

# Information System & Waste sorting how to get rid of plastic ?



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# INTRODUCTION

Bags, water bottles, packaging, keyboard... Plastic is everywhere and does not escape any area. Preferred material of manufacturers, its success is explained by its properties.

Lightweight, resistant, malleable and cheap, plastic has properties that have quickly attracted manufacturers. An undeniable success but with its disadvantages and collateral damage.

Even if plastic is present in everyday objects, it is unfortunately found everywhere in nature. The ocean rejects millions of tons of plastic waste on the beaches of the whole world, signs of a kind of indigestion in the nature.

It is also an extremely persistent pollution, some plastics may take more than a thousand years to degrade completely.

Plastic is a subject that today focuses on many environmental issues, related on the one hand to the consumption of resources that it requires for its manufacture and on the other hand to the production of waste that it causes because of its short life.

Pollution by plastics around the world in figures:



**10% of human waste is plastic!**

The topic of plastic has been in the forefront of the environmental news scene for a few years: growing awareness on the part of citizens about the problems related to plastics, international commitments and binding national regulations, in particular to reduce the use of plastic.

The regulation sets new recycling ambitions, both for Brussels (new circular economy package by 2030) and for Paris, the government has set a target of 100% recycled plastics by 2025 (Bonus-Malus System).

However, the Circular Economy Roadmap published by the French Government in April contains very few measures to tackle the two main issues in this area, namely the recyclability of plastic and its overconsumption.

The Circular Economy Roadmap simply provides:

- France's support for the European ban on fragmented plastics and expanded polystyrene containers (EPS: Packaging, cups for hot drinks).
- The possibility for local authorities to experiment with joint deposit orders for plastic bottles, without precisely knowing for the moment the financing methods and the scale of the device, which will only concern single-use packaging,
- Installation by 2020 of plastic particle recovery filters at plastic production sites,
- The possibility for companies to make a voluntary commitment to reincorporate recycled plastic in their production, as much as possible.

Therefore, we will support our diagnostic basing on the example of Renault and how Information Systems can add value to the circular economy. There are multiple reasons why we chose Renault as an example. Indeed, in the sector of automobile, the part of plastic is rising, and in addition Renault is a French leader and a pioneer of circular economy. Finally, its global politics and efforts made on green business are ambitious.



Circular economy model is based on a systemic vision inspired by the observation of nature. Nature does not produce waste: everything is reused, composted and digested.

Circular economy reduces the use of raw materials and contributes to the preservation of limited natural resources, an economic model that enables Renault to meet economic and ecological challenges.

Behind every car produced is a ton of special waste: catalytic pots, used batteries and tires, plastic bumpers, dirty solvents, account for most of the waste generated by the use of the automobile. It is possible to reduce the amount of waste produced or its toxicity.

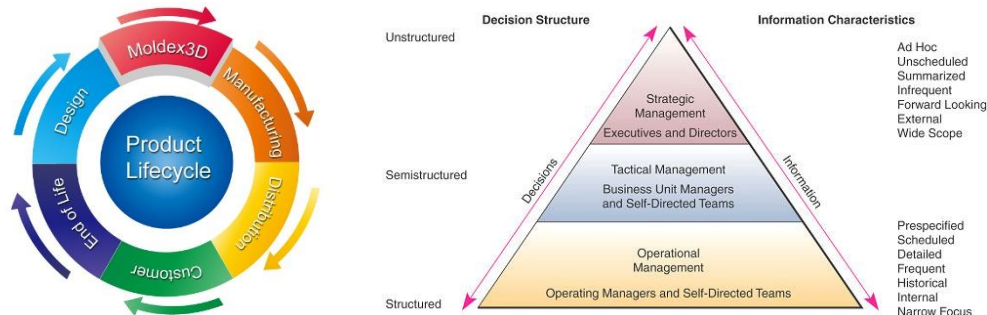
Renault has set up a network for collecting after-sales waste in a pilot region: most of the collected waste can be recycled or reclaimed through recovery channels.

Recycled plastic costs about 10% less than virgin plastic. Enough to give Renault the strength to continue: pioneer and leader in Circular Economy.

Manufactured products - too - can be manufactured at the lowest energy cost and reintegrated into the production process, through their repair, reuse, or re-fabrication.

Renault promotes the replacement of raw materials, derived from natural resources, by "secondary" materials derived from recycling.

These results were obtained either by a more rigorous management of raw material flows or by the implementation of clean technologies where the information system can be an added value by collecting data.



These information systems manage and connect the data of the vehicle components from their eco-design of their production to their valuation. The IS allows to detect errors earlier in the planning phase.

For manufacturing companies, it would be very interesting and effective to be able to control the life cycle of products and, thus, to include the stakeholders of the economic circular for the design of future products. For more than twenty years, Renault has been using Suez to manage its industrial waste.

Rather than pay an eco-organism without any hope of profit, the majority of car manufacturers prefer to control the recycling of cars at the end of their life. They could be integrated into a database for the design of future products. With the northern company Boone, they have gone one step further by joining forces in the recovery and resale of metals from end-of-life vehicles (ELVs).

Taking the example of Renault, we will ask the following question to the CSR (corporate social responsibility) and IS Manager:

## In the areas of Information System and economic efficiency:

### Why is it in your best interest to get rid of plastic?

To answer it, we will make a diagnosis on the Renault Company and its issues and goals about plastic production. Then the benefits of using the Information System to achieve a better ecology footprint and concrete and feasible solutions to plastic production using IS. We will finally ask ourselves: is it possible to get entirely rid of plastic?

# Renault and its plastic production: Issues and Goals

During the production of Renault vehicles and automobile in general, the proportion of plastic reaches 20%.

The type of plastic used during the production of this vehicles are classified into two categories:

- Thermoplastic which represent 85% of the plastic that can be heated and formed at will. Polypropylene is a semi-crystalline thermoplastic polymer of high consumption.
- Thermosets which represents 15% of plastics whose particularity is that they cannot be modifies after being heated.

After the definition of circular economy we have given in the introduction, in this case we talk about manufactured products that can also be produced in a more energy-efficient way, by going through the process of repair, reuse or remanufacturing.

Renault realized that the circular economy objectives made good business in sense that they optimize their resources and minimize the environmental impacts.

Therefore, they initiated a collaboration with multiple stakeholders like for example ELV's, a corporation created by the automotive industry in order to promote the industry's environmental efforts in recyclability, education and outreach. Renault Environment coordinates also a large share of the group's circular economy activities, such as the Indra an automotive recycler subsidiary of Renault environment which collects and handles end-of-life vehicles, Gaïa (end-of-life waste) and Boone Comenor companies (metal waste).

Currently, the results from these collaborations showed that only 36% of the total mass of a newly produced vehicle is made from recycled materials. In a New Escape (Model of Renault vehicles), 20% of plastic is from recycled material.

Renault uses around 42,000 tons of recycled plastic a year and is aiming to increase to more than 50,000 tons in the next 3-5 years.

The company also hopes to expand the initiative of recycling plastics from ELV's beyond Europe to other markets around the world, like India or Brazil.

To achieve a similar percentage of recycled plastic as this European example, it would require a supply of more than 200,000 tons of recycled materials to succeed in this goal for these markets.



# Why should your Information System focus on get rid of plastic?

## **The economic reasons:**

The price of raw materials has increased of 6% since 2000, and became more and more volatile with 80% of the products that will be thrown in the first 6 months of their life. There are more and more partners in the Circular Economy which are referenced in many web sites as [circle-economy.com](http://circle-economy.com) or [economiecirculaire.org](http://economiecirculaire.org). The major partner is Ellen MacArthur, which is the partner of Renault since 2010.

From the side of the consumers, the ecological label takes more and more place in their mind. Actually, 30% of them are aware of these labels without necessarily taking them into consideration, whereas 23% of the consumers are aware and take it into account.

This is related with many ecological scandals like the Garbage Island which made the global opinion aware of the problem of plastic. If we focus on the automobile industry, 94.3% of the sold vehicles are from green class with 48% of them in class B (just after the class A). Renault was the world leader in the automobile industry in 2017. To keep its place, Renault has to search for innovations and new politics which are part of the Green Business. If we add this imperative to the trend of being aware of the plastic's problem, we can easily show that Renault has to make a big investment to get rid of virgin plastic.

Each company has a Corporate Social Responsibility (CSR) and because of Renault situation, it should try to make its best to make CSR one of its mains goals. Actually, an ADEME study in 2016 showed that sorting of waste has allowed to save 3 million euros each year. Because of the part of plastic that represents 20% of a car in average, this constitute a non-negligible saving.

To conclude, Renault can take part of the economic trend to keep his position.

## **The social reasons:**

Secondly, we have to focus on the social reasons.

Companies have to respect the social laws, beyond that, each company should try to do their best to improve their social image. In fact, it could make customers more attracted (the marketing and economic part) as well as engineers and many employees who will support the company because of their fidelity.

Trying to get rid of plastic could have a benefic impact on the unemployment as much as the health and the working conditions of the employees.

The Circular Economy had created 3.9 million jobs around the world where 800 000 of them are in France and represent 21% of the jobs related with Circular Economy.

France is a major actor of the green business. Renault should focus on the green business and particularly on the plastic's problem because it would permit to relocate some part of

Renault production in France and would improve his image for Europeans and so for the rest of consumers.

The production of a car represent some risks for the employees.

We'll focus on the plastic production because it represents a risk of dermatological disease linked with the plastic residues (as phenol for example) which represent a cost for Renault. Moreover, there was a scandal in France with the Cleon's Renault's factory where some overseers asked to the employees to not take health break.

Be aware of recycling plastic is shown as a benefic politic because of the improving investment of each employee in the company. In fact, each employee feels like a real actor in the company and in the ecology.

Finally, we can highlight that trying to get rid of plastic has a social interest for the development of Renault.

### **The marketing reasons:**

From now, we'll focus our point of view to the expenses of Renault and think of the opportunities to improve its sales.

Marketing services use the Green Business to improve their sales. We will show why Renault should go ahead to get rid of plastic by demonstrating the impact that such communication as well as such strategy could have on his position in the market.

The Green Washing is in fashion. Actually, 3% of the 13 964 ads saw in 2013 used the ecological argument, and 93% of them complied with the deontological recommendations. Therefore, the problem with the vehicles ads is that only 2% of them are more overcautious. It means that the rest could contain some exaggerations, which could lead to the loss of consumers' confidence. Trying to get rid of plastic, it's distinguishing oneself from the rest of the competitors; Renault is the leader of the Automobile industry since 2017, so he has an impulse role. Moreover, it suffered from its product's quality compared to the competitors.

With the development of the Green Business, the trend of the consumers to be more responsible and the plastic part in each vehicle that has grown (+20% of plastic since 1970), it seems logical to make sorting waste a main problem. From the side of the benefits, Renault has proved that taking care of the sorting waste leads to profits. The main illustration is the partnership with Ellen MacArthur (a major partner of the Circular Economy) since 2010 to recycle plastic: it allowed to save 0.5 Billion euros each year thanks to this partnership and this policy.

To conclude, such a policy is positive to the company because of the opportunities to grab market share and strengthen consumer loyalty.



### **The legal reasons:**

At last, we will demonstrate that Renault has a big interest trying to do his best on getting rid of virgin plastic. Besides of the opportunities, Renault has to forge ahead because of the fast evolution concerning plastic production and Data protection.

We will finish by studying the future “Bonus-Malus’ system” as well as the obligation to be aware of the General Rules of the Data Protection (GRDP). The French government wants to force companies to get rid of virgin plastic with the “Bonus-Malus” law which will become effective in 2019. Each company would have a bonus going up to 10% of the plastic price if the company recycle it. However, the company would have penalties if it uses another source of plastic than the recycled plastic.

Beginning a green business required a strong Information System to collect data and use them to implement an efficient recycling process. These collects are for lucrative purposes so the Information System needs to agree with the GRPD’s law. Renault has to provide a Data Protection Officer and a Responsible of Treatment.

To conclude, we saw that Renault’s Information System has an interest focusing into getting rid of plastic because in a general way, everyone involved are in line with the law.

## Using the Artificial Intelligence (AI) to get rid of plastic:

When we talk about the applications of AI in the activities about waste sorting, we need to know what AI is:

Definition in dictionary Merriam-Webster: a branch of computer science dealing with the simulation of intelligent behavior in computers. The capability of a machine to imitate intelligent human behavior.

Nowadays, in the context of the era of big data, artificial intelligence has been given more complex meanings, its content has become very extensive, and more branches have been extended, such as machine learning.

Machine learning is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn" from data, without being explicitly programmed. Machine learning is the core technology in the field of artificial intelligence. In the era of big data, many popular technologies are developed based on machine learning, including computer vision technology and data mining.

### **The solutions:**

Computer vision technology: it is a technology that allows computers to learn how to 'see'. The computer captures the material, shape or color of the item through a camera or other sensors, then analyzes these data through machine learning to identify the item.

Data mining: it is the process of discovering patterns in large data sets involving methods at the intersection of machine learning, statistics, and database systems. Aside from the raw

analysis step, it also involves database and data management aspects, data pre-processing, model and inference considerations, interestingness metrics, complexity considerations, post-processing of discovered structures, visualization, and online updating.

With the enhancement of information technology computer capabilities, a large number of extensive and complex data can be stored and analyzed by computers. Data mining can predict the future data by finding the pattern of data existence, so that the information system containing the database becomes an indispensable and important part of providing decision-making for modern businesses.

Big Data: a term used to refer to data sets that are too large or complex for traditional data-processing application software to adequately deal with. The enterprises have collected more and more data, the volume has growth and the variety has become complicated. Processing data requires new methods, so new technology based on big data has become an important point for enterprise.

### **Application in Renault's circular economy**

Renault has made a commitment to protect the environment. One of the important parts is the realization of a circular economy. The circular economy can not only reduce costs, but more importantly contributes to environmental protection. To achieve a circular economy means to re-use waste, through the recycling of materials, and increase the proportion of recyclable plastics in the fabrication of automobile. In order to achieve this goal, a good coordination between the company's decision system, information system and operating system is required.

In the waste recycling process, a sorting process is required. In many cases, this process needs to be operated manually. For companies engaged in recycling, this will cost a lot of money. But through computer vision technology, we can automatically identify waste products, thereby freeing people and reducing labor costs. At the same time, through the automatic sorting machine, we can record each piece and transmit the data to the company's information system for analysis, that is, to digitalize the sorting.

Example: ZenRobotics specializes in machines that automate the sorting of waste. This machine uses computer vision technology to identify the type of waste in real time, so that the accuracy of machine sorting is greatly improved, and the efficiency is much higher than manual sorting.

Material recycling is an important part of Renault's circular economy concept. With European automobile recycling company Indra, and metal recycling company BOONE CONEMOR as subsidiaries, if Renault is able to apply such machines at the operating system level for the classification of automobile waste materials, the company will invest less in the recycling economy, but the recycling efficiency will be higher.

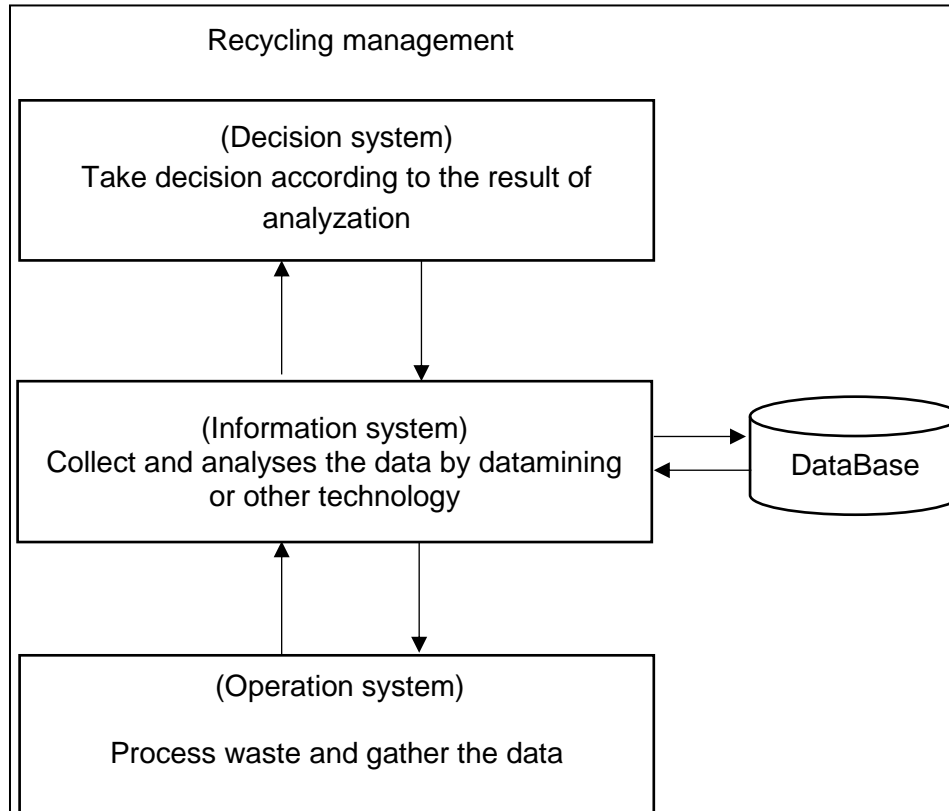
At the same time, the waste material information is recorded and uploaded to the database of the information system, and the data of the recycled materials are analyzed by data mining for different aspects.

For example, analyzing the recycling efficiency of various materials and predicting the future recycling efficiency, the basis for purchasing in future can be provided. And with Big Data, members of the waste and recycling industry can optimize their routes based on historical waste and recycling data collection, which helps reduce emissions by having less trucks on the road, increase the efficiency of collection operations and drive better operational performance.

In this way, artificial intelligence is applied in the recycling management to optimize the supply chain and improve the profit. At the same time, it can help to understand the

customers' used-cars recycling behavior, and more importantly, reduce the pollution generated at the supply chain.

By applying the artificial intelligence approach to information systems and operating systems, we can obtain and analyze data on waste disposal, thereby providing advice to decision makers to make decisions that are more conducive to business and the environment.



## Management system

**Decision system:** all the human, material and software resources that make it possible to achieve the objectives through the social object.

**Information system:** all human resources, hardware and software that processes information for effective decision making.

**Operating system:** all the human resources, materials and software that realizes the social object.

In the management system (MS) of a company, decision system sometimes has ideas to develop the company, and information system (IS) has to give some supports to help decision system decide and help operating system to achieve company's goals.

In our example, Renault's decision system wants to increase the company's profits in some way. Through data and case studies of IS, they suggest that recycling waste can not only reduce costs, but also help the company improve its reputation through environmental protection. With more information exchanged between the decision system and the IS, the decision system puts more specific requirements on the IS and the IS also provides more specific data for the decision system (DS) to help them make more detailed and feasible decisions.

Then they hand the plan of final solution to the operating system (OS), which implemented activities of Renault and achieved the goal through this detailed plan. There is also much information exchanged between the OS and the IS, the IS can analyze data and write some algorithms to help the OS to implement better and faster.

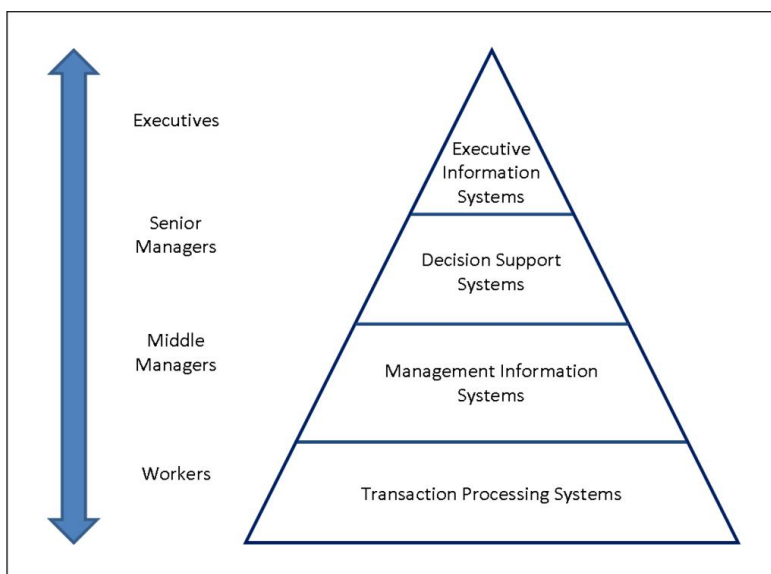
Now we will create a module of this MS, and we will talk more about the work of the IS.

### **Information system**

An Information System (IS) is an organized system for the collection, organization, storage and communication of information. More specifically, it is the study of complementary networks used by people and organizations to collect, filter, process, create, and distribute data.

Any particular IS is designed to support operations, management and decision making. Information systems are information and communication technologies (ICT) used by organizations and are the way people interact with this technology to support business processes.

There are 4 levels of information system.



Tools used by Renault: Hadoop Hortonworks, Hive, HBase, SPARK, Scala, Oozie; Elastic Search.

### **Data processing system (DPS)**

Data Processing System (DPS) or Transaction Processing System (TPS), which collects data that can be used for management and generates reports to support the organization's working activities – MRS (Management Reporting System, the narrowly defined Management Information System MIS).

When engineers begin to design a vehicle component, recycled materials are often considered the second choice. We are worried that the quality of recycled materials will not match the original materials or that they are not qualified to be used in car production. In order to verify the feasibility of recycled materials in automobile production, Renault needs to pass a series of experiments on recycled plastics and original plastics, input and store

experimental data into a specific database. And convert this large amount of experimental data into a chart to visually see the comparison between the two.

From the experimental results, it was found that a well-recycled material can provide good results regarding the performance of the recycled material compared to the original material. When the decorative parts are made of recycled plastic (Renault Megane), the potential of recycled materials is outstanding, and the quality and function are no different from the customer. Therefore, recycled materials can be applied to automobile production on a technical level.

Having verified of the usability of recycled plastics, the IS will assist the DS to determine whether to use recycled plastics for production and the proportion of production through other indicators.

These staff members in this system can also use Decision Support System (DSS) to complete their decision-making work.

### **Decision support system (DSS)**

Decision Support System (DSS) is an information system that supports business or organizational decision-making activities. DSS serves the organization's management, operations, and planning levels (usually mid-level and senior management) and helps people make decisions about issues that may change rapidly and are not easily specified in advance.

DSS uses tools and techniques to help gather relevant information and analyze options and alternatives. DSS typically involves the use of complex spreadsheets and databases to create "what if" models.

Tools used by Renault: Hadoop Hortonworks, Hive, HBase, SPARK, Scala, Oozie; Elastic Search.

There are three fundamental components of a DSS architecture:

1. Database: Database where they store experimental data/results,
2. Model (the decision context and user criteria)
  - Is it worth it to use recycled plastic in car production?
  - Which type of recycled plastic to use can be better?
  - Which indicators can be better used to compare these different plastics? Better mechanical and/or thermal properties...
3. User interfaces
  - Interface with chart, set of menus and simple comment which helps the interaction between the user and the software system.

After reading the report of data processing system, staffs in this system of Renault can start to decide in four phases:

1. Intelligence – Searching the environment for conditions that call for a decision  
The decision-making process starts with Intelligence Phase, which emphasizes importance of right problem definition before building anything (product or business).  
Defining organizational objectives – increase the value and profits of the business  
Problem identification and classification
2. Design – Inventing, developing and analyzing possible courses of action

Formulate a model for designing new solutions, or evaluation models for assessing ready-made solutions.

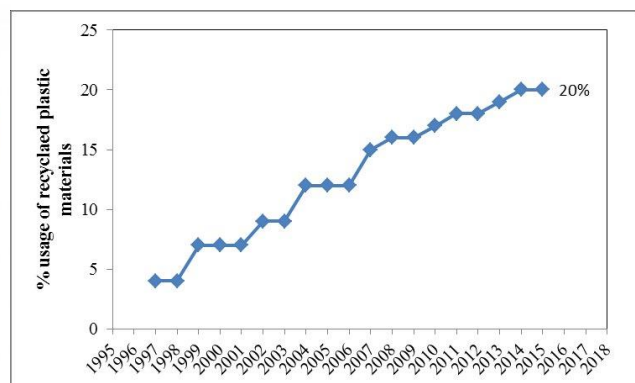
3. Choice – Selecting a particular course of action from those available

4. Implementation – Adopting the selected course of action in decision situation.

This system can be used for decision-making, and for the coordination, control, analysis, and visualization of information in an organization. After creating reports, extracting data, it can assist in the decision-making processes of middle and operational level managers

After many experiments and decisions, Renault has gradually determined the type of recycled plastics, the scope of application in automotive production, the amount of use, etc. The most used plastic in Renault vehicles is polypropylene (PP). For this type of material Renault develop design guidance tools in order to prevent the pollution of the polypropylene with parasite polymers of equal density and incompatible materials present into the polypropylene process (PVC, glued textiles, metallic inserts etc.).

Their experiments and such decision-making processes has never stopped, and they are committed to find better solutions. Through the chart, we can see that the percentage of recycled plastic used by Renault for automobile production is increasing year by year.



Parts in recyclable and renewable plastic material for Renault Megane vehicle and  
Evolution of the recycled materials used on Renault cars

Thanks to this idea, Renault has succeeded in reducing the cost and getting a good reputation for the environmental protection.

# Optimization of IS and 3D printers

Having detailed plastic management in Renault's IS and introduced the importance of AI in the plastic's life cycle of the operating system, it is essential to finish this chapter by giving concrete solutions to IS optimization.

The effectiveness of the information system is a key issue in the ecological footprint. Better managed computer hardware means there is less need for it in quantity, so less plastic is necessary. Indeed, remember that a computer is composed of 22.99% plastic, which gives it the second position in the ranking in terms of materials used.

Although hardware and IT infrastructure must be applied in the company because obviously they are very useful, there is still the major drawback of having an obsolescence programmed on each hardware. This obsolescence clearly leads to efforts to be made in terms of maintenance, and that is another cost for the company.

Today, it is estimated that most servers and workstations of large companies like Renault are only used between 8 and 15% when they are lit. Regarding the energy cost, it can now represent up to 40% of a company's overall IT budget. Finally, for 1 € spent on the purchase of a computer, you have to spend more than 50 cents on energy. And because of the obsolescence of the material, for the same computer it will be necessary to foresee 71 cents in 4 years.

For all these economic and ecological reasons, several solutions exist. They are simple and feasible to put in place, and thanks to them, not only the energy footprint will be improved, but also the economic cost will be reduced by the decrease of direct purchases (purchase of computer, maintenance) and indirect purchases (energy cost). After a more complete interview with Renault about what we can do, we will have the pleasure of reading and signing the IT charter to be able to access the IS of the company and implement the following solutions.

## **Virtualization**

It is a technique that reduces the number of machines used in an Information System while providing processing power, and cost control. Server virtualization makes it possible to host multiple physical machines on a single server, in other words, with virtualization, it is possible to operate on a single physical machine, several operating system: this is called server consolidation. Virtualization appears as a viable solution given the latest statistics, as the power available in modern machines is far from being fully used. Fewer computers but more power is a winning combo to not only save money but also save energy and use less plastic for production!

There are multiple advantages about virtualization. First, it allows you to run a program originally planned on a different operating system from the one you usually use. In terms of security, the virtual machine also makes it possible to surf in a completely secure way since the possible infections contracted will be done at the level of the virtual machine and not at the level of the host machine. Finally, developers will be able to create different development environments and specific tests on the same machine, which is a huge gain of time for them and their work.

There are different solutions of virtualization such as VirtualBox, VMWare, Virtual PC.



## **Cloud computing**

After doing this work on virtualization, what comes naturally after, is an effort put on the cloud. Imagine a 100% information system in a cloud: no need for a single server, no need for any IT infrastructure. The 100% is a mandatory rule in the Silicon Valley when a start-up is created, because these growing companies must be flexible, fast and innovative. In France we are a little overcautious with the cloud, but some companies are already well anchored in this sector. In France, SaaS is still largely the most used type of cloud service, at 48%; IaaS is 19% and finally PaaS only 5%.

To be clear, we do not advise Renault to migrate to 100% cloud. Indeed, it would not be at all adapted to their structure and their trades. Economically it would not make much sense since for a company with a strong existing, applications like ERP, accounting on a well-defined perimeter and fixed number of users, make the cost of such a transition very heavy and expensive. However, it is still possible to partially migrate the information system into the cloud before reaching a certain cost and feasibility limit. There are several things to know about moving to the cloud. First of all, it is necessary to treat the problem of the network connection, where in France it is not yet ubiquitous, because the network accesses remain a key point of the diffusion of the cloud. Then, the data security problems arise: given the sensitivity of business information, access had to be completely secure. Finally, the cloud does not correspond to certain trades, for example the 3D design is, with its strong constraints in terms of computing power, display and large volumetric of its files, one of the last system to resist the cloud, although technical efforts are triggered.

## **What about your 3D printers?**

Speaking of 3D printing, we know that at Renault, these systems are used in research and development. 3D printing is a very good technology, unfortunately, it has the huge disadvantage of being environmentally dangerous. In fact, the organic components released during printing are irritating and potentially toxic. In addition, many thermoformable plastics are used as main components, without ever being recycled.

Fortunately, it is possible with some start-ups to order environmentally friendly filaments. The price of 1kg of recycled filaments are in a fairly large price range of 22-45 euros (given the diversity of solutions), while the price of 1kg of standard filaments are in a range of 30-35 euros. Finally, there is also the technique of "do it yourself" since plastic extruders are gradually appearing on the 3D printing market with the key the possibility of creating its own printing filament. Existing projects include ProtoCycler, FilaMaker, 3DEvo, FelFil Evo, Filabot or Plastibot. Using recycled filaments instead of standard filaments seems to be a simple and efficiency solution to achieve your goal, which is using more recycled plastic.

### **Quick conclusion to make your mind clear:**

Finally, to give a final conclusion on this matter, these are the following advice to keep in mind:

- Use and develop virtualization: less quantity of computers (therefore of plastic), and more quantity of power being used
- Migration of Data to the cloud (same as virtualization, less quantity of materials, therefore of plastic): as much as it can in terms of economic and material constraints
- Replacing standard plastic filaments with recycled plastic filaments for all your 3D print. As seen, there are multiple providers in this sector, and the price of recycled filaments can be cheaper than the non-recycled! And of course, all recycled filaments are compatible with your 3D machines, and they work the same way.

## In the end, is it possible to get entirely rid of plastic?

For global plastic production, packaging is the first outlet. It has increased by more than 40% in ten years, going from 255 to 348 million tons a year. According to a study by the magazine “60 million consumers”, published in March, only 26% of plastic packaging is correctly recycled. The share of raw materials reused in the production of the plastics sector is the lowest when compared with that of paper or aluminum. To change this percentage, the French government is going to implement a device whose objective is to achieve 100% recycled plastic in 2025.

It's going to be a “bonus-malus system” that will be implemented next year, in which the purchase of non-recyclable plastic product will be penalized.

Brune Poirson, secretary of State for Ecological and Solidarity Transition declared in an interview in “le Journal du Dimanche (JDD)” that in the future, when there is a choice between two bottles, the first one made of recycled plastic and the other not, the first one will be cheaper. This will aim to make it easier for consumers to choose between buying a recyclable product and one that is not.

However, this system is only part of the solution since it only concerns recycling and not plastic reduction. The question remains unanswered, and not only, but we do not yet know how this device will be put in place, and how it will lower the cost of recycled plastic items. There is not clarification on this subject.

Stakeholders around the world are starting to set up initiatives to try to solve the issues of sorting waste and especially plastic waste. To give illustrations of this, in Chile and New Zealand, plastics bags for single use have been banned just like in France, for those who are not compostable.

In Ireland, the government put in place a tax of plastic bags in 2002 known as the “PlasTax”. They aim to trigger a change in the consumer's behavior and promote a more ecological way to replace plastics bags. In the year after the introduction of the tax, the use of plastic dropped by more than 90% and the consumption of plastic bags has decreased from 328 to 21 bags per year. The success of the Irish tax proves how consumer's behavior can change with the adoption of a high tax. However, it's undeniable that for the success of such a tool, the participation of the stakeholders is essential.

Then we have the example of the government of Rwanda. They have strictly prohibited the manufacture, use, sale and importation of all types of plastic bags. They replaced the plastic bags with paper bags, or else the inhabitants started using reusable bags made of cotton.

Nevertheless, the stakeholders were insufficiently consulted for the design of this policy. Over time and despite the problems the people endured, they got used to the new regulation and Kigali, the capital of Rwanda was nominated by UN Habitat in 2008 as the cleanest city in Africa.

The government of Kenya also announced, in 2017, a ban on the production, sale, importation and use of plastic carrier bags. In the case of non-compliance with this prohibition, offenders can face fines of up to \$38,000 or four-year jail terms, making Kenya's plastic bag ban the most severe in the world.

Other countries in the world have implemented initiatives similar to those previously presented but all with the same goal: the decrease in the production of plastic, and the establishment of alternatives to replace it. However, once again we come to the same conclusion: there is no real solution for the reduction of plastic waste. Despite the fact that there are no existing solutions up to date, there are still initiatives that are being developed.

We have seen that many initiatives regarding the reuse of plastic that has been put into work but it is more difficult to talk about initiatives to reduce plastic. Although it is very helpful for the ecosystem, the question still stands. However, it is not a coincidence that this problem continues without present and applicable solutions.

"Plastic Tide" is a start-up created by Englishman Peter Kohler, with the aim of identifying the most polluted places in order to launch massive cleaning operations. To do this, he uses aerial photos taken by drones and he then forms an algorithm in artificial intelligence with these photos, allowing him to distinguish a plastic bag from a jellyfish, a bottle cap from a shell. Its goal is obviously global, but it's still a project in progress, and they need volunteers.

The problem of plastic reduction is more complicated, we realize that in some cases it is almost impossible to eliminate the plastic completely. To illustrate this idea, when we talk about the components of a computer, in the mother card we find non-replaceable components that cannot be reused or completely destroyed by their physical material of which they are composed.

# ANNEXES

- INTRODUCTION
- **Systèmes d'information et développement durable : modèles théoriques et pratiques organisationnelles**<https://www.cairn.info/revue-management-et-avenir-2010-9-page-304.htm>
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