31/05/2020

Antonio Acquavia

Operational DIrector

Operations

IR2

# Introduction

## The products

IR2 is a company that produces 2 kind of robots for a domestic usage:

* Dolly: the robot vacuum cleaner
* Molly: the mop robot

These robots are very similar each other in terms of architecture, design and mechanical/electronic components.

Currently on the market there are the line S, released some years ago and near to the end of it life cycle, and the line X, the spearhead of the company.

Dolly and Molly of the line X are more powerful, more accurate and smarter.

Of course, the production focus is on the last line released, but we are still producing a huge amount of product of the line S.

## The activity

Our company has a factory based in Tuscany, in which about a hundred of people are employed. This factory deals only with the assembly phase, because the company has agreements with several firms for the supplies.

There both the two lines of robots are assembled.

Our production is characterized by medium volume and medium variability: because we have substantially 4 distinct products although they are not very different.

# Product Flow & Layout

Considering the previous statements, our company is in this situation:

Immagine che contiene orologio

Descrizione generata automaticamente

Figure 1: Volume-Variety Chart

So, we have adopted a hybrid between batch environment and line process: the group technology.

The principle is that many problems are similar and by grouping similar problems, a single solution can be found to a set of problems, thus saving time and effort.

We can adopt this solution because there are some parts in the assembly phase that are very similar each other and use similar machinery, but we maintain a throughput higher than the batch process.

According to this, the manufacturing of our company is organized in a Cellular Layout.

The machines are grouped according to the process requirements for a set of similar items that require similar processing.

Workers in cellular layouts are cross-trained so that they can operate all the equipment within the cell and take responsibility for its output.

It's very often used in assembly phase.

Immagine che contiene orologio

Descrizione generata automaticamente

## Production Details

Our machinery and our employees provide us to produce up to:

* 3077 Dolly X per month (about 750 weekly)
* 2963 Molly X per month (about 750 weekly)
* 1846 Dolly S per month (about 450 weekly)
* 1778 Molly S per month (about 450 weekly)

The production is organized in 2 shifts of 8 hours. This means that the overall hours of work in a month are 320, if we consider a month composed by 4 weeks.

About 45 employees work in each shift, in each of which there are:

* 14 people which deals with testing
* 5 people quality responsibles
* 2 people responsible of warehouse
* the others work on the cells

## Master Production Scheduling

The scheduling of our production is based on a mixed plan: we vary both the production and the inventory tuning the capacity of our machinery. This choice was made in order to have the production a minimum flexible to the demand, keeping the inventory as low as possible.

On the other hand, we cannot be full based on the demand, because we want to vary the production by limiting ourselves to increase / decrease the work of the machinery, while not affecting the work of our employees. This line of though comes from one of the ethical principles of our company: IR2 has a high regard for its employees and it knows that a succession of layoffs / hires can undermine the morale of the workers.

The master production scheduling is based on the forecasted sales of each month.

## Weekly Production Planning

## Planning of delivery

The delivery for the products destined to go to Mediaworld is monthly, while the ones destined to the customers that have bought in the website are delivered as soon as possible.

# Supply Chain

In order to assembly a robot, we need several mechanical and electronic components:

* Engine
* Wheels
* Frame
* Actuators (ex. Aspirator)
* CPU
* Motherboard
* Sensors
* Body
* Accessories (e.g. bags, brushes...)
* Battery
* Power Supply

These components are provided by **external** suppliers. This decision was made taking into account that suppliers have specialized research and know-how: they can provide us very high-quality components. Moreover, we couldn’t exploit well the economy of scale producing these components by ourselves. It’s not convenient from an economical point of view and the future volume are uncertain: the technology evolves quickly, and the requirements can change drastically.

Instead the assembly is fully internal: it’s a way to guarantee a higher quality of the product and we want to install and configure the software by ourselves, in order to keep the secret of its details and eventual limits.

## Our suppliers

We can divide all our suppliers in two main categories:

1. Suppliers that supply the critical products: that are customized for our company (sensors, batteries, bodies, power supplies)
2. Suppliers that supply the leverage products: our company needs an high volume of that but there is an huge amount of suppliers in the market.

For the first category there is a “one source” policy, we established very detailed contracts with:

* a company that produces very accurate sensors, this company is at the forefront in this field.
* a company that produces durable battery and the power supply
* a company that produce in large scale the body and the frame of the robots using our indications for design and for material

For the second category there are multiple source:

* several companies that produce hardware components: they provide us the motherboards and the CPUs
* several companies that produce accessories with standard interfaces. (the brushes, the bags)

## Research Institutes

Our company focuses heavily on research, we think costantly to the future. In order to pursue this scope, we have several agreements with different research institutes, specially in the field of the university.

These institutes, as part of the agreement, do research on particular electronical or mechanical topics that are problematic for us. They organize teams that are in a very close collaboration with our R&D department.

Together, they find high-tech solution to our problem and produce prototypes, design and report of their work.

This agreement gives us the advantage to be always ahead in the technology development and to have always the latest innovations.

On the other hand, this collaboration is very suitable also for the research institutes:

* we contribute economically to their researches
* we consent to researchers to present their discoveries in our stands during the most important exhibitions in Italy and Europe.

## Inventory Management

IR2 keeps three types of inventory:

* final product stock
* half-processed
* raw materials

## Final Product Stock

Here we can see the levels of the inventory forecasted during the 2020.

Immagine che contiene mappa

Descrizione generata automaticamente

Immagine che contiene screenshot

Descrizione generata automaticamente

Immagine che contiene screenshot

Descrizione generata automaticamente

For example, a Dolly X, is on average only 4 days in the warehouse.

These values are quite positive because:

* obsolescence is avoided
* the inventory level is kept low

## Half-Processed Inventory

This inventory is kept very low because the productions cells are well balanced and a half-processed has to attend very few times between two different processes.

For this reason, we are organized to keep the half-processed very near to the next cell where they are going to be processed.

## Raw Materials

Our suppliers have an average lead time of a week. There is a minimum order that is specified in the contract. Our supply-chain management takes under control:

* forecasted demand at the beginning of the next week
* booked order at the beginning of the next week
* predicted inventory at the beginning of the next week
* security stocks

Based on these parameters, they place the order minimum to comply the requests of the next week.

In this way, the inventory remains as low as possible, but a security stock is always maintained.

The average stock of raw material will decrease in 2020, according to the forecasting about the production.

# Quality Control

IR2 is a company that has the quality of its products and manufacturing process as its main characteristic. IR2 improvements are focused on the customers’ needs.

Our customers want robot characterized by:

* high accuracy
* smartness
* durability

The defects could rise up from poor quality of input material or software tests that do not verify all possible cases.

We have to ensure:

* high quality for input material
* an intensive testing phase for the software
* close to 0 defects in the assembly phase

## Suppliers Quality Management

For each supplier, in the phase of integration into the development process we discussed about:

* our quality requirements
* the quality assurance system of the supplier

We have established all the phases, all the checks and the frequency of the inspections.

The inspections are more frequent for the suppliers considered "critical".

In the contract with the suppliers there is a detailed section about the penalties in the case of non-compliance with quality requirements.

In the contract with the suppliers, we have established two type of sampling plan:

* single sampling for the supplier less reliable: the order is sent back if it has the defect level in a sample batch higher than a threshold established by contract.
* double sampling for the most reliable suppliers: in this case, if a sample batch has the defect level higher than the threshold, another analysis, taking in consideration another sample batch, is done.

## Internal Quality Management

Our company, and consequently all our suppliers, respects the ISO9001 standard.

According to this standard and to our philosophy we don't limit ourselves to keep this level of quality, but we do a great effort to increase it more and more.

### Quality Assurance

In order to assure quality, our products have been projected with a robust approach: they are projected to be kept under control from the statistical point of view.

It consists in finding the right combinations of parameter in the project phase in order to make the production process insensitive to variation or to the influences of disturbing factors as much as possible.

This approach provides us products with:

* higher quality level
* higher flexibility in terms of improvement
* less control costs

### Quality Assurance Metrics

Our company uses the following quality assurance metrics:

* Defect Severity Index: defects are divided in category and to each one is associated a weight. We take under control this number and when it increases rapidly, we address it immediately.
* Defect Leakage

### Quality Control

The quality control is done in critical points of the production process by specialized employees.

They use check-sheets and control charts and when a defect is found they investigate in the source using the 5-whys analysis.

At the end of each day of work, they write up a report that resumes all the controls of the day.

If one day, the report underlines a highlighted non-compliance, they are able to communicate with the management to address the problem quickly acting on the source.

### Testing

Despite all our effort of quality assurance and control, it's also provided an intensive testing of the components and of the full product. The test of the full product is very important to ensure that the behavior of the robots is the expected one. It has been elaborated for each type of robot a set of specific tests to cover all the possible problems that can happens. When a behavior not covered by the set of tests is found in any process phase, the test set is updated.

In this way there is a continuous improvement of our testing phase.

Also, for testing, there is suitable staff, responsible of doing physically the test and to write documentation.

In the case of robots that fail one or more test, the testing is repeated. In the case of another failure, the robots are put aside to be analyzed, in order to understand the problem.