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Palletizing Systems for Integrated Manufacturing Plants

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Abstract

Any manufacturing plant is composed of various individual subsystems working together. A snapshot of manufacturing system at any instant will show various subsystems like WIP, equipments, people etc. Proper working of any manufacturing system requires that all the subsystems within it must work in an integrated fashion. It is the integration of manufacturing system which is responsible for its optimum performance. Better integration is feasible only if the subsystems inside the manufacturing industry are well designed. This paper considers one of the most important subsystems of manufacturing i.e. a Palletizing system. Traditional approach considers the inclusion of palletizing systems in integrated plants as compact machines like robots, inline machines etc. which have certain integration issues. Instead, the new approach presented in this paper proposes the development of an entire palletizing cell which enables its good integration as well as ensures flexibility & re configurability.

1. Introduction

The market trend in last few years have been drastically changed particularly with respect to increased competition, shorter product life cycles, availability of newer technologies at affordable price, higher quality requirements demanded by end users and stringent time restrictions over delivery. Today, in order to win the confidence of the customers and be the market leaders, manufacturers should have the capability to be flexible, adaptable, proactive and responsive to changes [1]. This is impossible without proper integration in plant. Now what does the integration mean? Basically, individual modules of manufacturing system are interconnected, operated and controlled by a pervasive network with physical & logical dimensions. The physical dimension is called physical integration & logical dimension is called logical or control integration. Better physical integration is enabled by selecting proper layout configuration, designing suitable automated material handling system abbreviated as AMHS. Also proper design of other manufacturing facilities and selection of proper manufacturing resources is equally important. The design of facilities plays a key role in operation of manufacturing systems. E.g. a well integrated FMS may not exhibit re configurability & responsiveness (to changes) unless it is designed with capability to deal with the cases of equipment failures [2]. H Nylund & P. H. Andersson [3] highlighted that resources required for production plays an important role for any manufacturing system. H. Pierreval et.al [4] showed while designating any manufacturing system, layout and configuration must be given proper importance. Layout greatly impacts the system performance [5]. The role of control integration in manufacturing system is vital. It monitors & controls the operation of facilities and coordinates the activities occurring inside the manufacturing system. The scope of control system is not only limited to this. In fully integrated plant, control system spans from CRM -customer relationship management to MEMS – micro mechanical system [6]. Improperly selected control system can lower the performance of even well designed plant. E.g. if we want an AMHS to be reconfigurable online, then both supporting hardware & software associated with it must be designed for an online reconfiguration capability [7]. Thus following two things can be easily verified.

1. Proper integration is required for better performance of manufacturing system.
2. Both physical & control integrations are counterparts of each other and are interdependent.

This is because improper selection of control system will surely impair the performance of even well designed manufacturing system. And improper layout selection & poor configuration will not justify the cost of sophisticated control system. Figure 1 shows this interdependence of integrations by means of an overlap between two functions. Any manufacturing system is composed of many subsystems working simultaneously. In order to get the optimum performance, these subsystems must be properly designed to enable better physical and even control integration. These two kinds of

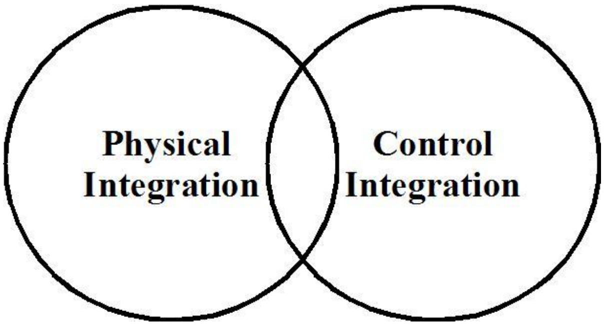

Fig.1 Integration in a plant

integrations are interdependent. This paper addresses one of the most important subsystems of manufacturing i.e. a palletizing system. Traditional approach considers the inclusion of palletizing systems in integrated plants as compact machines like robots, inline machines etc. which have certain integration issues. Instead, the new approach presented in this paper proposes the development of an entire palletizing cell. The paper considers the present facilities, addresses the key issues in their use and finally proposes an overall palletizing cell development so as to achieve best integration and performance. This paper is organized in four sections including this introductory one. Second section describes present scenario of palletizing and points out certain critical issues concerned with it. Third section proposes a new way of development of palletizing facilities and advocates its features and finally we put a conclusion over the entire discussion carried so far.

2. Existing approach of palletizing

Basically two kinds of industrial equipments are used for palletizing. 1 In line machines 2 Industrial robots first will discuss the inline machines briefly. These are high speed automated machines particularly suited for high speed production industries. And have capacity to handle even 40 cartons per minutes [8]. But these have little scope in FMS. This is because they have limited capacity to handle different carton sizes and hence lack part flexibility.

As far as Industrial robots are considered, they are versatile machines on account of their programmable nature and mostly used for palletizing purpose in modern FMS. Sophisticated robots have excellent features embedded in their controller. But their use has certain issues which are discussed below. Figure 2 shows the generalized configuration of a robotic palletizing cell. It consists of a robot, Material transport system, and an auxiliary system like automatic pallet changing facility or similar other. The figure also shows the general way of Physical & control integration. Wide arrows show the physical integration and narrow dotted arrows shows the control communication. The robot is coupled with

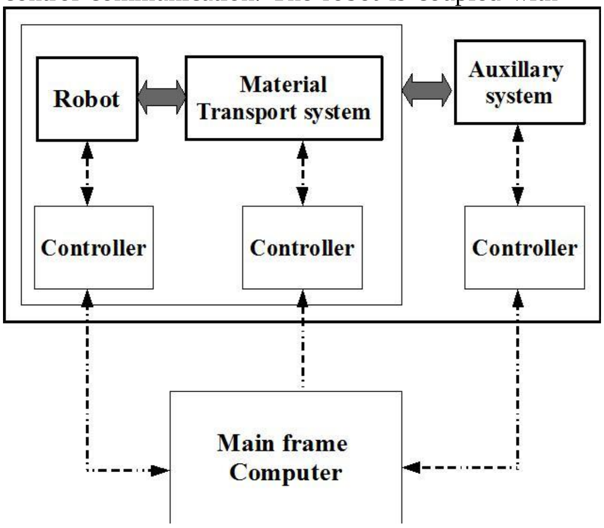

Fig.2 Existing approach

material transport system both physically and logically (logical connection not shown in figure.) Physical coupling is achieved by maintaining proper orientation of transport system with respect to robot. Common example is of a robot and a feeding conveyor. Logically these two are connected by suitable interlocking feature embedded in robot's controller. This combined system is then coupled with auxiliary system which forms a robotic palletizing cell. The controllers of individual machines communicate with mainframe computer. This is one cell working in an integrated FMS. In FMS or integrated manufacturing, number of different cells work together and are further connected physically and logically. E.g. a conveyor feeding a robot might be serving simultaneously to other workstations. If we examine closely the figure 2 we will notice that we have included the standalone robot in a manufacturing system and integrated the same with rest of the system by adopting suitable integration hierarchy. Now consider the case of main feeding conveyor failure. In this case if standby conveyor is not provided then the operation is delayed by the time taken by main conveyor to get recovered. Even if the standby conveyor is present, then putting this conveyor into service certainly requires change in robot's control logic and hence requires change in robot program (as the working cycle is altered.) Also new interlocks are to be put in service. Consider another case of unexpected human entry in robot's work volume. The safety feature designed in robot controller will surely trip the operation of robot. The main frame computer in this case will simply record the failure incidence the cause of which may not be recorded by main frame computer. Also the online reconfiguration is not possible in this robotic work cell. The control hierarchy in this case permits limited controlling through main frame computer e.g. switching between main & standby conveyor is not possible via remote station. Parallel working of individual controllers with respect to one another (see figure 2) may not exchange important information between one another. E.g. improper orientation of carton on conveyor may not be communicated to robot. Similarly, if the automatic pallet changer does not load pallet correctly but communicates normally with the main frame computer, then robot might be forced to load the carton over improperly positioned pallet. While programming robot, one needs to make lots of decisions like setting sensors and motions, defining speed, different hardware utilization etc. [9] also the control logic error is major source of accidents in case of robot. [10] Thus any events (some of which are mentioned already) unnecessarily demanding the changes in robot's control logic will surely affect the operational performance of palletizing system.

3. Proposed Approach

The shortcomings mentioned above can be eliminated with the development of a palletizing cell as shown in figure 3. Instead of including a general purpose robot in system and selecting particular integration hierarchy, the concept shown in figure 3 considers the development of an entire palletizing cell. Now how does this approach differ from the approach that we have discussed previously?

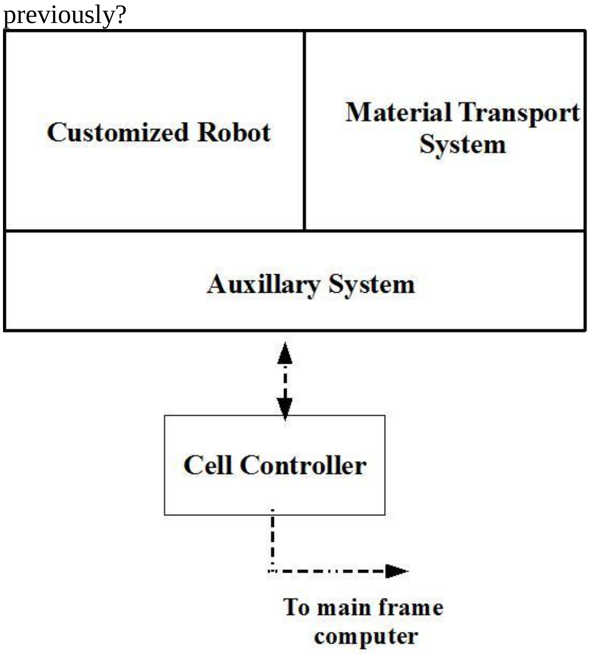

Fig. 3 Proposed approach

The development of a palletizing cell shown in figure 3 focuses on integration of various elements working in that system. In fact this approach treats the palletizing cell as sub system of an integrated manufacturing plant and accordingly designs each individual element in it. E.g. the design may include the provision of additional standby conveyor in palletizing cell with proper physical layout and configuration. More over the controller of overall cell is so designed to accommodate the proper interlocking between these two conveyors so that in case of failure of main conveyor, standby conveyor motor is automatically picked up. The customized lay out design of cell ensures minimum set up time or minimum changes in robot's working cycle so that the robot can be remotely operated to accept cartons from standby conveyor. Also design of proper layout can ensure isolation and prevention of unexpected human entry in robot's work volume. The dedicated cell controller monitors and controls the operation between various individual elements of systems hence synchronization between various elements is much easier than that in the case shown in figure 2. The robot used may be general purpose or its configuration may be designed suitable to particular layout. This enables better physical integration between robot and other systems working in palletizing cell.

4. Discussion and result

Do we have proposed an entirely different system? Certainly not! All the components of the system represented by figure 2 are also present in the system represented by figure 3. The palletizing system shown in figure 2 was robot centric i.e. it was designed considering the robot as main element and remaining elements in the system like material transport system are integrated with it by known integration methodologies. Whereas the new approach shown in figure 3 is rather atomic in nature i.e. it considers complete cell as an important subsystem of an entire integrated manufacturing plant and concentrates on designing of an entire palletizing cell rather than inclusion of a standalone machine like robot in the system. This surely results in better integration and improved ability of reconfiguration.

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