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E-commerce enforces criteria for performance-based sorting technology

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Due to the constantly increasing online trade, there is a growing need for efficient distribution centers with complex sorting systems. Therefore, general cargo sorting is once again becoming the key process within the overall intralogistics process.

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For many years, the boom in online trade has been ensuring a continuous increase in parcel volumes in distribution centers. In Germany, for example, this causes the yearly parcel volume to increase by about four percent per year on average [1]. The main result of this development – in addition to increased demands for the delivery service – is a growing need for efficient parcel sorting and distribution systems. In this context, the terms "sorting" and "distributing" are usually used as synonyms, although these terms need to be distinguished from a purely "academic" point of view. In fact, according to its scientific definition, "sorting" only involves the logical allocation of identified targets of shipping labels on current terminals. "Distributing", instead, describes the subsequent physical implementation of the sorting result. The terms "sorter" or "sorting system", which also stand for the overall process involving information flow, material flow and organization, have now established themselves. However, with regard to systematic considerations, the subprocesses involving feeding, preparation, identification, sorting and discharge should be differentiated and initially considered separately.

Features of the different sorting technologies

With regard to the overall intralogistics process, sorting, which involves functions such as loading, distributing and buffering, is the actual core process. Generally, the term-defining factor for the overall system is the distribution technology used. The enhanced systems that are used especially in distribution and parcel centers include the cross belt sorter, the tilt tray sorter, the zip sorter and the split tray sorter **(Image 01)**. In these cases, these Anglo-American terms or other company-specific terms are frequently used.

First of all, in order to be able to systematize the entire series of technical implementation options [2], the carrying elements, i. e. the elements on which the goods to be sorted are placed during the distribution process, are divided into "segmented" and "continuous". Important features for the sorting process can be derived from this systematization.

On the one hand, segmentation allows early and clear allocation between the goods and the terminal, ensuring high transparency. On the other hand, optimiza-

tions of the sorting performance can be hindered through the creation of a flow density that depends on the size of the goods. The latter, however, can be implemented via continuous carrying elements. Still, due to relative motions, incorrect unloading may occur and/or obstacles may arise, since the position of the goods on the suspension element is only determined during loading, whereas the unloading mechanism is later triggered in a time-controlled manner, and can no longer respond to intermediate disturbances, such as slipping or obstacles.

Another important distinguishing criterion in systematization [2] is the working principle of the unloading process, which can be divided into traction (friction), tight fit (carrier, deflector) and force field (gravity, centrifugal force).

Functional safety is a priority

The high-performance sorters available on the market with a throughput of more than 10,000 units per hour can be divided into two types: loop and line. Even in this case, the Anglo-American terms "loop sorter" and "line sorter" are used. A loop sorter and a line sorter have several differences from an operational point of view. In the case of the loop sorter, the goods circulate and pass through the terminals several times if, for example, the related order has not yet been assigned to a terminal. The loop sorters are generally operated in batch, namely, the orders are gathered into groups and then distributed together to the terminals in a specific time frame. In this way, new targets can be assigned to the terminals for each batch. Loop sorters are therefore designed to process a wide range of orders.

For these systems, however, the correct feed has to be used. In fact, the goods that move around or are placed on the free terminals, block the sorter and can reduce its performance, also bringing it to a deadlock.

Line sorters, instead, have a fixed terminal allocation, therefore they are frequently used at parcel centers, for example for mail or the CEP industry. Regardless of the technology used, operators believe that great importance should be given to functional reliability. The sorting system is generally the key element and is not redundant, which, in the event of failure of the distributing conveyor, may lead to a process standstill. Therefore, during selection, in addition to suitable technology, a solid structural design and an experienced manufacturer are to be preferred.

For example, the malfunctioning of machine elements due to mechanical stress, caused by high dynamics and heavy loads, may cause a failure in the sorter. Faulty packaging with contents falling out, straps and belts that come loose, entering into the guide or connecting elements, or goods placed in an unstable position, must also be taken into account.

However, a distributing conveyor with a highly developed structure, featuring a corresponding loading area and terminals, does not in itself guarantee a functional and efficient sorting process [3]. Upstream subprocesses are characterized not only by high potential for performance improvements but also malfunctioning.

In order to ensure safe identification and target allocation, which is essential for the process, we can now take advantage of ID solutions used in high-performance cars. In addition to the improvement in the performance of laser scanners, development is strongly pursued mainly in the field of image processing.

Active and passive separation

A major challenge within the sorting process lies in the separation that takes place during the preparation phase. Reliable

01 The basic sorter technologies (cross belt sorter, tilt tray sorter, split tray sorter and zip sorter) are used primarily in distribution and parcel centers

02 Adjustable drive segments in active isolation systems, such as the Vision Singulator by Siemens, correct the position and direction of each individual item

identification, loading and unloading requires a defined position and direction of the goods to be sorted in relation to each other and in relation to the conveyor. Depending on the technology and strategy used, specific distances are required between these, as well as a defined angle of the longitudinal axis for the parcel in relation to the main conveying direction. In order to solve this issue, separation systems are required, which can be differentiated into active and passive solutions.

In the case of active separation **(Image 02)**, the position and direction of each individual item is corrected, depending on the visual arrangement of the goods – using adjustable drive segments – thus generating the desired product flow over a relatively short distance.

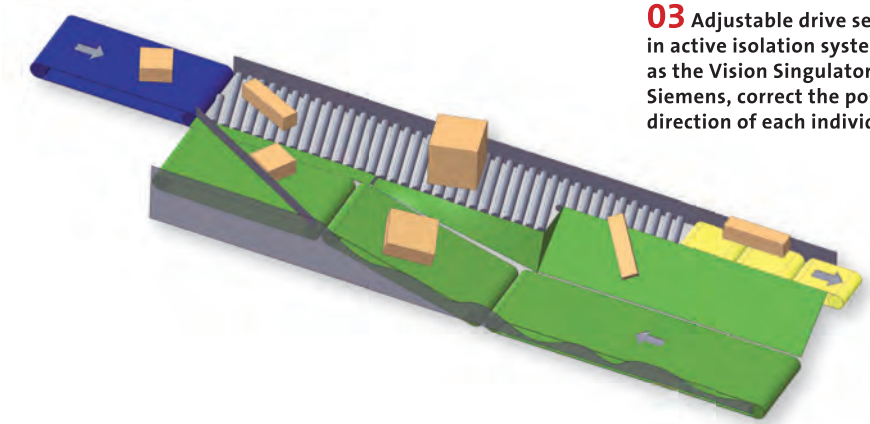
Passive systems **(Image 03)** combine various "obstacles" on the conveyor line, which, however, requires a longer route or return trip.

The processes described have been established in practice in order to separate the goods arranged on one level – in two dimensions – so that they can be converted into a flow with just one dimension (conveying direction). Thanks to the current developments achieved by logistics service providers, which considerably increase the efficiency of their parcel distribution centers due to the volume increase described in the introduction, complex situations will have to be mastered in the future.

High-performance sorting requires effective parcel unloading

In order to sort 40,000 to 50,000 parcels per hour, manual unloading technologies for transport vehicles are hardly sufficient. This requires ongoing development work focusing on automatic parcel unloading concepts. For example, parcels that are to be unloaded in a pile come in bulks, whereby the parcels of a load (about 1,000) are arranged arbitrarily in three dimensions with no specific order. In this case, separation is much more difficult and further elements are required for separation. In this respect, interesting solutions have been recently presented. Without being able to judge its general functioning, it is evident that, in the field of general cargo conveying with continuous conveyors, significantly more research needs to be carried out with regard to the behavior of goods during highly dynamic processes, as well as the motion involved. At the Institute of Logistics Engineering of the Graz University of Technology, Austria, research has been conducted on this subject for years. Various approaches have been developed for a practical simulation of general cargo motion during the continuous conveying process. In this case, the challenges lie in the high amount of elements and the resulting exponentially increasing number of contact points, which are to be calculated at each time step during numerical simulation.

It is therefore clear that the booming online trade does not only require new and more powerful sorting technologies but also more effective interaction between the upstream processes of parcel unloading and separation.



03 Adjustable drive segments in active isolation systems, such as the Vision Singulator by Siemens, correct the position and direction of each individual item

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About ITL

The Institute of Logistics Engineering (ITL) at Graz University of Technology in Austria focuses on research and teaching concerning the physical part of logistics.
The practice areas include analysis, design and optimization of intralogistic material flow systems like order picking-, sorting-, transport-, handling- and storage systems. Beside selection, dimensioning and configuration of applicable technologies the Institute observes processes, Auto ID and loading equipment. Actual research fields are energy efficiency, availability, computational methods of system design and simulation of goods behavior in highly dynamic conveying processes. A topic that has recently been added to the Institute research activities is urban logistics. E-mobility, distribution and redistribution of goods in cities and last-mile-logistics are located in this field.