertwined elements : low cost, high quality and fast/ flexible response [JMC]. Thus, Material Handling Systems have to play a greater role of a 'fundamental enabler'. This can be possible if the organization can relate its Information strategy to the business strategy and the state of art in information technology as Wide Area Networking, Decision Support Systems available today.

We highlight a few of the typical problems faced by the a Material handling organization today :

(a) Accurate weighment is often not possible or it is a time consuming process at receiving/despatching locations.

(b) Material Storage space is a constraint and organization wants to keep a minimum inventory level.

(c) On-line information on storage location status is not available in a geographically diversified unit.

(d) Monitoring the movement of Trucks/Wagons and timely loading/unloading of material is often not ensured timely leading to demmurage payment.

(e) Reconciliation of Material/Trucks/Wagons is a cumbersome process.

(f) Various Statistical/MIS reports cannot be easily compiled to help in decision making.

The broad objectives that the Material Handling System desires to achieve can be summarized as follows:

* MINIMUM COST
* SHORTEST LEAD TIME
* MAXIMUM INFRASTRUCTURE UTILIZATION
* MINIMUM WORK IN PROGRESS
* MAINTAINING SAFETY STOCK
* ROBUSTNESS AGAINST UNEXPECTED EVENTS

Some of the above mentioned objectives are complementary and some of them are conflicting with other. Minimum Cost and Highest Quality, Shortest Lead Time and Maximum Machinery Utilization with Minimum Work-in-progress and Safety Stocks are conflicting. For example, maximum machinery utilization needs large Stocks which have shortest Lead time and highest Quality [Mori, 91].

The model proposes to address the above mentioned problems by generating a satisfactory solution to the problems faced by the organisation. The model addresses the area of Material Handling at two levels, facility and enterprise. The facility level systems are responsible for tasks such as Production Planning, Material Requirement Planning and Work Station Operations. Typically, the role of human labour takes place only for transportation of material and in some cases for loading/unloading and amounts to a maximum of total 40% of the total effort, the rest is information processing [Cheng Hsu]. At the enterprise level the goal is to bring synergy at all levels.

THE PHYSICAL SYSTEM FLOW

The system involves carrying of Raw Material from sources which may be owned by the organization or purchased from other organizations. The Material Handling is done by loading the required material at the Despatching Location, weighting it and sending the details of the material to the processing locations. The Figure 1 gives an schematic view of the Physical System flow. The Material Requirement Planning Cell generates the Raw Material requirement based on the Yearly Production Plant. The Monthly Production Plan/Rolling Plan is also generated. Based on the Production Plan, the Recipe or the raw material requirement is generated.

For example, to produce 1 unit of a Material M1, the raw materials R1, R2, R3 are required in the proportion of (p1 * R1) on date D1 in location L1 from source S1, (p2 * R1) on date D1 in location L2 from source S2, (p3 * R2) on date D3 in location L1 from source S3, (p4 *

R2) in date D2 in location L2 from source S1 and (p5 * R3) on date D1 at location L3 from source S1, respectively. p1, p2, p3, p4, and p5 are percentages respectively. The recipe generates a Date wise Production Plan based on the units of M1, M2 etc. to be produced as per their recipe. Based on the Production Plant the Source Department generates an estimated Material Requirement Plan along with the sources from which they need to be procured. The Despatch Plan is thus generated at the Source Department so as the required quantity of material reaches the desired location in required time. Raw Material Requirement can also be transmitted to the non-captive locations. The total day wise Truck/Wagon requirement is also generated. The Material is loaded and weighed and sent with the Gate Pass and Challans to the processing locations. At the processing locations the material is weighted and transported to the desired location.

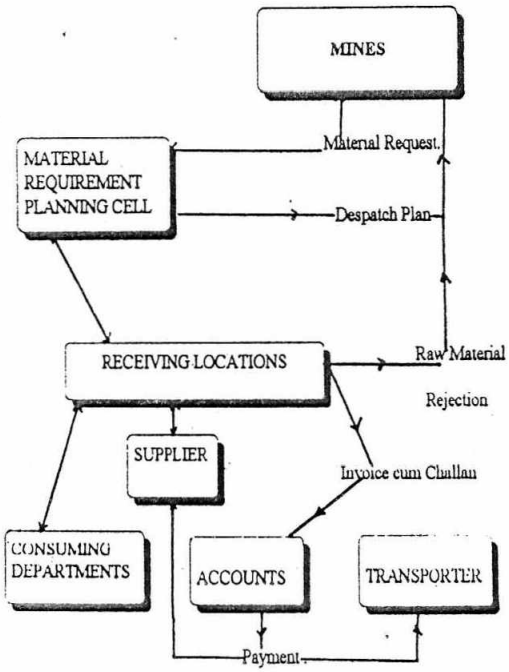

Fig. 1 : Schematic view of the physical system flow

The Supplier/Transporters payment need to be processed in the shortest possible time. In the Model the Suppliers/Transporters submit the Invoice cum Challan to the Receiving Sections and the details are captured in the System. The Challans and the Computerised printout are signed and send to the payment section. The Accounts System

matches the Challan and the corresponding Purchase Order and prints Payment advice with Cheques and send it to the Departments. This will lead to saving on account of interest due to delayed payments and also reduction in quoted price from the Suppliers apart from improved satisfaction.

THE NETWORK MODEL

The challenges lie in selecting the various products and methodologies available for networking the Source/Consuming Locations. There are various options available as using leased telephone lines, ISDN services and putting WAN traffic on Internet. Figure 2 gives a pictorial representation of the Network Model.

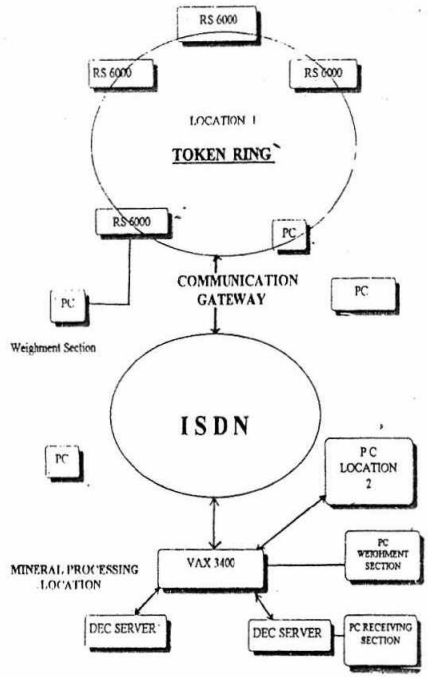

Fig. 2 : Pictorial view of the network

The client PC is where all the Network converges. The client server consists primarily of redirector and Network Transport Software. The redirector recognises the applications request for resources and transport programs packages the data according to the Network transportation specification and send the data packets out to the LAN adapter. LAN adapters translate the data inside the computer to a higher power serial stream for external connection. The Hub provides electrical iso-

lation. Switching is the latest technique available for reducing LAN congestion. A switch routes packets of data between the LAN's. With the advent of Internet, users can provide access to the intranet over the internet. However, this model suggests using Servers with Modems and ISDN connections that have built in security and no unauthorised access is provided. The basic equipments in ISDN are local exchanges, terminals and PABX's connected via the basic access multiplexer.

The hardware connectivity between Despatching/Receiving Locations is by means of routers which ensure that the local traffic does not overcrowd the long distance links and segregate the traffic by destination. The backbone choice at the different Locations has been fibre optics cables with segments isolated by routers. The management of Network is by Network Management console systems which help in ensuring performance and gathering data across the WAN via the Simple Network Management Protocol (SNMP). This provides manual and automatic controls of WAN and internal backbone operations. SNMP Remote Monitoring Database has made it practical to put reporting capabilities in wiring hubs. The Network Management System also monitors the status of each server. They take care in software Management and also in generating reports on Hardware status and also of Software connected to LAN'. Management activities as running virus checks and distributed software updates are also handled. It is important to backup data in the Network. This can be done at different locations. However, enterprise backups systems are available and they backup not only the application programs but also Web Servers, mail servers and individual PC's.

The system uses different network transport protocols. Most of the Network Operating System available today make use of TCP/IP protocol. It is desirable that all Locations have a uniform protocol. The advantages are access to variety of print files, communications and Database severs. The Desktop PC Network Operating System have client software available for several server software. Thus, a desktop networked under OS/2 Wrap Connect or Windows '95 can be assigned to servers running Netware, OS/2 Wrap Server. The client operating system is hence able to communicate with multiple servers and use for file/print services. The client programs use IP/IPX transport to carry request to a Database server which may be a Main-frame/Mini-frame or a Heavy duty PC storage system. A software called 'middle ware' (for example Microsoft Open Database Connectivity (ODBC), is used for translation from client queries (as linking programs with the Data-

base) and the Database. The tasks as indexing, sorting, etc. are done in the Database server thereby reducing traffic on the Network and workload at each client.

THE INFORMATION MODEL

The Database is a centrally controlled, logically organized integrated collection of Data. The database can also be distributed across various locations. The architecture of the Database is divided into three general levels, internal level is one closest to the physical storage and is concerned with the way the Data is actually stored. The conceptual level is concerned with the level of indirection. The external level represents the user system interface. A Distributed database is typically a Database that is not stored in its entity at a single physical location but rather is spread across a Network of computers that are geographically dispersed and connected via communication links. However, the user is transparent to it and it looks like a centralised System to him. In a client server environment, the role of the server is providing services to the requesting processes. The requests are processed by the clients. The semantic data dictionary exists at each Database location, along with a sharing advisor. Logically, the schemata consists of collection of types and mapping data for global functioning. The schemata can be Local, Import or Export. The export schema consists of schema that the local database is willing to share with others in federation. This may be data regarding the Despatch Schedule, Production Planning or Receipt Status. The import schema consists of information the Database needs to use from other Databases. A federal dictionary keeps information of names and network addresses of the others. The global data dictionary must include Data Structures, Access Methodologies and Manipulation Languages.

The model has the master files and the facility to update exists with the Database Administrator and is universally available at all the locations. A few of the master files are Location/Capacity file, Wagon type, Plot Master with plot capacity details, Department master File are maintained centrally and access is across the Database. The yearly Production Plan database is basis for generation of the yearly Raw Material requirement. This is by means of the recipe master file having the manufacturing recipe. This in turn forms a basis of the Monthly Production Plant. The Rolling Plan is also generated. The Raw Material Planning Cell generates a Raw Material Requirement List Datewise. Based on the Datewise Production Plan the Location/

Datewise Raw Material Requirement is generated. The PPC has the flexibility to alter the same and decide the procuring location. The Despatching Locations can also inform PPC in case of inability to deliver the material. Safety Stocks are also maintained at the Consuming Departments. The Location - Datewise Raw Material Requirement is exported to the despatching Locations. Based on this requirement and considering various factors as transportation time, availability and other factors, the schedule is generated.

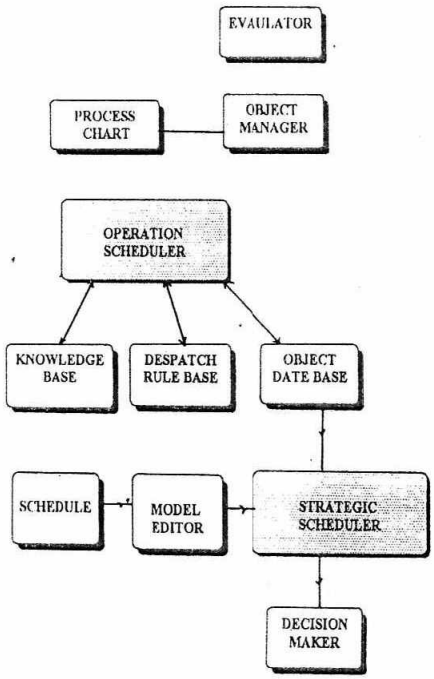

Fig. 3 : Scheduler

The scheduling is handled by a scheduling system operating at the despatching locations. It consists of Operational/Strategic Level scheduler. The pictorial representation is depicted in Figure - 3. The system is dynamic to handle unexpected events. The system generated a schedule based on the parameters in the Knowledge Base, Despatch Rule Base and other Databases. Human interface can be applied to modify the generated schedule by human-computer cooperation. The algorithm for the best path and minimum cost on various routes is generated. The flow chart in Figure - 3 depicts the same. Based on the expected transportation cost along the best route and availability of the transport the schedule is generated so as the material reaches in time.

The Human interference is needed only when there may be certain unexpected events as Road jam, strikes or blockades, where alternate route is calculated.

The Loading Schedule is made and the material loaded after weighing it over the weigh bridge. The weight is captured along with the Transportation medias weight to derive the actual weight. This Despatch file is transferred to the Receiving Location. The Receiving Location receives the material and updates the same on the computer in the receipt file. Thus, if any Truck/Wagon has not been received, the status is transmitted to the relevant locations. The Reconciliation Statement of material received-despatched is generated. The discrepancy is the basis of lodging claims with the parties. The transportation of the Raw Material may be to the Production Location from the Central Receiving Locations. In the plant various options are available as Conveyer Belt System. A better option is by means of an Automated Guided Vehicle System. The system has grooves cut in the floor in the tracks in form of wires carrying alternating current. The magnetic field resulting from flow is picked by the induction coils and the vehicle.

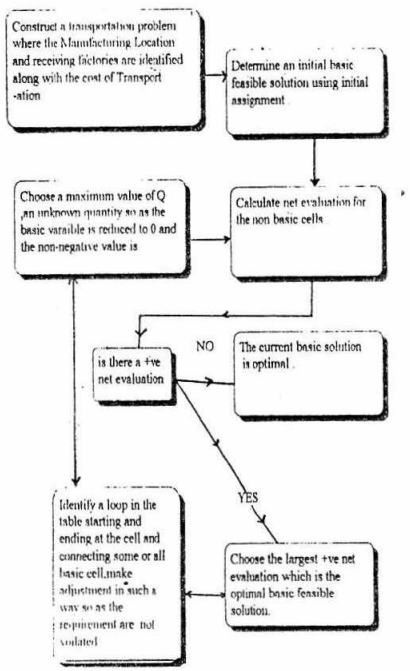

Fig. 4 : Flow chart for genrating the best transport route at minimum cost

However, a Free Range Automatic Guided Vehicle System has paths which can be programmed. The Operations System basically receives the transportation request from sources as the Production Controller or the vehicle. It schedules the request and downloads the route and time order to the vehicle. The Performance monitoring is done by updates received from sensors, receiving locations. The divergence is also reported and action taken to reschedule the affected vehicles. The encoder keeps track of the wheel rotation. The time tabled route is selected and the information is sent to the vehicle. The vehicle fulfils the request based on the Guidance System. The ultrasonic Obstacle System detects any object, say 2 meters in from of it. The CAD database is used to extract information regarding nodes and links connecting them using DXF or IGES. This system is linked to the main system by the standard manufacturing automation protocol (MAP).

At the Production Locations the material is unloaded in the bunkers and later issued for production. The Location-Capacity master database ensures that the material greater than the bunkers capacity is not transported. The users are able to Query the status of the consignment form the system at any time.

The data can further warehoused in a central environment. This data in the warehouse provides integrated access to the corporation. Moreover, data which is dispersed across different locations is cumbersome to access. Data warehousing can be used to access various sub-systems and help decision markers to improve the Quality of the decisions.

The application of Robotics in Material Handling in a Mineral Processing Organization can be explored. Robots represent the ultimate in integrating computerised equipments. The mechanical robots is an ideal vehicle to transfer from AVGS to Conveyer or from Workstation to the Conveyer device. A No. of Industrial Engineering techniques related to orientation by vision, tactible sensing and task level and knowledge based programming are emerging.

BENEFITS AT AN ENTERPRISE LEVEL

The system not only aids in improving operational efficiency but has an overall impact on the organization. The major potential areas of benefit are as follows :

1. Improved Productivity
2. Improved Quality

Dynamic Scheduling
Material Status available on-line
Accurate weighment
Frequent and Accurate Reporting

3. Optimum Inventory Levels.
   Organization can maintain optimum inventory level as Material Status is available on the finger tips.
   Elimination of Obsolescence.

4. Improved Corporate Communication
   Accurate Data Channeled.
   Accurate Weighment
   Monitoring possible at all levels.
   Communication links between locations.

5. Positive Practice Management
   Better Planning Capability
   Improved effectiveness.

CONCLUSION

The implementation of such large scale systems have their own rewards. The challenges lies with not only with the Management but with the disciplined and diversified users. In a dynamic state new technologies and methodologies are being applied and the unacceptable ones are being discarded or superseded. The opportunity created by IT has enabled faster decision making. Most important of all is the creation of Databases which help in future Decision making. The above model aims to improve operations so as the organization gains a competitive edge. The ability of the organization to anticipate information requirements and provide right, accurate and timely information is crucial for the organizational success. The model, with minor refinements can be used by any Mineral processing based organization.

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