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## DESIGN AND FABRICATION OF BOX SHIFTING MECHANISM USING GEARLESS TRANSMISSION

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DOI: <https://www.doi.org/10.58257/IJPREMS34077>

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### ABSTRACT

In this study, a single slider crank mechanism is used to convert rotary motion to reciprocating motion. The key objective of this prototype is to replace conventional conveyer systems with purely mechanical ones that are exceptionally efficient and have low setup and going on costs for upkeep. These small-scale mechanical conveyer Box transport systems are primarily intended for small-scale industrial businesses and organizations. Belts, large input/output motors, and other components add to the original and continuing costs of conventional conveyer systems. This prototype only has a modest rotary motor and is based on a four-bar arrangement. Rotation motion generates reciprocal motion. This prototype will surely reduce the effort needed by small-scale industries. Typically, a switch is used to control the operation of the wrapping machine.. The efficient movement of boxes or containers within industrial, warehouse, or logistical environments is crucial for optimizing productivity and minimizing operational costs. This abstract presents the design and implementation of a box shifting mechanism aimed at automating and streamlining the process of moving boxes in various settings. The mechanism comprises several key components, including conveyors, robotic arms, sensors, and control systems. Conveyors form the backbone of the system, providing a means to transport boxes along predefined paths within the facility. Robotic arms equipped with grippers are employed for handling boxes at different stages of the shifting process, facilitating tasks such as loading, unloading, sorting, and stacking. Sensors play a vital role in enabling the mechanism to perceive its environment and respond intelligently to changes in box position, orientation, and condition. These sensors include proximity sensors, vision systems, and weight sensors, which provide feedback to the control system for real-time decision-making.

**Keywords:** box transportation, slider crank mechanism, DC motor, push box, Gearless Transmission, Hub, Links Mechanism, Elbow Mechanism, Gearless

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### 1. INTRODUCTION

Efficient handling and movement of boxes or containers are fundamental operations in various industries such as manufacturing, logistics, and warehousing. The ability to shift boxes swiftly and accurately greatly impacts overall productivity, operational costs, and customer satisfaction. In response to the increasing demand for automation and optimization in these sectors, the development of sophisticated box shifting mechanisms has become a focal point of research and innovation. The introduction of advanced technologies, including robotics, sensors, and control systems, has revolutionized traditional box shifting methods, enabling the design and implementation of highly efficient and flexible mechanisms. These mechanisms are capable of automating tasks such as loading, unloading, sorting, and stacking boxes with precision and reliability. This introduction serves as a primer to explore the key components, functionalities, and benefits of box shifting mechanisms. It outlines the challenges associated with manual box handling processes and highlights the motivations behind the development of automated solutions. Additionally, it sets the stage for a deeper examination of the design principles, implementation strategies, and real-world applications of box shifting mechanisms in various industrial and logistical contexts. By harnessing the power of automation, intelligence, and integration, box shifting mechanisms offer promising opportunities to streamline operations, optimize resource utilization, and enhance overall competitiveness in today's dynamic business landscape. This paper aims to delve into the intricacies of these mechanisms, providing insights into their design, functionality, and potential impact on the future of box handling operations. The box moving or shifting set up has a simple mechanism, operated with crank and links arrangement. As by the electric motor rotary motion is converted into the To and Fro motion of the linkages, it takes very simple. The rotary motion is converted in to linear motion by the crank and mechanical linkages arrangement. The conveyor system is either continuous movement or if the time delay is to be produced there will be definite requirement of software programming which will be costly. So, a basic module of moving packages is designed with time delay which can be used to do alterations if required in the package or move the package for any

other purpose. This invention relates to improvements in transfer and conveying devices, and it relates particularly to devices for transferring set-up cardboard boxes from a box folding or forming machine to the operator of a semi-automatic box wrapping machine. A great many manufacturers of fancy wrapped or covered cardboard boxes used for packaging candies, cakes and other confections, cosmetics and other articles are equipped with the so called quad staying machines by means of which a box blank is folded or set-up into box like form. These setup boxes are transferred by means of a conveyor to an operator, who picks up the boxes and places and centers' them on wrappers with which the boxes are to be covered. The boxes and wrappers are then conveyed to a box wrapping machine where the wrapper is folded around and glued to the box. Usually, the operation of the wrapping machine is controlled by means of a switch actuated by the box forming machine so that their operating speeds are related to each other. This invention relates to improvements in transfer and conveying devices, and it relates particularly to device for transferring set-up cardboard boxes from a box folding or forming machine to the operator of a semi-automatic box wrapping machine. A great many manufacturers of fancy wrapped or covered card board boxes used for packing candies, cakes, and other confections, cosmetics and other articles are equipped with the so called quad staying machines by means of which a box blank is folded or set-up into box like form. These set-up boxes are transferred by means of a conveyor to an operator. Who picks up the boxes and places and centers them on wrapper with which the box easier to be covered. The boxes and wrappers are then conveyed to a box wrapping machine where the wrapper is folded around and glued to the box. Usually, the operator of the wrapping machine is controlled by means of a switch actuated by the box forming machine so that their operating speeds are related to each other. Fully automatic machines are available for setting up the boxes, placing them on the wrappers and feeding the assembly to the wrapping machine. In many instances, however, the cost of replacement of the semi-automatic machines with fully automatic machines is so great that it cannot be justified by the increased rate of production possible with automatic machines. The principle different in the rate of operation of the fully automatic machines and the semi-automatic machines reside in the human factor, namely, the operator of feeder of the semi-automatic wrapping machine. Considerable manual dexterity and skills are required to pick up the boxes and centre them accurately on the wrappers as they move past the operator's station

## 2. CONCEPT OF BOX TRANSPORT MECHANISM

- This is mainly used for transporting (moving/shifting) boxes automatically.
- It is driven through a DC motor and is powered through the main battery supply.

## 3. PRINCIPLE

The principle of box moving is to change circulatory motion or cycling motion of the DC motor into translator motion with the help of levers and linkages through metal connecting rods. The principal of a box shifting mechanism is to automate and optimize the process of moving boxes or containers within industrial, warehouse, or logistical environments. At its core, the mechanism aims to achieve the following principles:

1. **Efficiency:** The mechanism should facilitate the swift and seamless movement of boxes from one location to another, minimizing delays and maximizing throughput. This involves optimizing the arrangement of conveyors, robotic arms, and other components to streamline the flow of boxes within the facility.
2. **Accuracy:** Precision in box handling is essential to ensure that boxes are positioned, sorted, and stacked correctly according to predefined criteria. The mechanism should leverage sensors, vision systems, and control algorithms to accurately detect box locations, orientations, and attributes, minimizing errors and rework.
3. **Flexibility:** The mechanism should be adaptable to handle a wide range of box sizes, shapes, and weights, as well as accommodate changes in production or logistical requirements. This requires modular design principles and configurable parameters that enable the mechanism to adjust its operation dynamically based on evolving needs.
4. **Safety:** Safety is paramount in any automated system, particularly in environments where human operators may interact with the mechanism. The design and operation of the mechanism should adhere to stringent safety standards and incorporate features such as emergency stop mechanisms, protective barriers, and collision avoidance algorithms to mitigate risks to personnel and equipment.
5. **Integration:** The mechanism should seamlessly integrate with existing infrastructure, control systems, and processes within the facility. This includes interfacing with warehouse management systems (WMS), enterprise resource planning (ERP) software, and other information systems to exchange data, coordinate workflows, and optimize overall operational efficiency.

By adhering to these principles, a box shifting mechanism can revolutionize box handling operations, driving improvements in productivity, accuracy, safety, and cost-effectiveness across various industrial and logistical applications.

#### 4. APPLICATION

- Can use this mechanism in medical production fields.
- It also can be used in bottle filling process.
- Can use this mechanism in cool drinks production.

#### 5. LINKAGE MECHANISM

A linkage is a mechanism formed by connecting two or more levers together. Linkages can be designed to change the direction of a force or make two or more objects move at the same time. Many different fasteners are used to connect linkages together yet allow them to move freely such as pins, endthreaded bolts with nuts, and loosely fitted rivets. There are two general classes of linkages: simple planar linkages and more complex specialized linkages; both can perform tasks such as describing straight lines or curves and executing motions at differing speeds. The names of the linkage mechanisms given here are widely but not universally accepted in all textbooks and references.

Linkages are often classified consistent with their primary functions:

- Function generation: the relative motion between the links connected to Frame.
- Path generation: the path of a tracer point.
- Motion generation: the motion of coupler link.

#### FUNCTIONAL DESCRIPTION OF THE PROJECT

The functional description of the project work is explained in brief here. For better understanding, the total project work is divided into various blocks and each block explanation is provided here. The complete block diagram of this project work is provided in the next chapter. The following is the description of overall function of the module. A box shifting machine is used to transfer boxes/cartons generally on an assembly line. Industries worldwide use conveyors as a mechanism to transport boxes from place to place. This mechanism includes strong belts, pulleys and heavy motors to rotate the pulley to move the conveyor.

As an alternative to this conveyor type, simpler and more comfortable machine using four bar mechanism can be used. This box shifting machine helps in transfer of boxes smoothly by use of four bars with a simple arrangement. The four-bar mechanism includes four links. One link is fixed and the other links act as crank, follower and connecting rod. The rotary motion of the crank is transferred to the follower by using connecting rod and is converted to the same rotary motion. This machine requires an electric motor to provide input to the system. Four-bar linkage A four-bar linkage also called a four-bar is the simplest movable closed chain linkage. It consists of four bodies, called bars or links connected in a loop by four joints. Generally, the joints are configured so the links move in parallel planes and the assembly is called a planar four bar linkage.

If the linkage has four hinged joints with axes angled to intersect in a single point, then the links move on concentric spheres and the assembly is called a spherical four-bar linkage. Bennett's linkage is a spatial four-bar linkage with hinged joints that have their axes angled in a particular way that makes the system movable.

#### INVERSIONS OF FOUR BAR MECHANISM

A mechanism is one in which one of the links of a kinematic chain is fixed. Different mechanisms can be obtained by fixing different links of the same kinematic chain.

These are called as inversions of the mechanism. By changing the fixed link, the number of mechanisms which can be obtained is equal to the number of links. Excepting the original mechanism, all other mechanisms will be known as inversions of original mechanism.

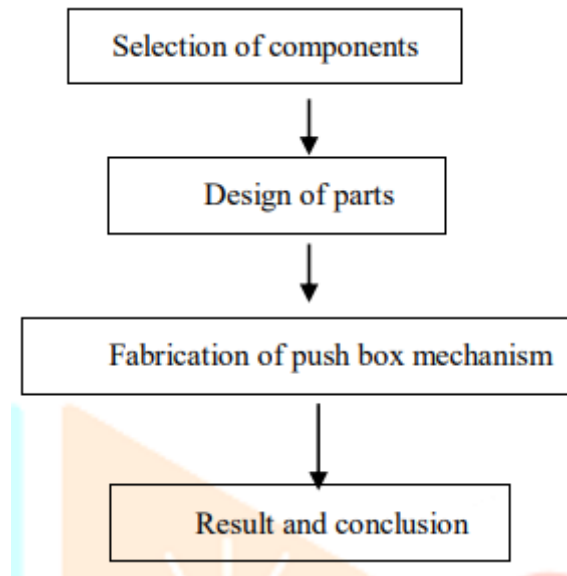
The inversion of a mechanism does not change the motion of its links relative to each other. One of the most useful and most common mechanisms is the four-bar linkage. In this mechanism, the link which can make complete rotation is known as crank (link 2). The link which oscillates is known as rocker or lever (link 4). And the link connecting these two is known as coupler (link 3). Link 1 is the frame.

#### DESIGN OF FOUR BAR MECHANISMS

The synthesis, or design, of four bar mechanisms is important when aiming to produce a desired output motion for a specific input motion. In order to minimize cost and maximize efficiency, a designer will choose the simplest mechanism possible to accomplish the desired motion.

When selecting a mechanism type to be designed, link lengths must be determined by a process called dimensional synthesis. Dimensional synthesis involves an iterate-and-analyze methodology which in certain circumstances can be an inefficient process; however, in unique scenarios, exact and detailed procedures to design an accurate mechanism may not exist. The picture shown below is for illustration purpose only.

## 6. METHODOLOGY



## 7. SELECTION OF COMPONENTS

- Wiper motor
- Steel frames
- Linkages
- Bolts nuts and washers

A four-bar linkage, also called a four-bar, is the simplest movable closed chain linkage. It consists of four bodies, called bar or links, connected in a loop by four joints. Generally, the joints are configured so the links move in parallel planes, and the assembly is called a planar four-bar linkage. If the linkage has four hinged joints with axes angled to intersect in a single point, then the assembly is called a spherical four-bar linkage. Bennett's linkage is a spatial four bar linkage with hinged joints that have their axes angled in a particular way that makes the system movable. The project, as discussed, is the combination of two different mechanisms. One is Box Shifting Mechanism and the another one is Gearless Power Transmission Mechanism. The set up consists of similar Circular Plates with drilled holes at the Pitch Circle Diameter of 100mm. The two circular plates are then connected with the help of three Links. These three links are bent at an angle of 90°. When the power is transmitted to the shaft, it starts rotating. This is a driver shaft which is already connected to the first circular plate. This circular plate starts rotating with the help of driver shaft. As we have stated earlier that the three bent links are connected to these two circular plates. So, because of this, the power transmission to the second circular plate becomes possible. The rotary motion of the crank is transferred to the Couplers and then the power gets transmitted to the upper structure

## 8. SELECTION OF MATERIALS

- a. Linkages
- b. M.S.Frame
- c. D.C. motor
- d. Bearings

The design and fabrication of box shifting mechanism constructed by various components such as hilum board, dc wiper motor, dc battery, steel stand and wooden pieces. In this steel frame build by using rectangular hollow pipes and steel rods these are connected by welding operation. The hilum boards are cut by using cutting operation. The dc wiper motor fitted on the frame by using bolt and nut joint. Power supply given from the dc battery (12volts and 7amps) through copper wires. Dc motor A windscreen wiper or windshield wiper is a device used to remove rain and debris from a windscreen or windshield. Almost all motor vehicles, including trains, watercraft and some aircraft, are equipped with such wipers, which are usually a legal requirement. A wiper generally consists of an arm, pivoting at one end and with a long rubber blade attached to the other. The blade is swung back and forth over the glass, pushing water from its surface. The speed is normally adjustable, with several continuous speeds and often one or more "intermittent" settings. Most automobiles use two synchronized radial type arms. Bearings A bearing is a machine element that constrains relative motion between moving parts to only the desired motion. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it

may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts. External Factor The service life of the bearing is affected by many parameters that are not controlled by the bearing manufactures. Examples are bearing mounting, temperature, exposure to external environment, lubricant cleanliness and electrical currents through bearings etc.

**Maintenance and Lubrication** Many bearings require periodic maintenance to prevent premature failure, although some such as fluid or magnetic bearings may require little maintenance. Most bearings in high cycle operations need periodic lubrication and cleaning, and may require adjustment to minimize the effects of wear. Bearing life is often much better when the bearing is kept clean and well-lubricated.

Many bearings require periodic maintenance to prevent premature failure, although some such as fluid or magnetic bearings may require little maintenance. Cleaning is of little use because cleaning is expensive, yet the bearing is contaminated again as soon as the conveyor resumes operation. Thus, a good maintenance program might lubricate the bearings frequently but never clean them.

## 9. PROCEDURE

Implementing a box shifting mechanism involves several steps to ensure its successful design, installation, and operation. Here's a procedural overview:

1. **Identify Requirements:** Understand the specific needs and constraints of the application, including the types of boxes to be handled, throughput requirements, available space, safety considerations, and budgetary constraints.
2. **Design Conceptual Framework:** Develop a conceptual design for the box shifting mechanism based on the identified requirements. This includes determining the layout of conveyors, robotic arms, sensors, and control systems, as well as defining the overall workflow and integration with existing infrastructure.
3. **Detailed Design:** Refine the conceptual design into detailed engineering drawings and specifications. Specify the dimensions, materials, components, and interfaces of each subsystem, ensuring compatibility, reliability, and scalability.
4. **Procurement:** Source the necessary components, equipment, and materials for the construction of the box shifting mechanism. This may involve purchasing conveyor belts, robotic arms, sensors, actuators, controllers, and other hardware, as well as software licenses and support services.
5. **Assembly and Installation:** Assemble the various components of the box shifting mechanism according to the detailed design specifications. Install conveyors, mount robotic arms, position sensors, and connect control systems, ensuring proper alignment, calibration, and integration.
6. **Programming and Configuration:** Program the control systems to orchestrate the operation of the mechanism. Develop algorithms for path planning, collision avoidance, box detection, sorting, and stacking. Configure parameters such as conveyor speed, robotic arm trajectories, and sensor thresholds to optimize performance.
7. **Testing and Validation:** Conduct comprehensive testing and validation of the box shifting mechanism to ensure functionality, reliability, and safety.
8. **Perform functional tests** to verify the correct operation of each subsystem and integration tests to assess the overall performance of the mechanism under various operating conditions.
9. **Optimization and Fine-Tuning:** Identify areas for improvement based on testing results and feedback from stakeholders. Fine-tune control algorithms, adjust hardware configurations, and optimize operational parameters to enhance efficiency, accuracy, and throughput.
10. **Training and Documentation:** Provide training to operators, maintenance personnel, and other stakeholders on the operation, maintenance, and troubleshooting of the box shifting mechanism. Document operating procedures, maintenance schedules, troubleshooting guides, and safety protocols to ensure safe and efficient operation.
11. **Deployment and Monitoring:** Deploy the box shifting mechanism into production or logistical environments. Monitor its performance and reliability over time, collecting data on throughput, error rates, downtime, and maintenance requirements. Continuously assess and optimize the mechanism to meet evolving needs and challenges.

By following these procedural steps, organizations can successfully implement a box shifting mechanism that automates and optimizes box handling operations, leading to improvements in productivity, efficiency, and competitiveness.

## 10. FABRICATION OF THE MACHINE

There are few types of fabrication methods are done on the machine.

They are: → Arc cutting.

→ Drilling.

→ Grinding.

Further Operation

→ Cleaning.

→ Assembling.

**Machining Operations** In this project it is used to cut the raw material such as plates, rod. This is done by arc cutting machine.

**Drilling** -Drilling is used to produce holes in objects. In this project the square type pipe required the holes for making rake assembly. These holes are done by vertical type drilling.

**Fine Grinding** It is nothing but a grinding process, which is done as smooth with fine grains. It is done by convention grinding machine.

**Cleaning** -It is the operation to clean the all-machined parts without burrs, dust and chip formals. By meaning the parts they are brightened and good looking.

**Electric Motors** – An Over View Electric motor, both ac & dc motors, come in many shapes and sizes. Some are standardized electric motors for general-purpose applications. Other electric motors are intended for specific tasks. In any case, electric motors should be selected to satisfy the dynamic requirements of the machines on which they are applied without exceeding rated electric motor temperature. Thus, the first and most important step in electric motor selection is determining load characteristics torque and speed versus time. Electric motor selection is also based on mission goals, power available, and cost.

**Power Source Description** -The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A RPS (Regulated Power Supply) is the Power Supply with Rectification, Filtering and Regulation being done on the AC mains to get a Regulated power supply for the devices being used. The motor used requires a supply of +12V DC, which is derived from the single-phase supply of 230V AC. A power supply unit can be broken down into a series of blocks, each of which performs a particular function. A DC power supply which maintains the output voltage constant Irrespective of a.c. mains fluctuations or load variations is known as Regulated D.C. power supply.

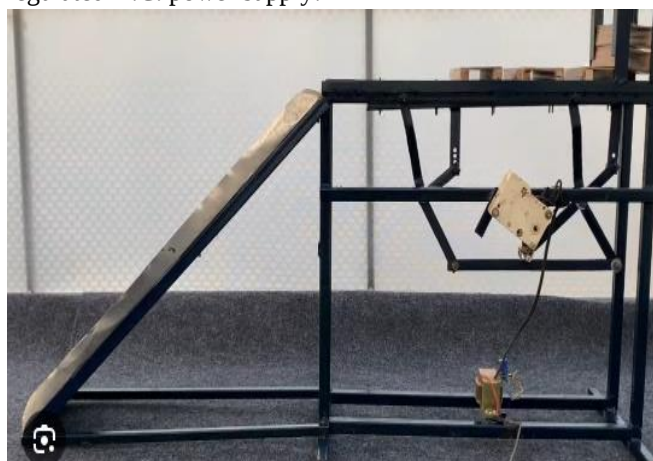


Fig.1 BOX SHIFTING MECHANISM

## 11. ADVANTAGE

1. **Efficiency:** Box transfer mechanisms automate the process of transferring boxes, improving efficiency and throughput in material handling operations. They reduce manual labour and minimize handling times, leading to faster processing and increased productivity.
2. **Versatility:** Box transfer mechanisms can handle a wide range of box sizes, shapes, and weights, making them versatile for different applications. They can be adapted to accommodate various types of boxes, crates, containers, and pallets.
3. **Flexibility:** These mechanisms offer flexibility in routing and sorting boxes, allowing for dynamic adjustments to accommodate changing production schedules, sorting criteria, or distribution requirements. They can be easily reconfigured or integrated into existing systems as needed.

4. **Space Utilization:** Box transfer mechanisms optimize space utilization in warehouses, distribution centers, and production facilities. They enable efficient use of floor space by minimizing the footprint of conveyor systems and sorting equipment, maximizing storage capacity and operational efficiency.
5. **Reduced Handling Damage:** By automating the transfer process, box transfer mechanisms minimize the risk of handling damage to boxes and their contents. They ensure gentle handling and precise positioning, reducing the likelihood of product damage or loss during transit.
6. **Accuracy:** These mechanisms provide accurate sorting and routing of boxes based on predefined criteria such as destination, size, weight, or SKU (Stock Keeping Unit). They minimize errors and misplacements, ensuring that each box is routed to the correct location or processing station.
7. **Integration with Automation:** Box transfer mechanisms seamlessly integrate with automated systems, such as conveyor belts, robotic arms, and sorting equipment. They enable the seamless flow of boxes between different stages of the production or distribution process, enhancing overall automation and efficiency.

## 12. FUTURE SCOPE

- Simulation techniques are not performed in this project, but still it will be very useful in many such projects. Therefore, it is highly recommended.
- Torque requirements are high in this project. So, more work needs to be done in order to reduce this torque requirements.
- Use of motors of different rpm and horsepower is needed for different operations, so this can be managed using different mechanical tools such as pulley, gear drives etc.
- Use of Wood as a material looks cheaper, so more work can be done in order to include other low weight materials in this project.
- Work needs to be done in order to check the possibility of gearless power transmission with less than three Bent Links.
- This project aims for the movement of light weight objects, so we believe that work can be done in order to achieve the movement of heavy objects as well.

## 13. CONCLUSION

The implementation of a box shifting mechanism represents a significant advancement in the automation and optimization of box handling operations within industrial, warehouse, and logistical environments. Throughout this journey, we have explored the key components, functionalities, and benefits of such mechanisms, highlighting their transformative potential in streamlining processes, enhancing productivity, and reducing operational costs. By embracing advanced technologies such as robotics, sensors, and control systems, organizations can unlock new levels of efficiency, accuracy, and flexibility in the movement of boxes.

These mechanisms automate tasks such as loading, unloading, sorting, and stacking with precision and reliability, minimizing errors, delays, and manual intervention. Moreover, the integration of box shifting mechanisms with existing infrastructure and information systems enables seamless coordination and synchronization of workflows, leading to improved resource utilization, inventory management, and customer satisfaction. Real-time monitoring and data analytics empower organizations to optimize performance, identify bottlenecks, and make data-driven decisions for continuous improvement.

In addition to tangible benefits in terms of throughput, accuracy, and cost-effectiveness, box shifting mechanisms contribute to a safer working environment by reducing the risks of manual handling injuries and accidents. Compliance with safety standards and implementation of protective measures ensure the well-being of personnel and the longevity of equipment.

Looking ahead, the evolution of box shifting mechanisms will be shaped by ongoing advancements in technology, such as artificial intelligence, machine learning, and collaborative robotics. These innovations will further enhance the capabilities and adaptability of mechanisms, enabling them to address increasingly complex and dynamic operational challenges.

In conclusion, the adoption of box shifting mechanisms represents a strategic investment for organizations seeking to stay competitive in today's fast-paced and demanding business landscape. By leveraging automation, intelligence, and integration, these mechanisms empower organizations to optimize box handling operations, drive efficiency gains, and deliver superior value to customers.

As we continue to innovate and refine these technologies, the future holds boundless opportunities for transforming the way we move boxes and revolutionizing the broader landscape of industrial and logistical operations.

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