MANUFACTURE TRANSPORT DEVICES DEVELOPMENT BASED ON SELECTED EXAMPLES

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Abstract

The paper is focusing on analysis of manufacture transport devices development tendency, as well as special requires resulting both evolution and automation processes of manufacture systems. Material handling systems development is strongly supported via Information Technology expansion. Development areas of transport devices (material handling) have been discussed on the base on conveyors and cranes because their large installation number and being into technological processes.

Material handling devices are playing mostly key position in any manufacture systems. Actions (transportation types) that have been directed on loads (subject of transportation) were a subject of evolution from mono- to multi - functional types, as well as integration focused to support technological process. The number of transport devices supported special man functions and communication between transport system elements, are also growing results wider user interest It is possible to estimate that development of material handling devices during coming years will support more stronger new and coming needs of human. The new sets of man- transport device, which better explore operation potential, are strongly overlooked results designing, construction and automation type use in practice multifunctional solutions.

Keywords: *manufacture transport, cranes, conveyor*

1. Material handling devices development areas

Globalization world-wide in business results impacting new needs and challenges, as well as changes in transportation sector into manufacturing. Transport is more and more complex process needed integrated load transport units and engineering undertakes focused on compatible, modularity, necessary transportation procedures simplification, shortening both loading and re-loadings times. It is increasingly difficult to capture the boundary between the movement and storage of the item. The observed strong development of transport infrastructure, mainly the people and information flow, is increasing the demand for individual means of transport (mobile type).

The consequence of changes to the requirements of the market was a qualitative evolution of production systems, especially used in them means of transport. Initially used in mass production simple solutions, are conventionally called the mechanization of the manufacturing process. Then increase the quality requirements forced the development of new methods, technologies, and consequently slow automated manufacturing systems and equipment involved in them. Activities aimed at the movement of cargo has evolved from mono-to multi-functionality and integration-oriented power-oriented processing (e.g. storage, processing). In practice industrial and other areas of the economy implemented strategies aimed at: a single product in terms of quality, variety production, minimizing time to respond to customer needs, willingness to implement new customer requirements. Be realized through a combination of process and equipment throughout the enterprise and embedding artificial intelligence in the process and equipment. Qualitative evolution of transport devices include the following objectives: to procure the transport devices for a given level of quality, ability to respond to the targeted production and transportation system to

changing market requirements, minimizing reaction time (change over) devices to new user requirements, equipment readiness for the implementation of the future (new) needs user.

Into designing and exploitation process of transport devices we are observing a strong influence on the techniques which are oriented into optimization (including the use of LM methods, called *Lean Management* and other) and to achieve the added values in the result of the implementation of the relevant strategy for management (for example, JIT, called Just In Time, and others). They are a consequence of [20]:

- changes on the action subject (load): less weight and dimensions, unification of units of cargo, the loading units incorporating features useful in the production process (e.g.: automatic identification, methods and techniques to eliminate erroneous operation),
- requirements for transport devices: integration of transport devices belonging to different classes in one system, moving away from using surface transportation hall in the direction of transport in a 3D workspace, and from individual control device for a centrally coordinated system for the use and handling,
- modular construction and unification of units of equipment,
- slimming equipment design and installed in their power to achieve the working movements (subsystems: executive, assisting),
- improvement of sub-control devices (project oriented to: monitoring, collection, coordination, communication, decision-making), and security (safety) subsystems,
- optimizing the quality of life indicators installed devices: increased requirements for safety, reliability and accuracy of movements and to minimize operating costs for the use and handling.

Modular construction of transport devices make possible their optimum and flexible configuration for the user needs and taking into account actual operating conditions. As a result, digital strong-coupling (in terms of hardware and software) phases of the life of the device (design, manufacture, use, operation) it is possible to quickly adapt to user requirements, and rapid prototyping (with appropriate: methods, tools, algorithms), aimed at improve the quality of life indicators. The modular construction of an additional beneficial effects the process of rationalizing use the device.

Practical engineering of new materials and methods for dimensioning structures using computer techniques along with advanced manufacturing techniques made it possible to reduce weight and dimensions of the equipment, and better yields are installed in power (compared to the total weight of the device and moving cargo). Observed is the integration of elements into groups, realizable as a result of the replacement of mechanical units of electronic assemblies, and the pursuit of multifunctional devices essential for the safety teams.

Today we are observing a rapid development in the management process of transport. It is aimed at installing and improving cooperation in the man - a technical object set, and at a high level of safety and reliability. Quality of service life is achieved in phases of operation and maintenance/ service (with use proper methods, tools).

In particular users interest of transport devices is the control subsystem of both transport device and transport systems, in particular in the fields of human supervisory position, the processing of data for decision-making, construction of integrated knowledge and data bases for use/ operation, the capacity for regeneration of all selected device subsystems.

Observed trends in material handling devices include projects aimed at:

- reduction of costs of energy consumed in the process (energy intensity),
- reduction of adverse impacts on the environment (in particular: noise, vibration, operator working conditions),
- increase safety and reliability of transport devices and transportation systems (increasing the total efficiency of the operation and service processes),
- providing more interactive mobility-oriented transport modes in manufacturing focused on industrial cargo and people.

2. Selected material handling devices

Analysis of the transport development areas showed the example of industrial conveyors and cranes because of the number of industrial installations and the importance of technological processes.

Areas of technology development with cargo transportation with use of cranes and conveyors (for example: in metallurgy and the excavated material in coal mines) include:

- modernization and development of construction of cranes and conveyors including issues of energy and environmental security,
- development and integration of horizontal and vertical transport into one,
- developing systems to monitor the relevant operating parameters of transport devices and devices process control under operation, automatic optimization of the device operating parameters,
- development of maintenance systems of cranes and conveyors and promote in practice the preventive approach,
- cranes and conveyors integration with other transport modes within the enterprise,
- integration of staff involved in maintenance process of transport systems and to take actions aimed at improving their skills in the field of knowledge and practice.

The technological processes in manufacture are using various types of conveyors, tailored to existing needs, from which the band are among the most popular. The group of less well-known means of transport devices are the harpoon conveyors used to move metal shavings (tangled together with the short chips, which contain oils, emulsions and cooling lubricants - lubricants) in the channel floor production facilities (industries: automotive, metal, machinery; companies: ball bearings, metal working machining).

In the last decade of the XXI century has changed the requirements for the construction and operation of the conveyor - the costs of investment are important, but significant of which are: to reduce energy costs and noise emissions. Meeting the functional requirements, safety and reliability of material handling devices must be accompanied by raising standards in their energy intensity. For example, the energy consumption of belt conveyors is possible to reduce as a result of proper selection of energy-efficient tape (in particular in running truck - covers the application of which can reduce the wattage by about 11-12%) and a reduced resistance rollers rotating (rated wattage due to the decrease of about 5-10%) [6]. Another of the courses of action aimed at improving the energy efficiency of the operating characteristics of conveyor belts, are resulting of changes articulated suspension kits [29]. Improving the operating characteristics of conveyor is also achieved as a result of its investigation of conveyor belts as a function of load and number of cycles of stretching and making the problem detection and diagnosis of local damage in rolling bearings in the conveyor drive system [22].

In the transportation process in industry, there is increasing demand for efficient integrated digital tools to help manage the process of exploitation. Users of most systems use the basic functions of databases on transport devices and events to accompany their operations, while generating estimates of lifetime major groups of transport devices elements is limited (for example, conveyor [5]). Expected by the users of forecasts are exchange units, the indices of wear and preventive strategies for data handling. The construction of the system, supporting the management of the operation of transport device on the example of overhead cranes is presented in monograph [18].

For example, into conveyor operation processes there is a lack of economic muller in Polish coal mines. No registration and processing of event data service for runners, especially as regards the possibility of re-regeneration and their performance as a function of the operating capacity acquired after regeneration compared to new muller prevents the timing of their work to the failure [12]. It was found that runners operating cost reduction is possible as a result of the implementation of rational muller management in coal mines and to establish quality control system in the processes

of use and playback capabilities operating in the process of regeneration.

The process of moving loads should also have environmental aspects. Any, meet the pipe conveyors for the transport of bulk materials along the line of the curve in the workspace without booster station. Signs of organic devices rely on the isolation of transported material from the environment to eliminate the possible interaction (for example, dusty material and exposed to the environment) [35].

Working machinery is a source of mechanical vibrations of high frequency spectrum, which may affect the operator appearing in the machine, all machine components and systems and indirectly on the surrounding environment. The transport device with hydraulic elements, vibration can affect the disruption of the hydraulic system equipment, and also to reduce the precision movements of the working bodies, unevenness in their work and to shorten the exploitation life of the device [8].

In manufacturing plants significantly down transport system is based on monorail type transport (suspended one) to enable the construction of modular and flexible track the movement of cargo in the workspace as a result of association between the characteristics of motor hoists and cranes, and in accordance with the required user configuration [24, 25].

In the construction of material handling devices, particularly cranes are being developed:

- new methods of design,
- new design solutions,
- new strategies in the manufacture and operation, aimed at reducing energy demand in the processes of use,
- energy efficient power systems as a combination of electric motors with low power loss, high transmission efficiency, and smart electronic controls and energy flow in electrical networks, especially in machinery and equipment working in continuous motion and at high loads.

The requirements of modern industrial material handling device market include:

- longer periods of operation,
- a large range of possible hoisting capacity, higher operating speeds,
- drives with frequency inverters and new technical characteristics,
- compact construction and small footprint (reduced size, compact design),
- steeples adjustment of speed, safe and quick positioning of the working, secure transmission of signals, at least in the technology of CAN-bus noise reduction in the use,
- radio remote control, device control displays the size of the work load and diagnostic errors of the consumption units (elements) and other security functions.

The above requirements needs meet series of linear rope hoists DR type by Demag [25].

In the last decade of the XXI century were used centralized (single devices installed in the enclosure) and decentralized machine modules (due to the significant dispersion devices in the workspace), the structure of propulsion systems and industrial control modes. An important issue in the drive technology is the material handling device safety [34].

Important in the operation of crane systems are monitoring and visualization of cargo transportation process HMI (*Human Machine Interface*). Their effectiveness depends on the applied use of control systems - measurement. Solutions to accelerate the process of prototyping control systems - measurement and verification and performance tuning of complex algorithms for intelligent control of overhead cranes mechanisms presented in [16]. Another important issue is the positioning of cargo in the workspace [19] using telematics systems [17], inertial navigation [4], or others. With this issue raises the problem of optimal trajectory of movement of the executive in charge of the work area in conjunction with the processes of starting and braking mechanisms driving, lifting and rotation. The problem has a direct impact on energy demand mechanisms, and processes of fatigue design and material handling devices mechanisms.

An interesting in material handling devices are the solutions guides, including the transfer of power cables and transmission of information (power supply and information) to external and

internal crane and conveyor systems. Properties expected utility guides are their reliability, quiet operation due to environmental requirements and increase operating speed [27].

Material handling devices are used for industrial large-scale movements of large loads of equipment or components for assembly at the destination (target installation), for example: electrical transformers transported with railway cars, gas stations, conveyor machines moved from the pit using tracked transporters (transport capacity of about 600 tones). The problem is the correct configuration of known transport devices to movement needs and loading processes, adaptation of existing solutions (resulting in weight saving while maintaining performance and safety requirements as a result of endurance tests, or other structure to allow optimization) or to propose new solutions. Useful tools in the analysis of strength are: MSC / Nastran, Ansys, Cosmos/ M, I-Deas, Abaqus/ Standard, Pro/Engineer, Catia. In practice, are also known specialized vehicles to transport bulky loads with large masses [26] and people in special environmental conditions, for example in underground mines [30] and special types of solutions, for example mobile crushers for construction (roads), recycling, rock [36].

Supporting structures subsystems of crane (e.g.: overhead crane, jib cranes, tipplers wagon) are characterized by dozen years periods of operation. As a result the operation process, there are numerous cracks of fatigue as a result of various factors: the phenomena of corrosion, faulty design development in the area call (notches), local over - rigid nodes as a result of services, dynamic interactions in the process of use, deficiencies in maintenance processes [13]. Therefore, crane test due to cross a specified operation time (exhaustion of service life) is an important issue. The above also is to determine the extent of damage to the unit after the accident, purchase of equipment used the preparation of equipment for upgrading and modernization works of receipt. Due to existing procedural hurdles are undertaken work aimed at building the technical procedures for the review of the girders [1, 9]. The issue is also relevant for machinery solutions for unusual design or operate the specific and diverse environmental conditions, including in terms of dimensioning large-scale intelligent material handling devices. Examples are the mining devices (e.g. transhipping devices) for which important to ensure that user requirements was to develop and implement an integrated control system and safeguards adopted to prevent exceeding the allowable stress design stage of computing, focused on the construction of the superstructure diagnosis [11].

3. Special requirements for the material handling devices

In the process of movement of dangerous goods is a big threat level, for example in the steel industry during the transport of hot molten mass with the use of overhead cranes, large loads at high altitude (generators in power plants), chemical and radioactive cargoes, as well as in environments where a sudden release of load on the level of the hall could cause significant losses. The proposed crane must meet the requirements of the Machinery Directive and the PN-EN 14492-2 in the possession of the security before the fall of the load during a failure kinematic chain. Meeting the requirements of security is achieved by, for example, redundant solution [25]: redundant mechanism for lifting the emergency brake on the rope drum, the compensating levers (buffer) instead of compensating disc systems, monitoring the load and speed, and not for use in construction (especially the rope) material losing its properties as a function of time and exposed to thermal effects.

A major issue in the process of moving loads in the system is a combination of means of transport - environment interactions as a result of a static and dynamic. The bridge cranes with high capacity system are an important team fender - bumper and a drive wheel system - rail pad and the crane beam. Proper selection of the type and parameters of the fender and method of mounting rails should ensure the creation in the construction of transport device and buildings/ constructions (have been classified into the environment), stress within the elastic limit as a result of energy absorption [20, 33, 37].

Another important issue is that the conditions on the job of transport devices and unloading of bulk materials especially in potentially explosive as a result of the release of combustible dust (of food processing, grain silos, chemical and pharmaceutical industries, and coal) must meet with the EU guideline 94/9/EC (ATEX 100a) [7].

The processes of moving loads represent sources of security threats to the environment. Therefore, it is important to anticipate potential threats and sources of conflict situations. Useful in this process is the 3D virtual reality application to simulate dangerous situations using the language (VRML called Virtual Reality Modelling Language) in VrmlPad [12]. Virtual Reality is a new type of interface of the man - machine - environment, which allows the user to create scenarios of possible process, simulated process and watch him interact directly, especially in conflict situations and threats. Material handling devices, which belong to the most dangerous machines, are in use forklift [32].

Digital tools are also important in the maintenance of transport devices, particularly in the visualization of assembly and disassembly of assemblies and subsystems (Solid Works, Solid Edge, Unigraphics, Catia, Pro / Engineer, Inventor). Models of 3D types of assemblies and subsystems of transport modes may be subject to different analysis of kinematics and behaviour under certain loads.

Important in the use of transport device is the working environment of operators [3], and remote controls devices of their movements. More and more applications are radio solutions that provide the freedom to choose their place of observation of the movement of goods using one or more transport modes [28].

Today the market of material handling devices offers a wide range of their deliberate use. A major problem for users is the right choice of a particular type of transport device at the stage of the planned investment as a function of current and future production needs and constraints. Issues to choose a particular type of transport means is also stretching the process of adaptation by the modernization of selected modes of transport. The issue of choice of transport devices should be preceded by a multi-criteria analysis, which was an attempt on the example of technological haulers in the mines of rock materials are presented in [2] and for loading the container terminals in work [9].

Different types of transport devices in industry as a result of integration afforded by the new user requirements. For example, use of supporting self-propelled transport system connecting the excavator to haulage type conveyor resulting in: a reduction of travel time required by the main conveyor belt, increasing the possibility of manoeuvring the cutting machine base overburden or coal in the strip mine and increase system performance [15]. The combination of electric and hydraulic lifts with swivel is used in automated multi-storey parking garages for cars, trucks and equipment to forklifts [31] allows independent of ambient processes, handling of cargo on pallets.

4. Final remarks

The development of the global market is heavily dependent on transport, which has significant influence are developed information technology IT (Information Technology), and management approach [21]. A particularly important issue is the safety of transport and integration of emergency transport (including information, technical and medical systems to ensure the safety and rescue in the multimodal transport), and ensure environmental protection against the harmful effects of transport and technical measures to create conditions for preserving efficiency and other vital functions (mobile) people.

Material handling devices in industry play a key role in production systems, as well as other applications supporting the diverse needs of society. There is growing interest in assisting with transportation specialist human activities, as well as interoperable communications with other elements of the structure of the transport system, and the use of a special type of cargo (hazardous and dangerous for the environment).

The development of material handling devices in the coming years will be even more focused on the flexible implementation of customer needs. Achieving this target will be formulated as a result of the construction and practical application of multi-system man - a technical facility to enable more effective use of the integrated operational capabilities.

Acknowledgements

Financed supported by Polish Science budget.

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