Attention of

Date 10/ 07 / 2020

Author Davide Zuffa

BUSINESS PLAN 2020 – 2023

CONTENTS

Executive Summary

Objectives

Capture a sizeable portion of the factory intralogistics market, specifically in the niche of high added value and low weight payload, starting from the pharmaceutical business.

Achieve it through improvements, over the state of the art, of
1) Quantitative nature: easier installation, better scalability, higher performance;
2) Qualitative nature: payload tracking for fine-grained traceability.

Mission Statement

We will build an intralogistics platform using aerial pods (also known as drones) to connect machines at different processing stages while offering 100% inter-station payload traceability, ease of installation and scalability.

The solution will be priced competitively against standard solutions based on fixed conveyors.

Keys to success

- The intralogistics market does not offer anything similar: this is the intralogistics "batch of one" answer.

- We can provide a "validated solution" for our first target market, with integrated IQ/OQ for the pharmaceutical segment with ease of installation (especially for existing facilities) and scalability.

- We have a significant competitive advantage: a patent covering the application of the key enabling technology in the broad application scenario.

- Our technology pillars are well understood and available from multiple sources: drone technology and control software accessible through consumer and open source platforms, and highly scalable through cloud technology.

- The main critical factors are de-risked through mitigation strategies:
    - Technical: functional safety compliance, possibly achieved through the use of enclosures or safety nets (cost effective and possible due to the indoor nature of the application)
    - Business: market acceptance, possibly eased by proving the value proposition through in-house pilots ("dogfooding").

Description of business

Customers investing in AGVs intralogistics automation technology would be subject to one-time costs when buying new equipment, an expense that in the long-term should reduce operating and maintenance costs and it would result to be cheaper than paying human workers for long-term employment in high-wage countries. The **increasing labor cost** over the decade, particularly for customers in high-wage countries, is expected to accelerate the AGVs market growth.
Customers usually have two situation cases: **new facility** (greenfield site) or **modernization & upgrade of a facility** (existing site).
Another important element in the decision process of customers is that the intralogistics solution is typically a **highly tailored-made solution**, specific to an industry's set of needs & application requirements within the material flow. Successful vendors that win the bid are the ones who demonstrate best ability, expertise, offerings and track-record that convince customers to assign the project providing to them, at the end, the best Return on Investment.

Customers that intend to pursue an intralogistics automation project should go through a process (buying factors):

1. Prepare the project
    a. Clarify needs & expectations. Set of priorities, unit loads (pallet, case etc.), dimension and weight of materials to be handled, capacities, average / peak performances and functionality (present, progression, security margins…) of your production process, and consider the possible evolution scenarios.
    b. Define investment limits / range.
    c. Prepare the relevant data (activity history of your company, product data file).
    d. Define greenfield or existing site, define target areas.
    e. Gather information about standards and regulations (Equipment & building, Electrical equipment, Ergonomics)
2. Prepare the consultation / bid process:
    a. Define the freedom of design that you intend to give to vendor (to select a System Integrator or an Equipment Supplier).
    b. What is the methodology used by the vendor? Does he have operational and formalized procedures? Are they accessible and auditable? Are they certified?
    c. Define internal project team and responsibilities.
    d. Enquire about the project and service resources of the vendor (language, operating hours, support services).
3. Compare the project proposals
    a. Compare the performance offered vs. your performance needs.
        i. Flow/Throughput rate
        ii. System availability and flexibility (consistency of flow rate)
        iii. Efficiency & Productivity performance
        iv. Safety and Ergonomics performance (products and personnel)
        v. Regulatory compliance
        vi. Return on Investment (project pricing, costs savings)
    b. Study the functionality of the software, system, maintenance & services.
    c. Look for hidden costs and exclusions.
    d. Check whether the solution matches the evolving business scenarios.
    e. Ask for feedback and references from other clients: track-record.
4. Organize and implement the project
    a. Define roles and responsibilities (internal team and vendor team).
    b. Define the governance & working relationship between company and vendor (meetings etc.).
    c. Define the work safety aspects.
    d. Plan the after-sales services (training, maintenance, customer service etc.).

Since customers compare different solutions, AGVs solution typically is an alternative to a **conveyors solution**, both are intralogistics automation solutions and are part of Continuous Handling Equipment category. Hereafter a summarizing table of main characteristics of both solutions:

Factors	**AGV**	**Conveyor**
Facility Layout	No need to modify the layout because AGVs are highly adaptable	Need to modify the layout because conveyors are a fixed infrastructure
Product size and weight	Versatile configurations of AGV	Limited configurations
Travel route	Usually mid-distance travel applications, with flexible routes requirements	Usually short-distance travel applications, with fixed routes
Throughput rate	High and consistent rate applications	Very High rate applications
System Availability	Redundancy of AGVs allow to overcome any breaking down that does not shut down entire system	In case of breakdown of conveyor, the entire system shuts down
Investment & costs	Usually higher investment but in case of scalability there is an option to proceed by steps. Main cost drivers are: € / AGV, # of AGVs, SW and training.	Usually lower investment but for a fixed asset with no chance to pursue scalability. Main cost driver is: € / m.

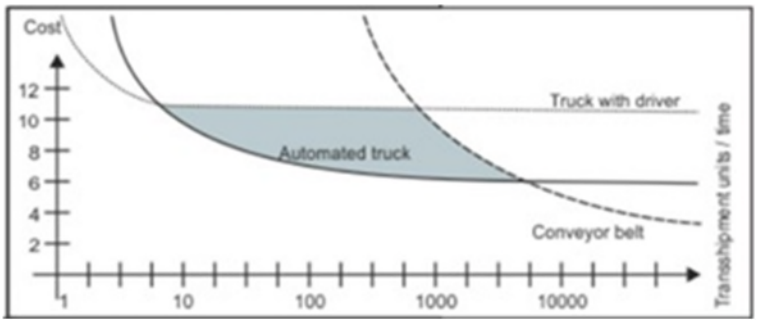


Figure 1 Type of comparison ratios between AGVs and Conveyors

Customers typically consider and evaluate both solutions before to proceed with an investment decision. Once evaluating the best solution customers consider some financial criteria to determine the **Return on Investment**, in the following some examples (just as a reference):

- Operating cost factor: Annual weight of material moved / Annual costs of equipment-system needed.
- Investment cost factor: (AGV CapEx – Conveyor CapEx) / Annual delta AGV cost savings.

In case of adoption of AGV technology solution, it should provide as benefits:

- Reduction of costs: reduction of labor costs (compared to fork trucks and manual handling), reduction of product and building damage (predictable movement at a consistent speed).
- Increased productivity and efficiency: improvement of availability and reliability with consistency of flow rate performance (AGVs can increase speed at any time, redundancy one AGV breaking down does not shut down entire system), reduction of cycle time (reduction of downtimes), accuracy of deliveries.
- Improved flexibility: easy modification of guide path, change of vehicles to accommodate future product changes, option to relocate the vehicles if needed.
- Improved Safety and Ergonomics: less accidents (versus fork trucks), improved ergonomics for employees (cleaner and quieter than conveyors)
- Improved investment affordability: sequence of steps for investment scalability (versus conveyors).

AGVs help to easier achieve Lean Manufacturing goals and are specifically applicable into **Flexible Manufacturing Systems** with Just-In-Time (JIT) and Just-In-Sequence (JIS) approaches. Ideal conditions are:

- High throughput rate
- Multi-shift and 24/7 operations
- High-frequency transports
- Mid-distance travel (in short travels conveyor solution gain a competitive advantage)
- Material flows with a large number of buffer locations and flexibility requirements

Segmentation by **Application** is:

- Work-In-Process transportation
- Assembly
- Packaging
- Storage (Raw Material, WIP, Finished Products)
- Distribution
- Others

Another relevant criterion that segments AGVs is the **Load Capacity**, distinguishing AGVs that carry over 100 kg weight and the ones that carry lighter loads. On the market we cannot find AGVs that carry less than 50 kg.
For payload under 50 kg we can find on the market only shuttle solutions based on rail applications (for example Montrac and Servus). These solutions have a heavy installation, flexibility constraints and high costs.

Servus ARC3

Servus is the first intelligent and autonomous Transport Robot. Servus communicates directly with its Colleagues, Assistants and Workstations. Every Transport Robot is equipped with its own address system and order logistic. This is the reason why time consuming programming and a centralised control are now obsolete.

Using aerial pods instead of standard AGV (when a small payload allows it) we can save space, we can easily install them upgrading an existing facility too and we can be more flexible due to the smaller payload.
Aerial pods can move inside limited dimensions conducts (approx 1500 x 1500 mm) easily installed like standard industrial plants, safety risks are mitigated using a complete closed area.
Below you can find a concept layout from 5 input machines (right side) to 3 output machines (left side) with an intermediate buffer station:

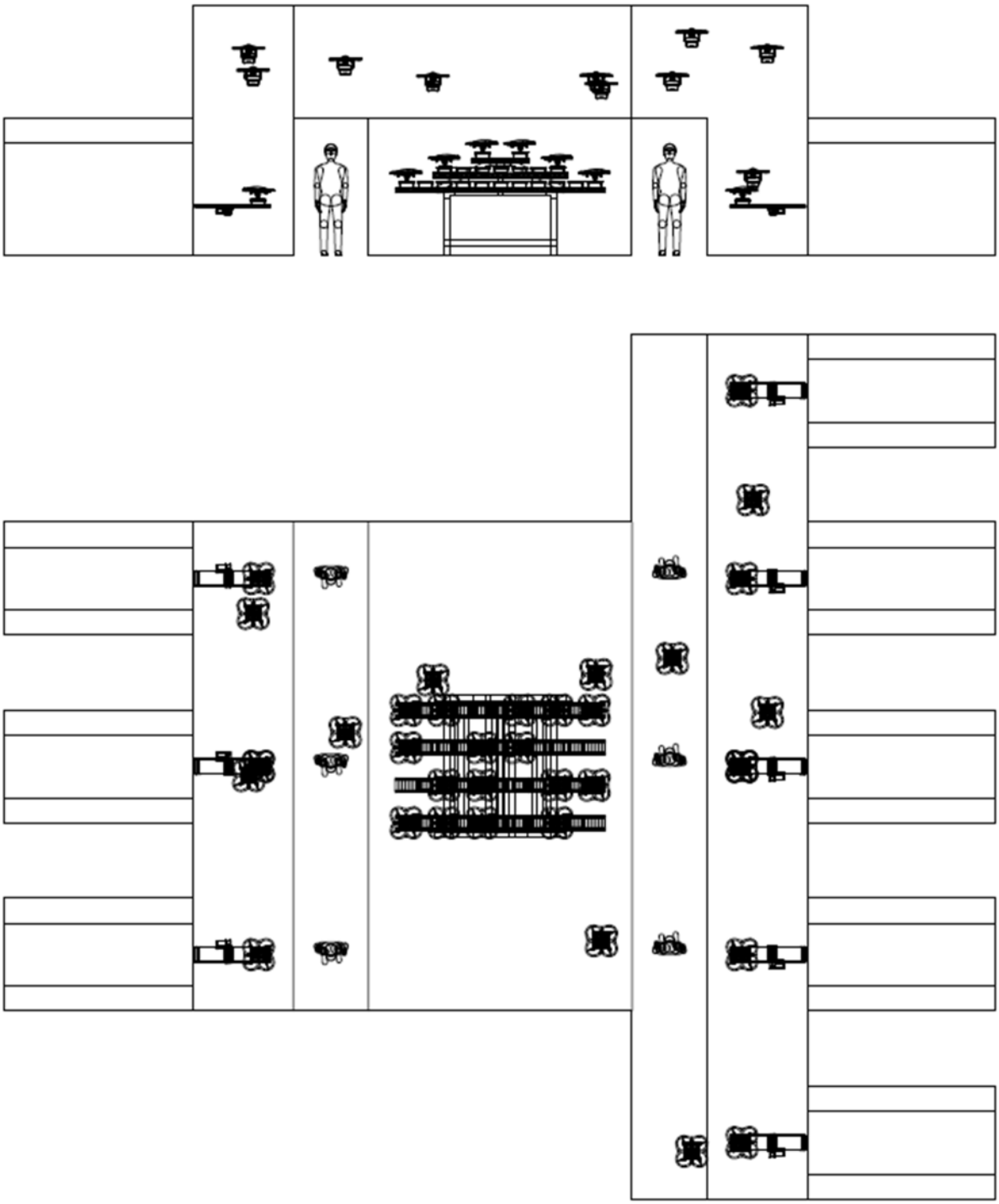


Figure 2 Conceptual layout with aerial pods

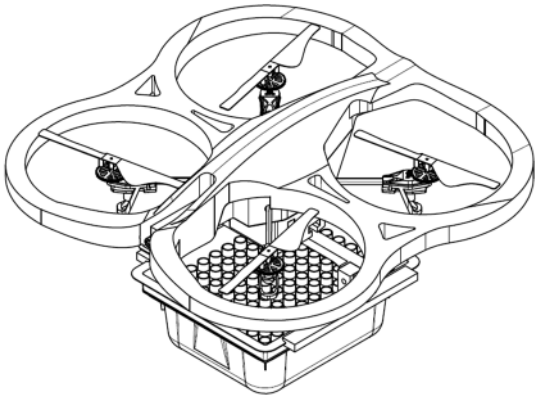
	**Aerial pods can handle small payload (under 3 kg) with an high flexibility and low costs.**

Figure 3 Conceptual aerial pod

In the near future the “batch of one” approach, especially in pharmaceutical segment, will redefine the intralogistics rules for both packaging and raw materials supplies.
Companies will need to upgrade facilities in order to reach a flexible logistic approach before and after automated lines with many changeovers per day: our solution could perfectly satisfy this need.

High level software control

Main Software Platform: **ROS (Robot Operating System) (www.ros.org)**.
License: BSD

Main operations:

- Software operating cycle management
- Shared management of resources
- Asynchronous management of the various software modules
- Message passing between the various software modules
- Logging system
- Simulation
- Reuse of code already tested and working provided by the community

Architecture:

- Decentralized modular software. Each node of the software network is an autonomous entity that exchanges resources with a master node on the network.
- Synchronous and asynchronous communication between the various network nodes.
- Automatic and reproducible logging system.
- Centralized management of the operating cycle: a single controller manages the high-level operations of all the network nodes, considering the current status of the task to be completed and the status of the individual network nodes.

The location of the drone's position within the system and its stabilization will be ensured by two suites of inertial sensors, a LIDAR on board drone and a series of visual code QR codes arranged on the path and read by a video camera on board drone.

Market potential

Market Background and Segmentation

If the vision of **Industry 4.0** is to be realized, most enterprise processes must become more digitized. A critical element will be the evolution of traditional **supply chains** toward a connected, smart, and highly efficient supply chain ecosystem. Autonomous logistics, which include driverless vehicles technology and drones, is one of the digitization options available.
We focus on the 3-5 year outlook for the following key technologies from the current Roadmap – technologies that are driving next-generation supply chains:

- Inventory and network optimization tools
- Sensors and automatic identification
- Cloud computing and storage
- Robotics and automation
- Predictive analytics
- Wearable and mobile technology
- 3D printing
- **Driverless vehicles and drones**
- Internet of Things
- Blockchain
- Artificial Intelligence

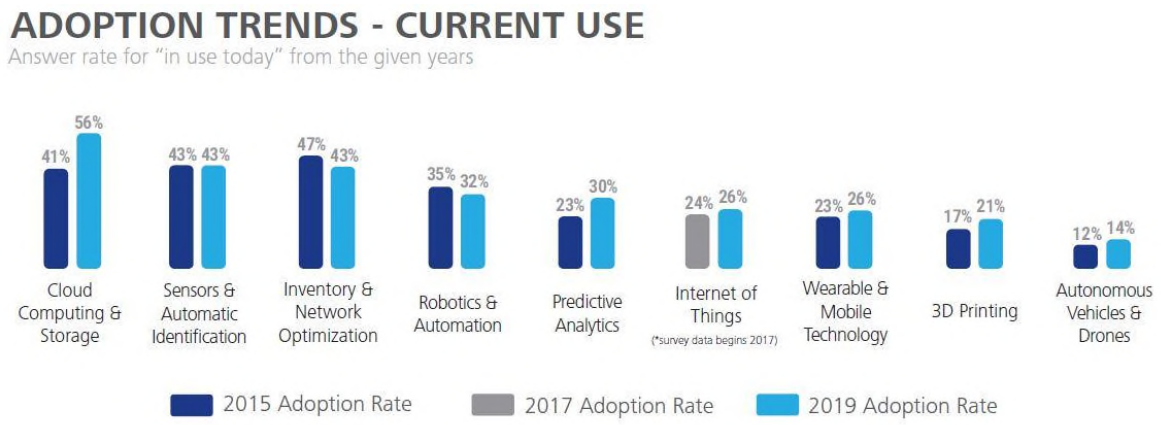


Figure 4 Autonomous logistics solution includes driverless vehicles and other robotic innovations that come to play in moving materials and goods today. (2019 MHI Annual Industry Report)

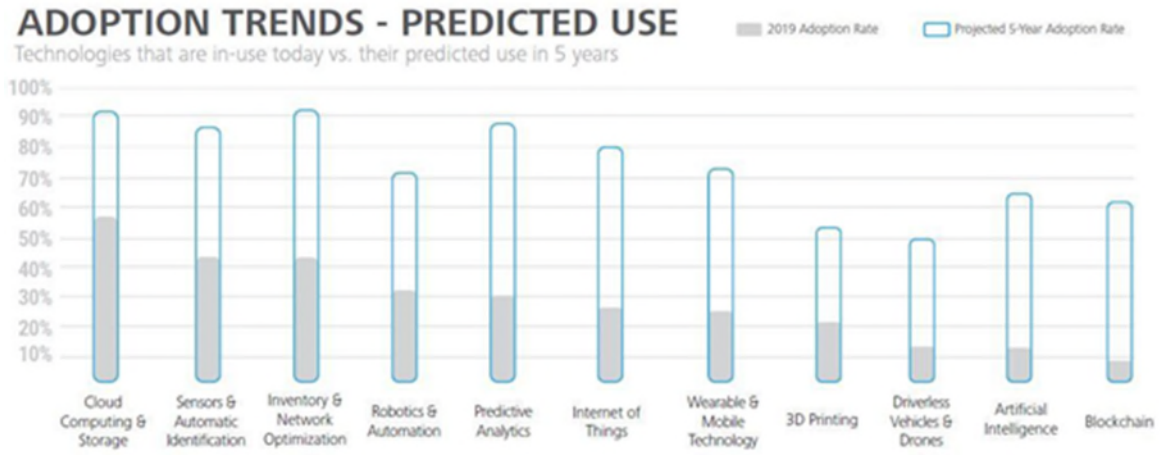
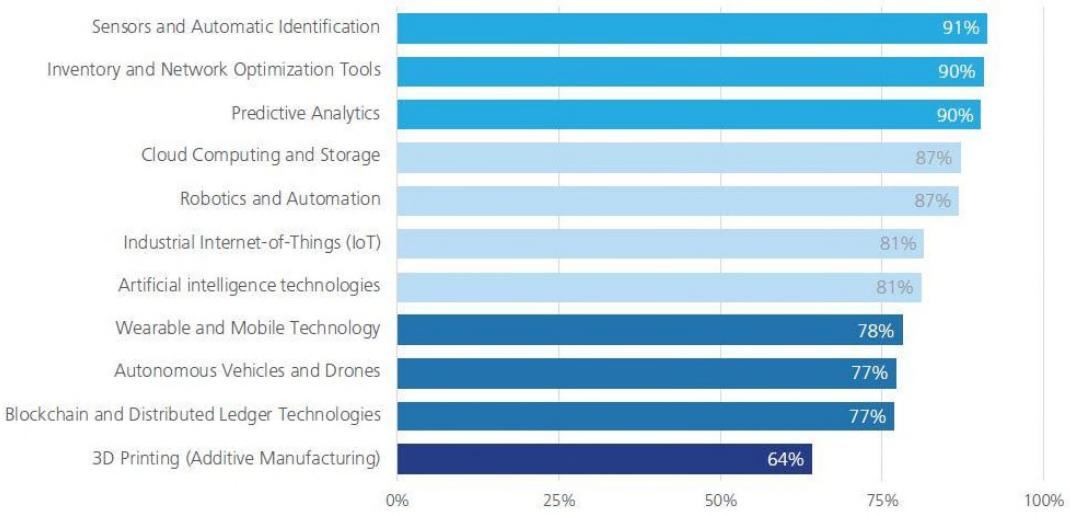
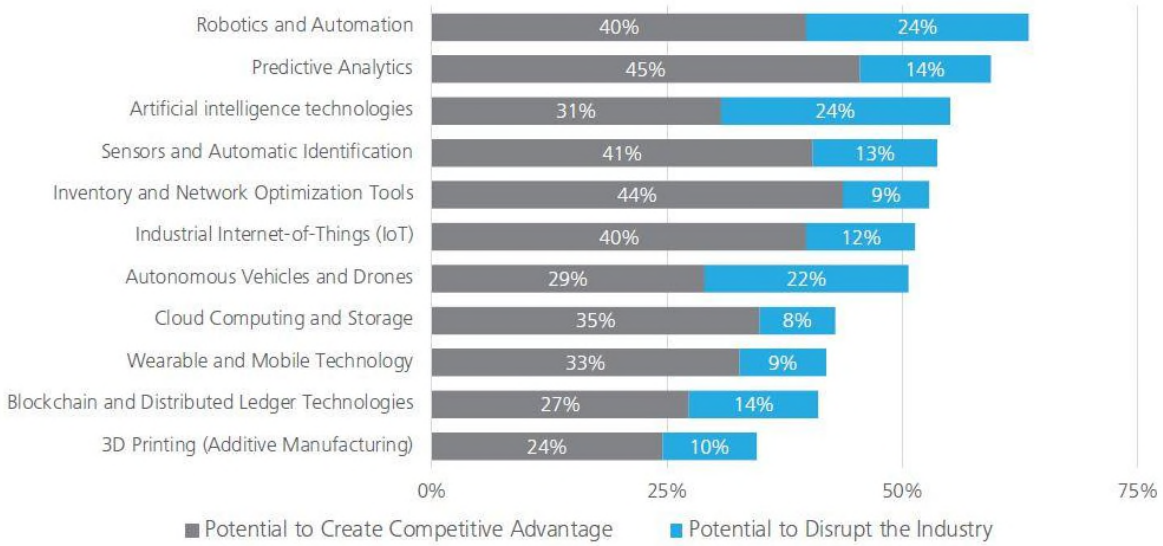


Figure 5 Autonomous logistics solution includes driverless vehicles and other robotic innovations that come to play in moving materials and goods in the following 5 years. (2019 MHI Annual Industry Report)

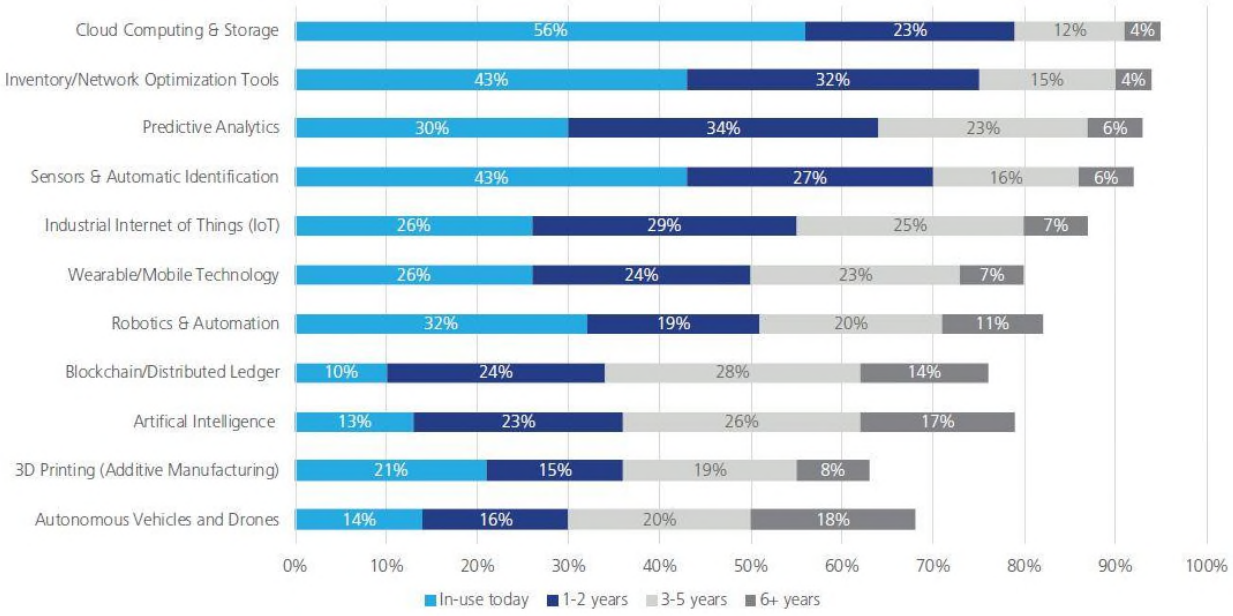
Expectations remain high that the digital innovations we have been tracking for the past six years will have significant impacts on supply chain. This year's survey results show that the vast majority of respondents expect these technologies to have a substantial impact on their supply chains over the next 10 years (Figure 6).



What's more, respondents generally believe that most of these innovations have the potential to disrupt supply chain practices and create lasting competitive advantage for companies that embrace them (Figure 7).



Cloud computing and storage has the highest current adoption rate, 56%, and adoption of this technology is expected to grow to 79% over the next two years, and to 91% over the next five years. Inventory and network optimization forecast to reach a 75% adoption rate in two years and 90% in the next five (Figure 8).



The limited adoption of driverless vehicles technology could derive mainly from a limited field of applications related to specific industries that demand not only efficiency but also agility and flexibility from supply chains with Flexible Manufacturing Systems. Also, it could derive from a fierce competition from alternative technology solutions (conveyors) that can provide a better Return on Investment to the customer.

Market Opportunity

The Material Handling industry consists on the manufacture of equipment that enable the movement, storage, control and protection of materials, goods and products. Main categories of equipment are the following, Continuous Handling Equipment category shall include among others:

- Autonomous driverless vehicles
- Conveyors
- Shuttle Automated Storage and Retrieval Systems (AS/RS)[1]

The Material Handling industry as value of production market size is the following expressed, data by region includes the export quotas while a different proxy should be pursued to determine the regional domestic market size.

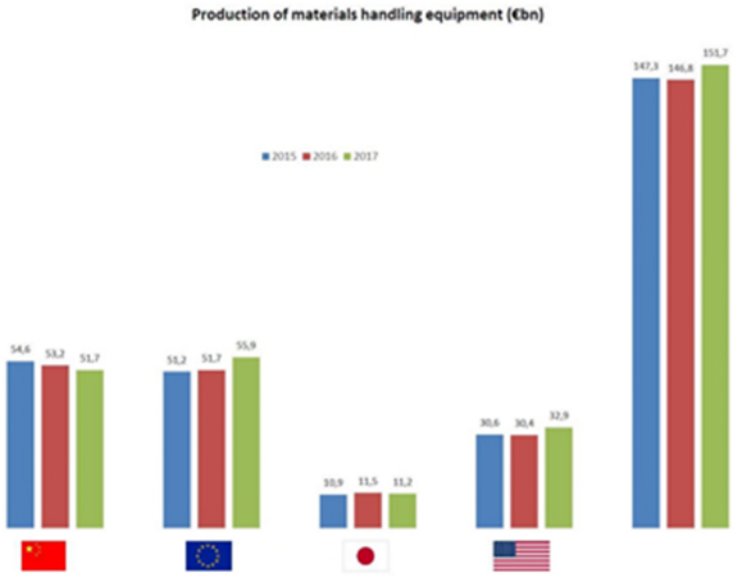


Figure 9 Value of Equipment Production (World Material Handling Alliance, 2015)

In 2017 the production value in the industry was about €152bn, European equipment providers had an average incidence of 37% on total production value. The Continuous Handling Equipment category as value of production is shown in the following figure by region.

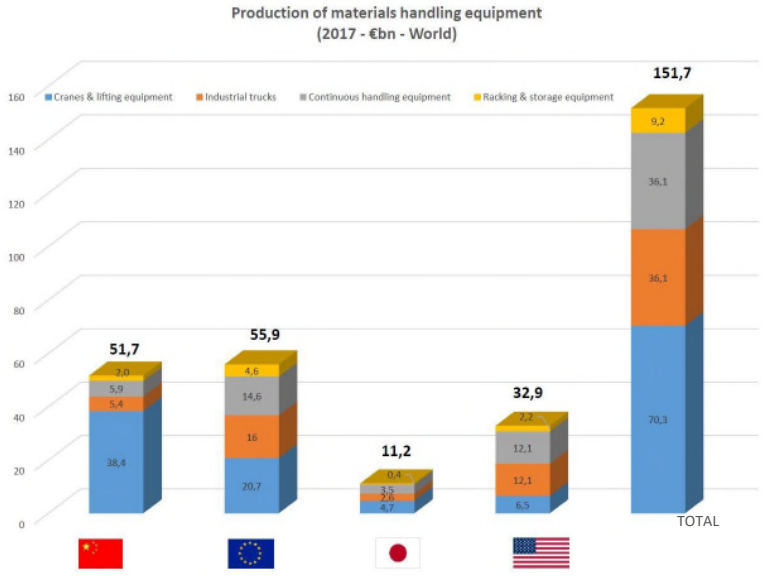


Figure 10 Value of Continuous Handling Equipment Production (World Material Handling Alliance)

[1] Among selected vendors of the panel there is Autostore, a AS/RS provider with a peculiar offering for automation of Warehouse. It is a kind of different automated solution compared to AGVs, thus it is not currently treated in this document.

Continuous Handling Equipment category in 2017 was about €36,1bn, €14,6bn in Europe, the category had an average incidence of 24% of value on total industry.
In this industry environment, according to data available from different providers but not from a consistent data source, the **automated guided vehicle market size** was estimated in a range of about €0,8-1,2bn[2] in the period 2015-2017 while European AGV market size in 2015 was estimated about €280mn. Thus, in 2015 according to these available figures AGV market should had an incidence of about 2-3% on Continuous Handling Equipment market while the AGV European market share should count for a third of the global AGV market. Europe is expected to lead a significant increase in the demand for the AGV market, intelligence providers agree that Europe will hold the largest market share dominating the global AGVs market.
Drone market is growing up every year: different companies are investing in inspection drones (ex. Airobotics), delivery drones (ex. Amazon), in warehouse and in automotive assembly lines (ex Audi).
This market is one the most active one but at the moment we do not find any application in packaging area.
If we consider in the near future an incidence for drones applications of 0.1% on Continuous Handling Equipment market only in Europe (this incidence should be €14.6mn in 2017) we can consider a market of around €15 mn per year starting from 2022 (end of present BP).

Below you can find an example of drone market movement:

Amazon Shows off New Delivery Drones

The retail giant is ready to launch the delivery service in months. The announcement was made at the company's re:MARS 2019 conference.

The future of Amazon drone delivery is here. The online shipping giant showed off their latest drone delivery system at its own conference in Las Vegas this week. The unusual drone is set to be able to deliver packages to customers within 30 minutes, Amazon said at the presentation.

When the delivery service will be set in motion is still unclear, but is likely to be before the end of the year. The self-piloted drones will use computer vision and machine learning to detect and avoid people or obstacles such as clotheslines when landing.

“From paragliders to power lines to a corgi in the backyard, the brain of the drone has safety covered,” said Jeff Wilke, who oversees Amazon’s retail business.

The drones are fully electric and have a range of 24 km and carry a maximum weight of 2.3kg, suitable for delivering toiletries or small books. It feels like we have been waiting for Amazon to finally get drone delivery for months.

The global company has experimented with the idea for years and says it has been working with regulatory officials to make their dream a reality.

In recent months, several drone delivery services have won Federal Aviation Administration (FAA) approval. Drones are being used in some parts of the world to deliver emergency medicine and other services.

[2] Estimation of figures related to AGV market in the report comes from different market intelligence providers, thus they could be used as a general reference but they do not come from a consistent data source (e.g. Markets and Markets, Ground View Research, Transparency Market Research).

Competition

There are three main elements that a vendor should provide internally or through third parties to compete in AGVs market: AGV robot, software and the system's set of capabilities of designing, installing, commissioning and servicing.
The **competitive landscape** of AGVs market is fragmented because of the presence of numerous small and large vendors.
Since it is an emergent market, in addition, lots of vendors both compete but also collaborate with each other. Thus, it is common to observe crossed collaborations on robotics components, SW and navigation systems.
Vendors could differentiate by **geographical presence** and **business model**. On geographic area side, vendors typically could have an international reach as global player or a local limited presence but highly specialized. Usually global vendors compete with other international players and locally with vendors specialized in a specific industry/application.

On business model side, typically there are two options:

- **System Integrator**: single source provider with a typical a turnkey offerings scheme that includes:
    - Concept simulation & design
    - Project Planning (AGVs fleet, SW, infrastructures and systems)
    - AGVs installation & commissioning
    - SW solution implementation/integration
    - Maintenance & services

- **Equipment supplier**: typically providing AGV robots and components or SW solution.

In the following table there are some examples of players.

Vendors typically specialize in **specific applications** within material flow thus they can better provide custom solutions and consistent offerings in terms of type of AGVs to companies with specific requirements, needs and expectations.
Just for reference the main applications are:

- Work-In-Process transportation
- Assembly
- Packaging
- Storage (Raw Material, WIP, Finished Products)
- Distribution

The portfolio offerings of vendors drive the ability of the vendor to satisfy the requirements of the customer for a specific application within the material flow.
One of the important factors affecting cost lies in how many AGVs are required to do the work, to perform the task **analysis of material flow** and **algorithm** are crucial: a **simulation tool** must be developed and customized.
An accurate analysis of the material flow starts with detailed knowledge of what materials must be moved to support operations. Material pick up locations, drop off locations, required timing, and frequency are all critical factors that will determine whether your automated material delivery systems will adequately support customers' needs.
The simulation and design of AGVs fleet is one of the main drivers to determine the price of the project to be offered to customers:

- Material Flow Analysis
    - Manufacturing output analysis
    - Layout analysis
    - Flow analysis
- Material flow spreadsheet calculations
- Material flow simulation modeling
- AGVs quantity calculations
- Descriptions of infrastructures and systems needed as AGVs solution
- AGVs solution pricing

Thus, it is an important aspect to have in-house these capabilities and expertise because they drive the **pricing of the project** that the customer will compare with other proposals during consultation / bid process and with its internal cost structure to understand the potential savings and ROI / payback determination.
So far, to our knowledge, **competitive advantage** in the market is expressed by the pricing of a turnkey-scheme solution related to an attractive Return On Investment to customers, with fulfilling of Operations' performances and compliance according to a specific application/industry through technical and technological features of AGVs system provided.

Conclusions and strategic considerations for the potential market

- Autonomous and driverless vehicles technology present a lower adoption rate comparing to other Industry 4.0 technologies. The size of the global AGVs market that demand this kind of intralogistics automation solution is estimated around €1bn (less than 1% of Material Handling market in 2017) with an expected growth in the range of 9-12% in the next future (while from a different provider, in the same period, the global logistics market should grow at 15% rate).
- Within this scenario, the expectations of a significant growth in the adoption of innovative intralogistics automation solutions among players is high. In addition, European / EMEA region is expected to hold the largest share of the global market.
- Automotive, Food & Beverages and Retail are the main industries where AGVs solution is applied, specifically in Flexible Manufacturing Systems and 24h/7days operations contexts. In case of AGVs adoption in Healthcare & Pharmaceuticals industry, mostly it refers to Hospitals (moving patient supplies and medical equipment) and if in Pharmaceuticals, Biopharmas and Pharma suppliers adopt AGVs mostly in assembly / secondary packaging lines.
- To compete with a System Integrator business model and a high specialization in a specific industry are premium factors that give competitive advantage. Customers seem to highly appreciate a single source provider and a turnkey offering scheme.
- Pharma lines are moving towards increasingly smaller production batches with many changeover per day: in the near future the intralogistics, for both raw materials needed by the lines and finished products produced by the lines, will be an important topic for all companies giving a strong boost to the self-driving vehicle market.
- Especially for existing facilities, an easily installable intralogistics line with few needed civil works could be a strategic advantage over the competition.

Intellectual property

This idea of “A PRODUCT TRANSFER SYSTEM IN A CLOSED INDUSTRIAL ENVIRONMENT” has been patented in different steps:

- **Italian Patent n° ITBO2014A.000474 August 29, 2014**
- **PCT procedure: from July 2015 to July 2018**
- **EU Patent Z.117.10 confirmed in November 2018**
- **European Patent confirmed in Italy, Germany, Denmark, Netherlands and Switzerland in March 2019**

Below you can find the abstract:

ABSTRACT

The product transfer system (10) located in a closed industrial environment (Z) and is able to transfer products from outlets (I1, I2, I3) of production lines (LP1, LP2, LP3) of a given product, to inlets (O1, O2, O3,O4, O5), of packing lines (LC1, LC2, LC3, LC4, L5) of products. The product 5 transfer system comprises a storage warehouse (M) designed to be able to receive and temporarily store the products, a first series of drones (D1) comprising relative pick-up means (P1) for picking up and releasing the products and being predisposed so as to fly internally of the closed environment (Z), and a second 10 series of drones (D2), comprising relative pick-up means (P2) for picking up and releasing production and predisposed to fly internally of the closed environment (Z). The system also has control and guide means (C, V1, V2) of the flight and the airborne movement of the first series of drones (D1) and the second series of drones (D2) internally of the closed environment (Z) designed 15 to command the drones (D1) of the first series of drones (D1) to pick up the products from the outlets (I1, I2 and I3) of the production lines (LP1, LP2, LP3) and transfer them to the warehouse (M) and to command the drones (D2) to pick up the products from the warehouse (M) and transfer them to the inlets (O1, O2, O3, O4, O5) of the packing lines (LC1, LC2, LC3, LC4, LC5).

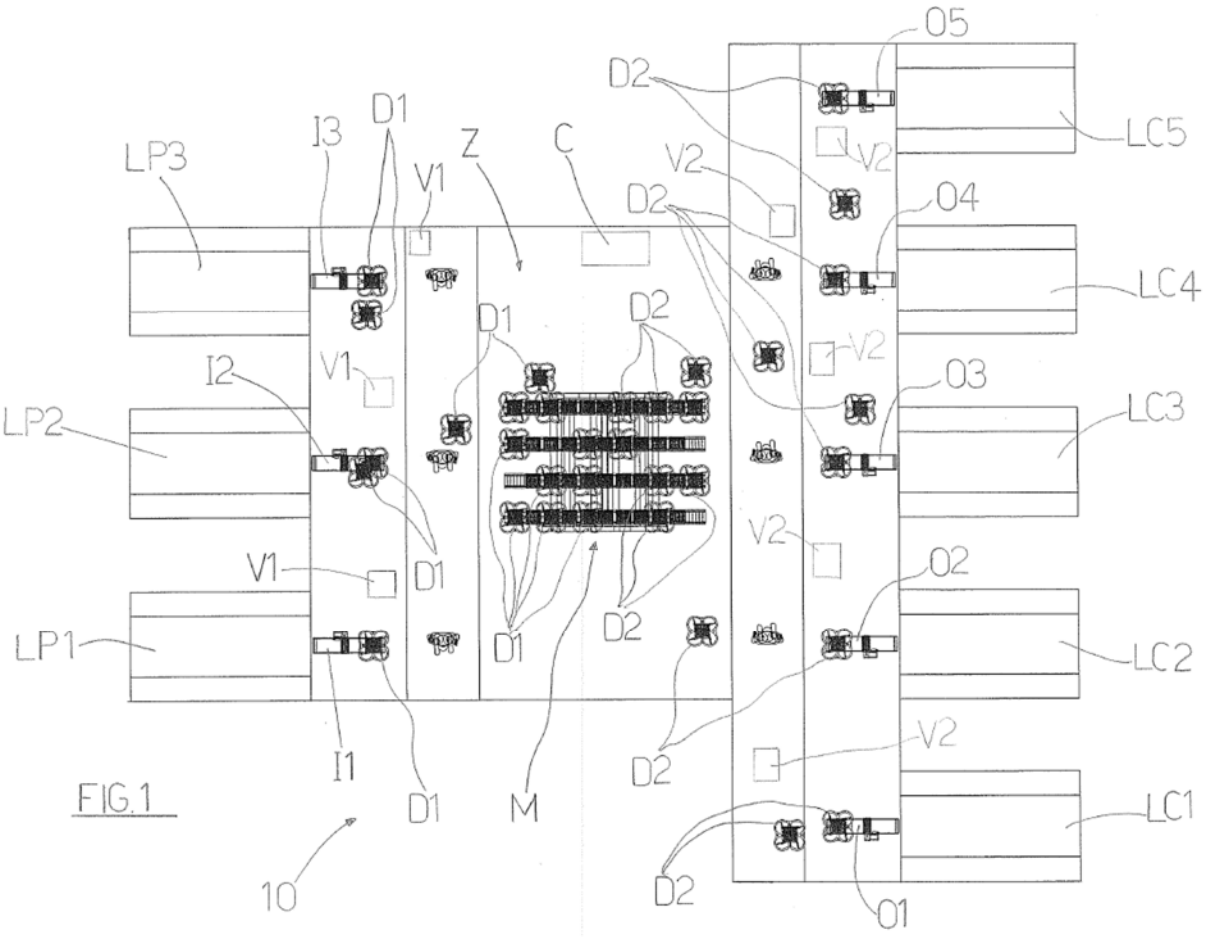

O5
D2
LC5
I3
D1
Z
C
LP3
V1
V2
O4
LC4
I2
LP2
O3
LC3
V1
D1
V2
O2
LP1
LC2
I1
M
LC1
10
O1

FIG.1

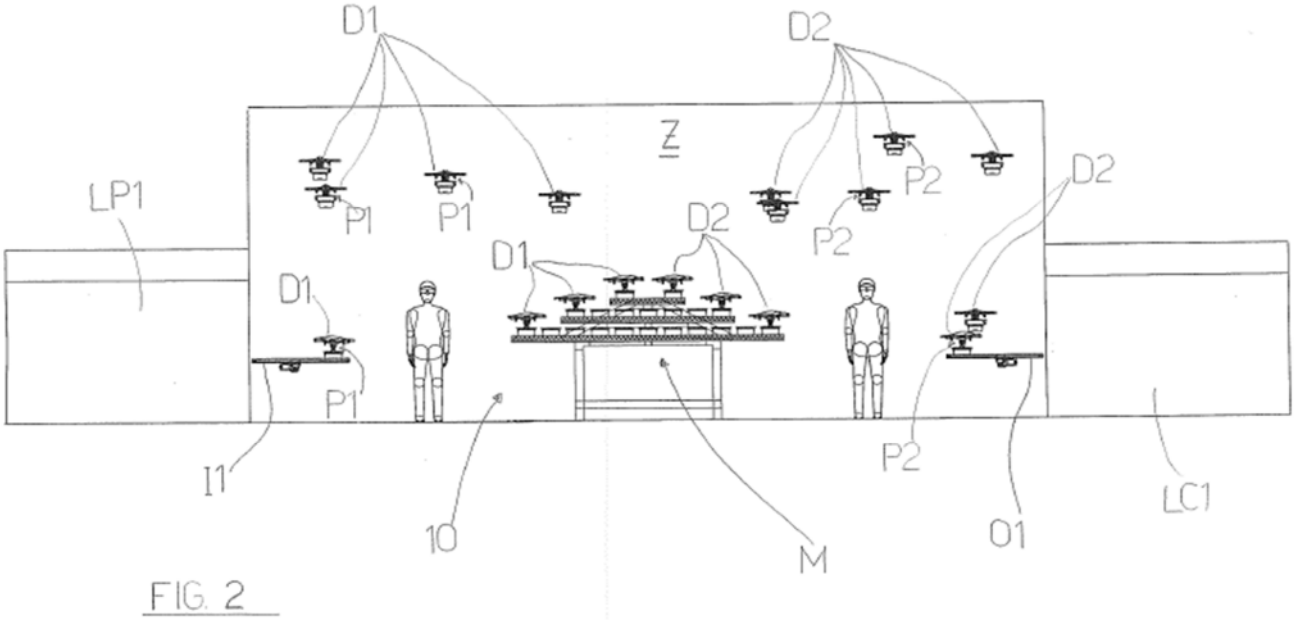

D1
D2
Z
P2
LP1
P1
D1
I1
10
M
O1
LC1

FIG. 2

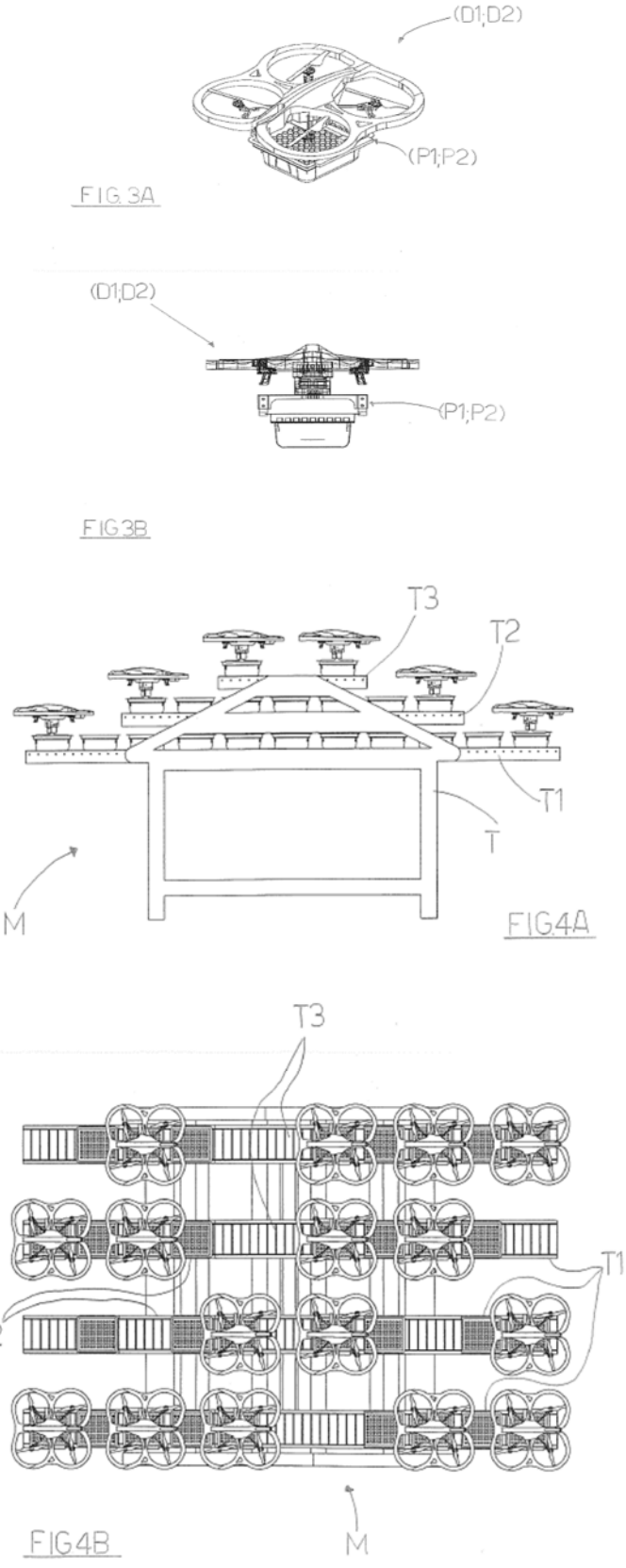


Figure 11 Patent Z.117.10 figures