CARTON BOX PALLETIZATION CELL, INTEGRATING AN INDUSTRIAL ARTICULATED ARM ROBOT

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The study consists in the presentation of a flexible manufacturing cell in which a palletizing operation of several types of boxes is performed. The application has 4 inputs and 4 outputs, with 4 different types of boxes and 4 piles. The application integrates the industrial robot MOTOMAN GP225 with an articulated arm architecture and 6 degrees of freedom, which is equipped with a vacuum effector with the role of making piles. The functional working scheme of the robot being the alternative arrangement of the boxes according to the bar code printed on them.

1. Introduction

The study highlights the structure of the flexible cell, along with certain changes to eliminate the need of a human operator and to fully automate the process of making piles. The cell started from a reference film with the following main elements:

Fig. 1 The highlight of the main elements in the cell

In the reference film, you can see the operation cycle starting with the input of the boxes on a belt conveyor, and then they are diverted according to the barcode printed on them to a roller conveyor using a roller deflection system. When a box reaches the end of the stroke (at the end of the roller conveyor), the box is taken over by the industrial robot which will make the pile. The pallets on which the piles are made are introduced into the cell by a human operator and are centered with the help of some metal corners. The evacuation of a complete pile is done with the same human operator who takes the pile with a lysis and transports it to a storage area.

2. The preparation of the assembly

The GP225 industrial robot is integrated in the cell and is located on an elevation system for the robot base (which can also be seen in the structural kinematic diagram). It is a 6-axis robot for general purpose used due to its large reach of 2702 mm, a maxim payload of 225 kg and a repeatability of ±0.05 mm.

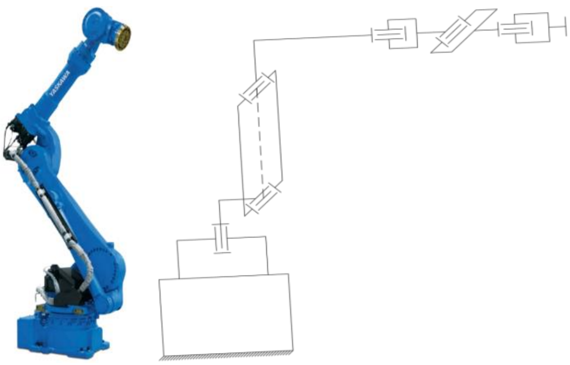

Fig. 2 The robot model with his structural kinematic scheme

For the robot orientation system, we have a mixed drive motors allocation with 3 motors located in the immediate vicinity of the driven elements for the first 3 axes and the last 3 motors are located at the end of the last segment of the robot for the last 3 axes.

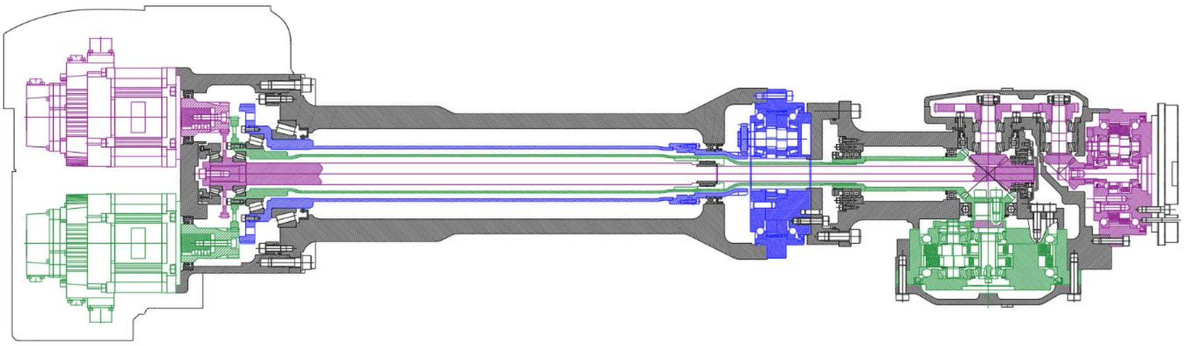

Fig. 3 A section through the orientation system

The section through the orientation system highlights in full the drive for axes 5 and 6 and partially for the axis 4. In the figure 2.3 we can see partially the structure in 3D format without motors.

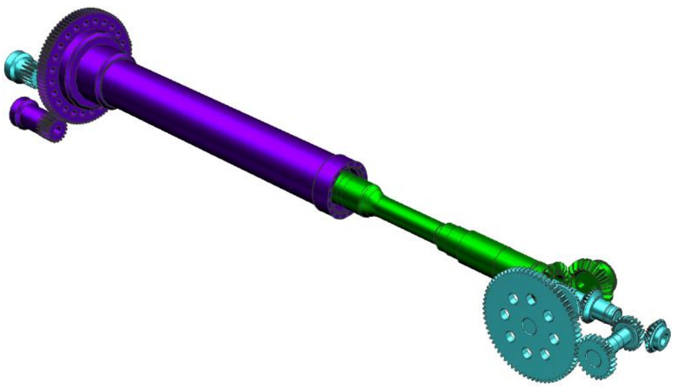

Fig. 4 The 3D structure of the orientation system realized in NX

The effector with which the robot is equipped is designed by me to be as close as possible to the one in the reference film, using standardized elements such as:

- A pneumatic island made with elements from Festo;
- Vacuum modules from Piab;
- Aluminum profiles from the company 80/20;

- The part of the hoses and cables were made in the Routing Electrical module of NX;
- An adapter plate between the robot flange and the rest of the effector which was modeled in the Modeling module in NX.

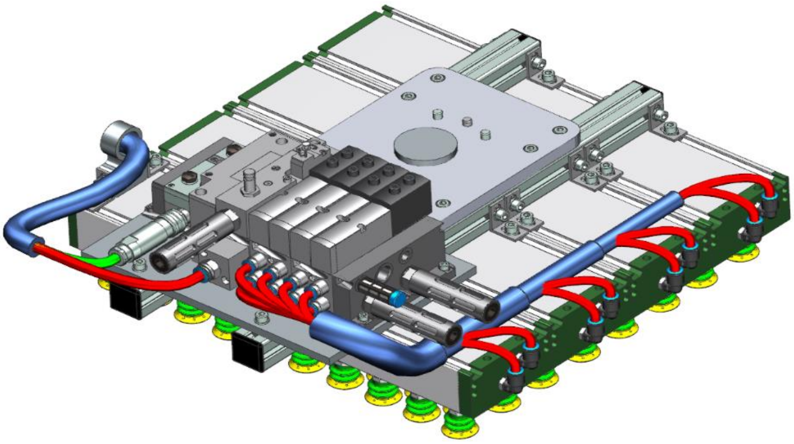

Fig. 5 The vacuum effector assembled in NX

Next, I made the execution drawing and the technological film for the adapter plate between the robot flange and the effector.

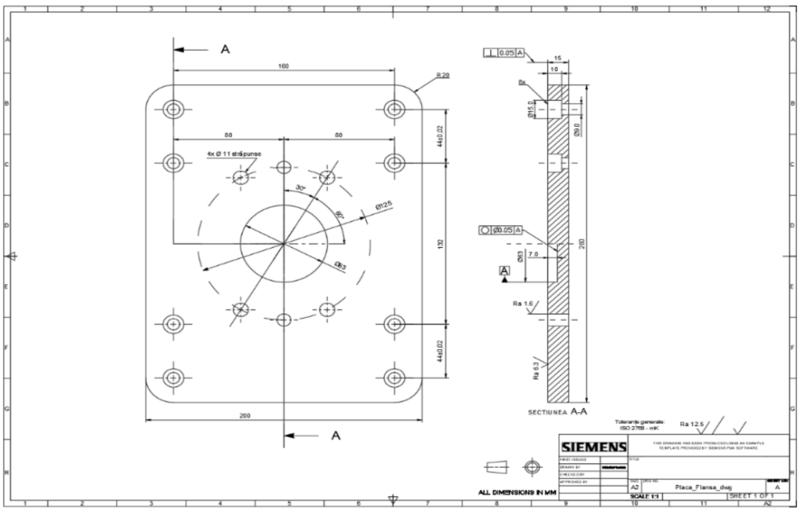

Fig. 6 The execution drawing for the adapter plate

For the technological film, I assumed the realization of the piece on a CNC machining center in 3 axes using the following operations with the specified tools:

- The orientation and fixing of the blank product after cutting to close dimensions on a universal with 3 jaws;
- The milling of the upper face done with a face milling cutter from Sandvik Coromant (CoroMill 245);
- The holes drilling using drills (CoroDrill 860 and CoroDrill 880 for different diameters)
- The reorientation of the blank product by rotating the part with 180° on the X axis and the fixing;
- The contour processing with a mill (CoroMill R215.H4);
- The milling of the lower face done with a face milling cutter (CoroMill 245);
- The detachment of the blank product;

- The final inspection done with a caliper;
- The preservation and the storage of the final product.

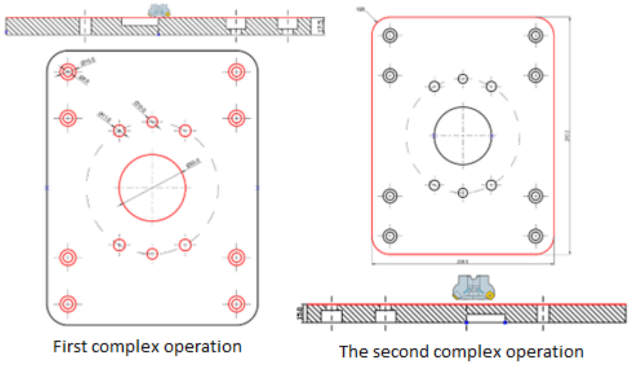

Fig. 7 The machined surfaces of the blank part

Below is the execution drawing of an elevation system made by me based on several similar systems from ABB Group and FANUC.

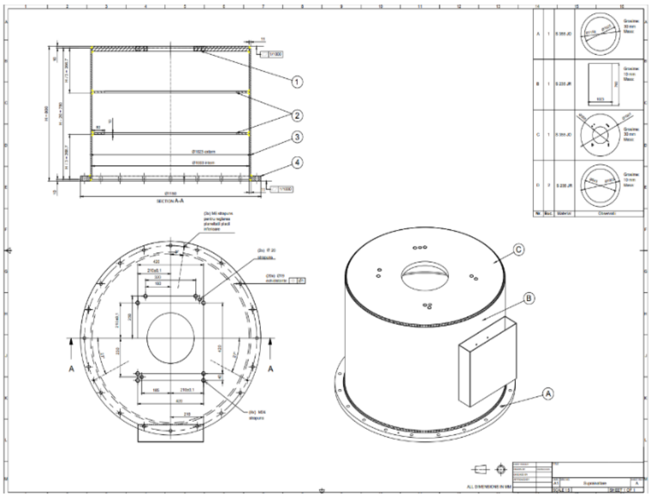

Fig. 8 The execution drawing of the elevation system

The changes to the cell are represented by some chain conveyors with the role in transporting the pallets from a pallet distributor, which is fed automatically by a guided vehicle, to the working points where the pallets are centered and fixed, and finally the complete piles are evacuated from the cell by another automatically guided vehicle.

The elements made by me using standardized elements, different from those in the reference film are:

- The robot base elevation system;
- The centering and fixing system of the boxes before being taken over by the robot;
- The centering and fixing systems for pallets in working points;
- Pallets and piles lifting systems;
- The conveyor assembly for evacuating piles from the cell;
- The pneumatic island corresponding to all the elements whose actuation is pneumatic in the cell.

Finally, the final variant of the cell is presented using the input part of the boxes according to the reference film and the input part of the pallets and piles evacuation made by me together with the preliminary version of the cable channel with plugs, cables, hoses and connectors for each element.

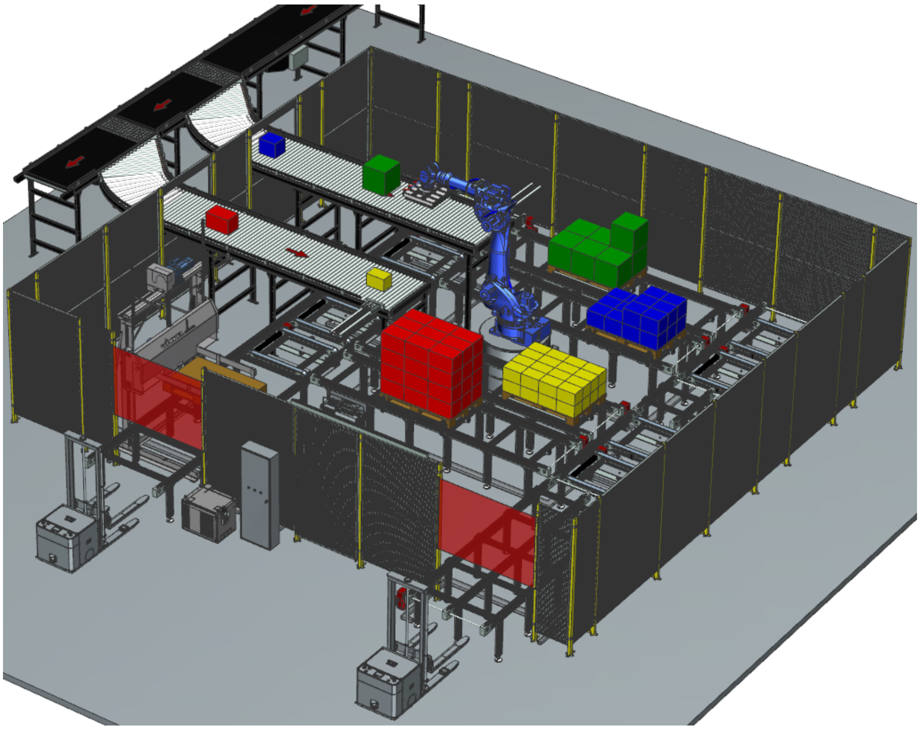

Fig. 9 The final version of the cell assembled in NX

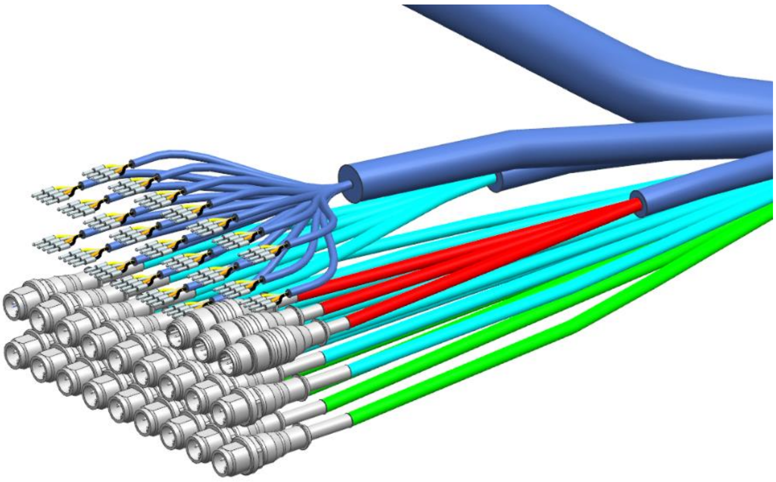

Fig. 10 Plugs from Sick and cables realized in NX

Along with the things presented above, I also performed a simulation in Tecnomatix 16.1 (Process Simulate) in which the work cycle of the cell is highlighted.

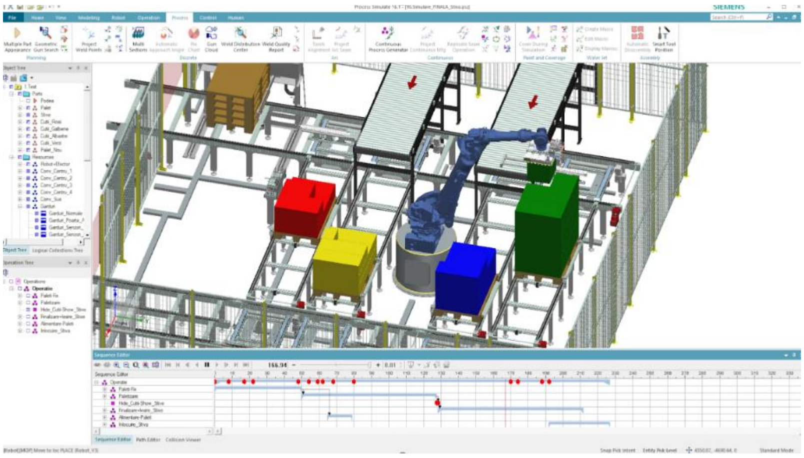

Fig. 11 The simulation realized in Process Simulate

3. Conclusions

To complete the study are also required:

- A section in which the actuation of axis 4 will be visible;
- The realization of a section view for the axis of rotation of the base of the robot together with the calculations of choice for the reducer and the drive motor;
- The completion of the internal structure of the robot;
- The completion of cables and hoses for each system in the cell.

4. Bibliography

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