UNIVERSITY OF NIS FACULTY OF MECHANICAL ENGINEERING

THE SIXTH INTERNATIONAL CONFERENCE
TRANSPORT AND LOGISTICS

til 2017

MECHANICAL TUGGER TRAINS SYSTEM FOR INTERNAL MATERIAL HANDLING

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Abstract

In this paper is described completely new mechanical tugger trains concept for internal material handling. The developed system consists of a tow tractor and a flexible combination of different train elements, E-frames (trailers) and trolleys (load carriers). The aim to organize line feeding with tow tractor which pulls several trolleys has been achieved with this system. This paper is analzying some parameters like energy savings, space reduction and risk of accident, before and after system implementation.

Key words*: logistic, material handling, tugger trains system, trailer, trolley*

1 INTRODUCTION

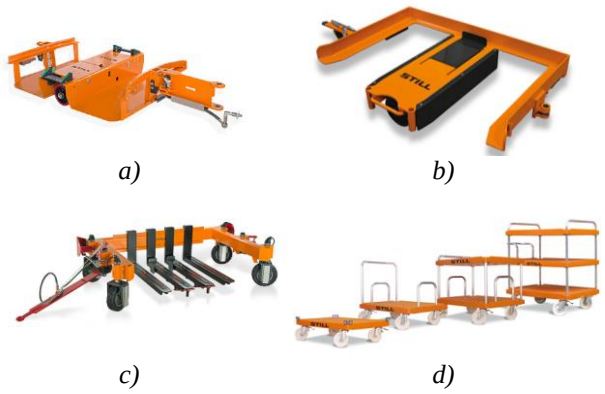
Complete internal transport consists of multiple operations such as: loading, transfer, unloading, reloading, where reloading is a combination of loading and unloading of material. Processes of individual, serial or mass production asking for the introduction of a suitable method of internal transport, which should be a productive, cost-effective and profitable, [1].
Efficient and flexible material flow requires appropriate logistic approaches to reduce cost and provide better safety conditions. The main requirements during the process of production and assembling is the elimination of the use of forklifts for material supply in manufacturing companies as well as reduction of Not Value Add Activities (NVAA), [2]. The aim to organize line feeding with tow tractor which pulls several trolleys has been achieved with developed tugger trains system. This completely new logistic solution has been developed recently by many manufacturers to respond to the demand for reliable solution from customers that want to improve their manufacturing line efficiency, [3]. This system allows lean concepts with a Just In Time (JIT) or Just In Sequence (JIS) supply of material, [4]. A single operator can supply material to an area of production or assembling alone without a forklift truck. The transport by tugger trains within production areas is faster and safer than transporting pallets by lift truck and handling time is reduced to a minimum. In this paper is described completely new mechanical concept of tugger trains system for internal material handling.

2 REVIEW OF EXISTING TUGER TRAINS SYSTEM VARIANTS

The tugger trains system developed by company STILL, shown on figure 1, commonly consists of a train truck (e.g. tow tractor) and a flexibile combination of different tugger trains elements like trailers (B, C, E – type) and trolleys (rollable load carriers) as shown on figure 2.

Fig. 1 *Tugger trians system developed by STILL [3]*

With the broad range of frames and trolleys, tugger trains can be assembled according to need, so that the various types of goods arrive in small batches quickly and efficiently at their particular deployment area. Frames are therefore designed to transport trolleys of different types and dimensions, and are developed and constructed individually in accordance with customer requirements. In practice, this system is named „LiftRunner“ as the trolley raised up within the frame during the journey. The lifting energy required for this is provided by hydraulics, pneumatics or electricity via the towing truck or autonomously via the frame, [5]. Before the tugger train sets off, the trolleys are slotted into or out of frames and are secured automatically. They can be loaded from the left or from the right (C- and E-frames) or from both sides, depending on the direction of the coupling, so that no re-coupling of the frames is necessary (B-Frames). The frames lowers automatically when driver leaves the towing truck or deactivates the appropriate switch and the trolleys can then be removed. A foot pedal activates mechanism that eases the trolley in the direction of the operator.



a) *b)* *c)* *d)*

Fig. 2 *Elements of tugger trians system: a) B – frame, b) E – frame, c) C – frame, d) trolleys*

In the table 1 are shown adventages and disadventages of each variants, [3].

Table 1 Tugger train LiftRunner system variants

System	Adventages	Disadventages
Hydraulic The power needed for lifting is provided by a hydraulic unit on the towing truck.	• Energy efficiency • Smooth lifting and lowering • Quiet operation	• Presence of oil • Maintenance
Pneumatic The power needed for lifting is provided via compressor on the towing truck.	• Energy efficiency • Smooth lifting and lowering • Oli free	• Maintenance
Electrical The power needed for lifting is generated via an electrical connection to the towing truck.	• Energy efficiency • Smooth lifting and lowering • Oli free • Quiet operation	• Maintenance
Autonomous It is the driving movement that generates the power needed to lift up the frame.	• Energy savings • Smooth lifting and lowering • Oli free • Quiet operation	• Maintenance

3 DESCRIPTION OF THE DEVELOPED MECHANICAL SYSTEM

The completely mechanical system shown on figure 3, consists of a train truck and a flexible combination of different train elements, E-frames (trailers) and trolleys (load carriers), [6]. E-frames shown on figure 4 are designed to transport trolleys of different types and dimensions, and can be developed and constructed individually in accordance with customer requirements. The number of coupled trailers is flexible, so the train capacity can be adapted to the amount to be transported.

The trolleys shown on figure 5 with four swivel wheels with ergonomic round profile are slotted manually into or out of the frames with two fixed wheels and are secured mechanically during the journey. Excellent driveability and directional stability provided by high quality wheels guarantees a high level of safety of the system. A foot pedal as a part of frame, figure 4, activates a mechanism that releases the trolley in the direction of the operator as shown on figure 6. The user-friendly system allows the trolleys to be pushed into the trailers at floor level. Due to the E-frame design, operators can load and unload individual trailers from a single side only that can be only one disadvantage of this part of the system.

Fig. 3 *Tugger trains composition with working aisle*

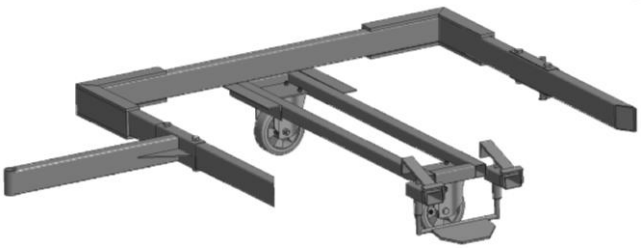


Fig. 4 *Trailer (E – frame) of mechanical tugger train [6]*

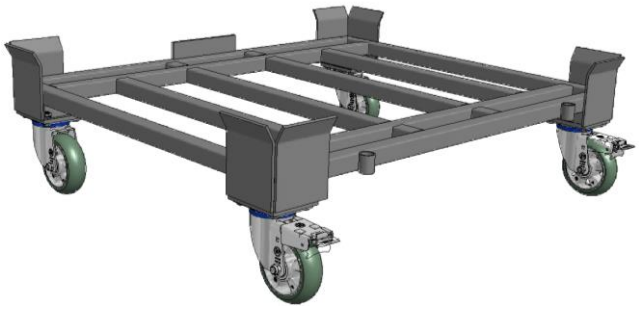


Fig. 5 *Trolley of mechanical tugger train [6]*

Fig. 6 *Loading/unloading operation with foot pedal*

A modular system of train elements allows individual adaptation to any situation as shown on figure 7. The trailers are compatible with each other and a quick coupling mechanism (front and rear drawbar) enables safe connecting and disconnecting of the trailers to the train which can be up to five E-frames long.
The trailers carry pallets or containers of various sizes up to a maximum of 2000x1200 mm or cage trolleys, rack trolleys etc., as shown on figures 3 & 7.

Fig. 7 *Composition with different load*

Generally speaking tugger trains concept eliminates traffic bottlenecks by reducing the pieces of equipment as well as manpower required for material load transfer. The lower cost train of trailers and trolleys are able to transport more load volume and weight in less trips compared with transporting loads utilizing traditional forklifts or tow trucks.
The operator of a tugger train has no frontal view obstruction because the operator sits in front with the towed load behind. The operator of a forklift truck has restricted frontal visibility due to the mask and transport load as shown on figure 8. Having unrestricted frontal visibility when driving in a busy congested facility makes the operation safer.

Fig. 8 *Loading operation with forklift truck*

Less traffic congestion on the floor space will prevent less equipment and product damage too. On the figures 9 & 10 is showing comparison of traditional alternative of using forklifts and tow trucks with trolleys and usage of developed tugger trains system. This concept eliminates traffic bottlenecks by reducing the pieces of equipment required for material load transfer.

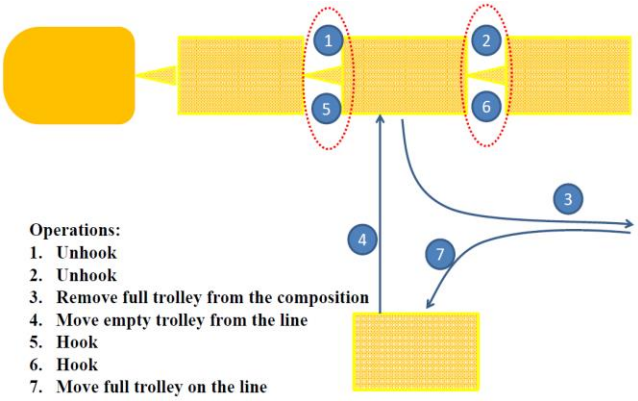


Fig. 9 *Operations of material handling before system implementation*

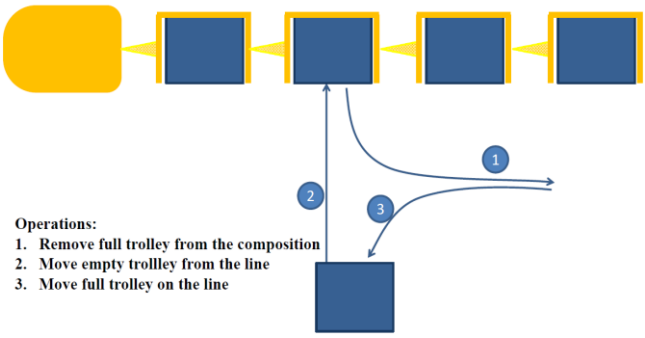


Fig. 10 *Operations of material handling after system implementation*

4 CONCLUSION

In modern and lean production logistics, tugger trains are indispensable for efficient flow of materials. They supply workstations, such as assembly and production lines, with the needed materials in different types of load carriers and in small batch sizes. For the company this means not only to reduce costs for logistics space in production areas, but also to reduce stock levels and energy consumption, besides lowering the risk of accidents due to lower traffic frequencies.

There are many advantages in using tugger trains. The economic benefits are two-fold: equipment and manpower. The tugger train concept requires less capital equipment investment when compared with the traditional alternative of using forklifts or simply trolleys. The reduction in manpower utilization is significantly less when comparing a tugger trains vs. forklifts or trolleys. With a single operator on the tugger trains, one is able to tow a train of trailers carrying a large capacity of parts. Additional benefits are the simultaneous provision and removal of materials and empty load carriers, clearly defined transport routes without wasted empty journeys and a reduction of traffic in the production area.
As the best logistical solution, a tugger trains holds the key to greater savings, higher output, less traffic, more flexibility, and better safety than the traditional alternative of using forklifts or tow trucks with trolleys.

ACKNOWLEDGMENT

The paper is a part of the research done within the project TR32036 supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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