

Material Handling Equipment: Exploiting Productivity Potential in Supply Chain

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“Improving your material handling system fuels a stunning return on investment. It makes more sense than almost anything else you can do.”

Material handling cannot be avoided in logistics, but can certainly be reduced to minimum levels. The productivity potential of logistics can be exploited by selecting the right type of handling equipment. The selection of material handling equipment cannot be done in isolation, without considering the storage system. Investment in the material handling system will be sheer waste if it is not compatible to the warehouse layout plan. The layout will create obstacles for free movement of equipment and goods, resulting in poor equipment productivity. Recent trends indicate preference for automated system with higher logistics productivity to enhance the effectiveness of human energy in material movement.

Everyone wants more control. The more control you have, the better you perform. Similarly good material handling systems give you control on productivity. Distribution, manufacturing, and warehousing are the areas where material handling plays a major role. To do these things well, you need control of processes, of equipment, of personnel, of space and also of time. The basic questions frequently asked are:

- When do things get done?
- How many people does it take to do them?
- Do your material handling systems increase control—or hinder it?
- What is cost involved?
- What is the up time of system?

Infact material handling systems power today's efficient distribution and manufacturing facilities. It is the secret weapon in logistics operations for improving system productivity. enhancing customer service and speeding up throughputs. By gaining control of your warehouse, you gain control of your profitability. Effective material handling systems create savings that helps directly to improve your bottom line. If your business relies heavily on manufacturing, warehousing, storage or distribution, the potential savings are perhaps your greatest opportunity. If your suffer from damaged products, slow pick rates, a lack of space, disorganization, or bottlenecks, don't think throwing more people at it will solve the problem—that's short term help at best, and you'll be stuck with ongoing costs which you cannot eliminate.

Role of material handling in supply chain

In the last several years material handling has become a new, complex, and rapidly evolving science. For moving material in and out of warehouse many types of equipment and system are in use, depending on the type of products and volume to be handled. The equipment is used, in loading and unloading operations, for movement of goods over short distances. The handling of material in warehouse is restricted to unitized forms, which require smaller size equipment. However, for bulk handling of material at logistics nodes such as shipyards, ports and airports different type of equipment is used. In warehouses, material handling operation is performed at the following stages:

- Unloading the incoming material from transport vehicle.
- Moving the unloaded material to assigned storage place in warehouses.
- Lifting the material from its storage place during order picking.
- Moving the material for inspection and packing.
- Loading packages/boxes/cartons on to transport vehicles.

The efficiency of material handling equipments adds to the performance level of the warehouse. The internal movement of goods has a direct bearing on the order picking and fulfillment cycle. The warehouse, wherein the material handling equipments is in use, is more sensitive to labor productivity than the manufacturing center as material handling is more labor intensive. There is a scope for reducing labor and enhancing productivity by emerging technology in material handling. A good material handling system will enhance the speed and throughput of material movement through the supply chain.

Material handling guidelines

The material handling function reflects on the efficiency and speed of warehouse operation, which ultimately result in elongated or compressed order completion cycles. Hence the investment in material handling system is strategic in nature and is always based on long term requirements, considering product volumes and varieties. For designing an effective and efficient material system, the guidelines normally followed are:

- Designing the system for continues flow of material, i.e. idle time should be zero.
- Going in for standard equipment, which ensures low investment and flexibility in case of changes in material handling requirements in the future.
- Incorporating gravity flow in material flow system
- Ensuring that the ratio of the dead weight to the payload of material handling equipment is minimum.

Various material handling systems are in use, right from those that are fully manual to the ones that are fully automatic. However, the selection of a particular system depends in factors such as:

- Volumes to be handled
- Speed in handling
- Productivity
- Product characteristics (weight, size, shape)
- Nature of the product (hazardous, perishable, crushable)

Recent trends indicate preferences for system with higher logistical productivity. However, investment cost goes up in more productive material handling system using sophisticated equipment. Hence, in a majority of case a combination of both manual and mechanized systems is quite common.

Manual handling

There are many problems associated with manual handling and sets out best practice in dealing with them. The advice is intended for managers of small firms or similar organizations. But the general principles are relevant to all workplaces, whatever their size. Avoiding injuries from manual handling makes sound business sense.

The Manual Handling Operations Regulations 1992, in UK as amended in 2002 ('the Regulations') apply to a wide range of manual handling activities, including lifting, lowering, pushing, pulling or carrying. The load may be either inanimate - such as a box or a trolley, or animate - a person or an animal. This guidance gives useful practical advice for employers,

managers, safety representatives and individual employees on how to reduce the risk of injury from manual handling. More than a third of all over-three-day injuries reported each year to the companies and local authorities are caused by manual handling - the transporting or supporting of loads by hand or by bodily force.

The most recent survey of self-reported work-related illness estimated that in, 1.1 million people in Great Britain suffered from musculoskeletal (Getting to grips with manual handling, Health and Safety Executive, www.hse.gov.uk) disorders (MSDs) caused or made worse by their current or past work. An estimated 12.3 million working days were lost due to these work-related MSDs. On average each sufferer took about 20 days off in that 12-month period. Manual handling injuries can occur wherever people are at work - on farms and building sites, in factories, offices, warehouses, hospitals, banks, laboratories, and while making deliveries. Heavy manual labour, awkward postures, manual materials handling, and previous or existing injury are all risk factors implicated in the development of MSDs. Prevention and control of MSDs, such as manual handling injuries, has been identified as a priority by the Health and Safety Commission in UK

Material Handling Systems - Types

Materials handling systems provide transportation and storage of materials, components and assemblies. Material handling activities start with unloading of goods from delivery transportation, the goods then pass into storage, onto machining, assembly, testing, storage, packaging, storage, and finally loading onto transport. Each of these stages of the production process requires a slightly different design of handling equipment, and some processes require integration of multiple items of handling equipment.

Design or selection of the right material handling system is one of the most important decisions that a manager can make, because of the effects on the rest of the manufacturing plant. It affects the material flow and the factory layout. Apart from the initial capital cost for a new system, the consequences of any misjudgment in material handling will have considerable and long-term effects on operations. In recent years computer based simulation tools have been developed to simulate material handling systems and their effect on the manufacturing process.

Loading equipment is aimed at providing the capability to load and unload vehicles; it is also referred to as loading bay equipment. The category can be divided into products that provide access from the loading bay to the vehicle and equipment that moves the product from the loading bay to the vehicle and vice versa. Equipment that falls into the access category are scissor lifts, goods lifts, dock levelers, loading ramps, doors, dock seals and vehicle restraints, and equipment that falls into the movement category are pallet trucks, conveyors and fork lift trucks.

• Lifting and Transport Equipment

Lifting and transport equipment is used to move product around the production facility, from loading bay to storage, from storage to production, around production, from production to storage, and from storage to loading bay. Equipment that falls into this category are fork lift trucks, order picking trucks, overhead cranes, tower cranes and belt, chain and overhead conveyors.

• Storage Equipment

Storage equipment, as the name suggests is used to store materials, components and assemblies. The level of complexity of this type of equipment is wide ranging, from a welded cantilever steel rack to hold lengths of stock materials to a powered vertical carousel system. Also within this category are pallet racks, mobile shelf units, and plastic, wood and steel containers.

- **Automated Handling Equipment**

Manufacturers of automated handling equipment produce automated guide vehicles, storage and retrieval equipment, conveying systems and product sortation equipment. The level of automation varies depending on the handling requirements. Fully automated handling systems ensure that the materials/components/assemblies are delivered to the production line when required without significant manual intervention. Semi-automatic handling systems provide less advanced solutions that deliver materials/components/assemblies to the production line with some manual intervention.

- **Automated Guided Vehicles (AGVs)**

An AGV is a material handling device that is used to move parts between machines or work-centres. They are small, independently powered vehicles that are usually guided by cables that are buried in the floor or they use an optical guidance system. They are controlled by receiving instructions either from a central computer or from their own on-board computer. In some applications they can be used as mobile workstations to replace the more traditional conveyor system.

- **Robotics**

Robotics was first introduced 30 years ago. Since then their applications and versatility have increased dramatically. The basic robotics technology is similar to CNC technology but most robots have more degrees of freedom. In manufacturing applications, robots can be used for assembly work, process such as painting, welding, etc. and for material handling. More recently robots are equipped with sensory feedback through vision and tactile sense. The main advantage of robots is that they can be used for repetitive, monotonous, mundane tasks that need precision. They can also be used in hazardous environments that are not suitable for human operators.

Material handling: designed for safe transportation

Due to globalization of the economies of many countries, companies all over the world are making efforts to further expand their business areas. So the need for container transportation is being increased, and container terminals should satisfy such needs. For example, container terminals should provide better services to meet needs, should handle materials more speedily, and should reduce the cost. Since there are the same needs in other countries as well, the 365-day 24-hour operable container terminals should be constructed. To meet the above-described needs, companies should establish:



Container crane



Transfer crane



Mobile harbour crane

- Terminal control systems that can ensure effective operation of the entire terminals.
- Automatic container terminals that enable labor saving and ensure high efficiency, after being unloaded from a container ship, any containers should be speedily transported and useless movement should be eliminated.

Considering this point, companies are now developing software to enable efficient container storage and control, and to efficiently operate the transfer equipment. In addition, they are also developing unmanned gates to shorten the gate passing-through time. Now they are developing automatic transfer cranes, AGV, and highly efficient container cranes to establish

unmanned automatic systems in various yards. In addition to the conventional anti-sway control devices, companies have adopted “Magic Eye” for the automatic transfer cranes in order to develop upgraded control systems for realization of automatic stacking. Companies have now realized low pollution and low fuel consumption by adopting electric motor drive for the AGV. The electric motor drive enables the AGV to travel freely to oblique directions by 4-wheel drive mechanism and to realize high efficiency in material handling. Moreover they can provide the best systems to the customers by proposing the operation management systems together with the vehicles.

Material handling equipments: Rational use

Now companies Mitsubishi Heavy Industry Ltd, Technical Review Vol.40 No.1(Feb 2003) think that the future material handling will be as described below. So they will be positively developing technologies in open markets.



- More demands for environmental protection and safety since engines and power electronics are the key components for environmental protection; they will place importance on development of technologies for these key components. Regarding safety, companies will adopt electronic control method to ensure safety.
- Rational “use” of vehicles concept that material handling vehicles should be "exclusively used" for certain specified economic purposes is spreading among customers. From the viewpoint of this concept, it is needed that the maintenance cost should be reduced, and the vehicle operation conditions should be properly managed in order to improve the efficiency in material handling. Besides the prolonging maintenance intervals and proving re-manufactured parts (recycled parts) for maintenance at low prices, it becomes important to further develop the information technology (IT) for material handling, such as collection and management of vehicle operation data, upgrade of failure diagnosis technology, and preventive maintenance based on reliability analysis. The vehicle related data accumulated will be very useful for providing the better services in the future. For example, such data will be used for proposal of optimum maintenance plans and of upgraded services.

New generation material handling system

The new-generation material handling system are highly automated system based on latest technologies, provided with flexibility capable of changing its own structure or function in response to changes from manufacturing systems, and autonomous functions to enhance system reliability. Such system is defined as “**MMHS - Metamorphic Material Handling System**”.(Intelligent Manufacturing Systems, <http://www.ims.org>)

MMHS Project was the fifth international R&D project in IMS program, and its was to contribute to industries, optimize life cycle of equipment, produce a system most suited to the global environment, and respect humanity through research and development activities. MMHS project perform research and development activities focusing on the following four Points.

- Life cycle optimization
- Environmentally conscious manufacturing
- User-friendliness
- Contribution to global industry productivity

Subjects and objectives of MMHS project conceived from this viewpoint were as follows.

- **Responsive:** Responsive to changes that may take place in manufacturing technology and environment, type of product or material to be handled, work schedule and load.
- **Flexible:** Capable of transforming itself and altering its function to meet any change in handling requirements.
- **Autonomous:** Able to make decisions on its own (to enhance system availability).
- **Highly automatic:** Incorporated with next-generation automation technology
- **Multi-functional:** Having such functions as assembling, packaging and disassembling, besides transporting.

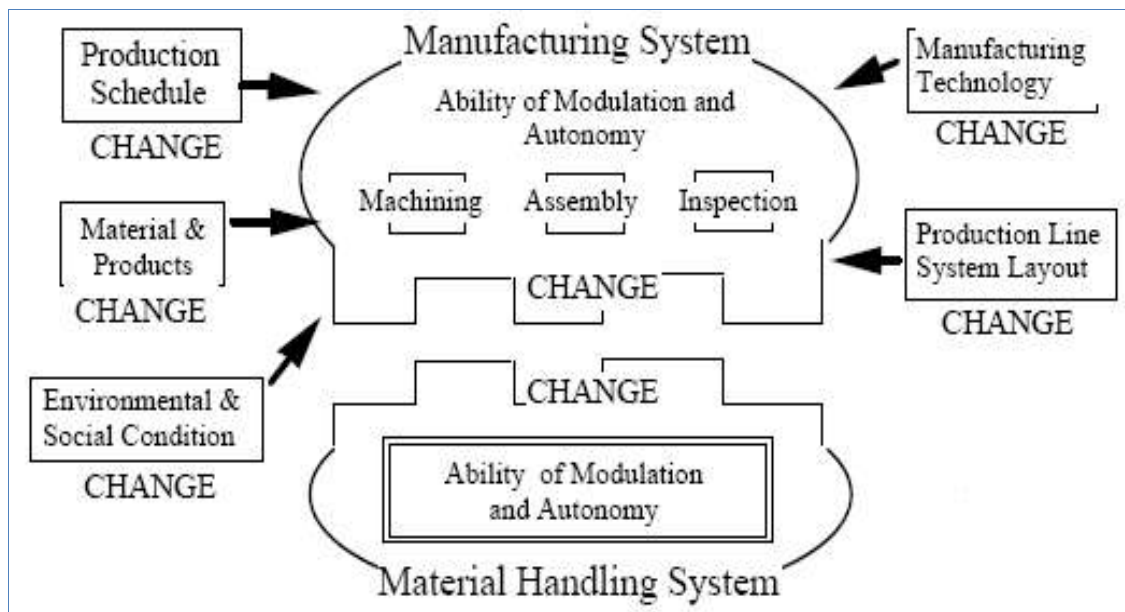


Figure: Metamorphic Material Handling System
 (Source: Project Report MMHS Intelligent Manufacturing June 2003, Intelligent Manufacturing Systems)

- **Modularized:** Composed of various modules, each with a distinct function; e.g. planning module, basic module, tool-setting module, communication module, capable of associating or dissociating one another to organize themselves into a configuration as required
- **Multi-level:** Designed into multi-level sub-systems so as to be capable of cooperating other independent material-handling equipment including AGVs and mobile robots
- **Compatible:** Capable of adapting itself to other existing material-handling systems.

Summary

The material handling is important activity in the logistics system. The speed of the material flow across the supply chain depends on the type of the material handling equipment and the sophistication in the system. In the logistics operation the material handling system is designed in and around the warehouse. Commonly, the following material handling operations are performed in the warehouse, unloading the incoming material from transport equipment, moving the unloaded material to the assigned storage place, lift the material from its storage place during order picking, move the material for inspection and packing, and load the packages on to the transport vehicle. These operations are performed using manual, mechanized or computerized controlled material handling equipment. The mechanized system shifts the fatigue to machine and brings effectiveness to human efforts. The selection of the appropriate system depends on the factors such as volumes to be handled, speed in handling,

product characteristics (weight, size, shape) and nature of the product (hazardous, perishable, crushable). The prime consideration before going in for mechanized material handling systems is the layout of the warehouse. The investment in the material handling system will be sheer waste if it is not compatible to the warehouse layout plan. The layout will create the obstacles for the free movement of equipment and the goods. The mechanized equipment requires the space for the free movement across the warehouse. They should have the accessibility to storage area for material loading and unloading during storage and retrieval. In the mechanized version the variety of equipment are used for the specific application. The range covers common types are wheeled trolleys, forklift trucks, conveyors, cranes, towlines and carousal etc. The more sophisticated systems such as robotics, automatic storage & retrieval and automatic guided vehicles systems are used in semi or fully automatic warehouses for speedy material movement.