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THESIS REPORT

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Thesis

CREATION OF A PRODUCTION METHODS DEPARTMENT AND PROCESSUS STANDARDISATION

Summary

Acknowledgements

I would like to thank all the people who contributed to my Thesis.

First, I thank Pr Laurent Daguet, my INSA supervisor, who helped me a lot with QMS (Quality Management Systems) and processus mapping.

I also thank Pr Agostino Villa who accepted to follow me, representing the Politecnico di Torino.

I want especially to thank Mr Frédéric Troester, my supervisor in the company Boccard Process Vessels (BPV), for his welcome and all the work we accomplished. Thanks to his trust, I could enjoy a lot each missions he gave me.

I also thank my collegues at the production methods department, Mr Mark Fernandes, Jean-François Lombard and Mr Gaëtan Pitiot, for advising me and supporting me all along my internship.

Finally, I say thanks to Mr Fancisque Demeure, plant director, and all the BPV team for the welcome I had, the specificities of boilerworks I learnt and also for all the good moments we had together.

1. BPV : Boccard's major advantage

1.1. Boccard

1.1.1. Boccard: the heating engineer who became industrial assembler

In **1918**, Joseph Boccard created a small company specialized in domestic heating system. This company rapidly developed in between the two world war and started specializing in piping for heating sytem and chemistry in **1939**. From renowned industrial piper, the firm became an expert in liquid's mechanic and during the **60'S**, they conquer markets with more value added like energy, steel industry and petrochemistry.

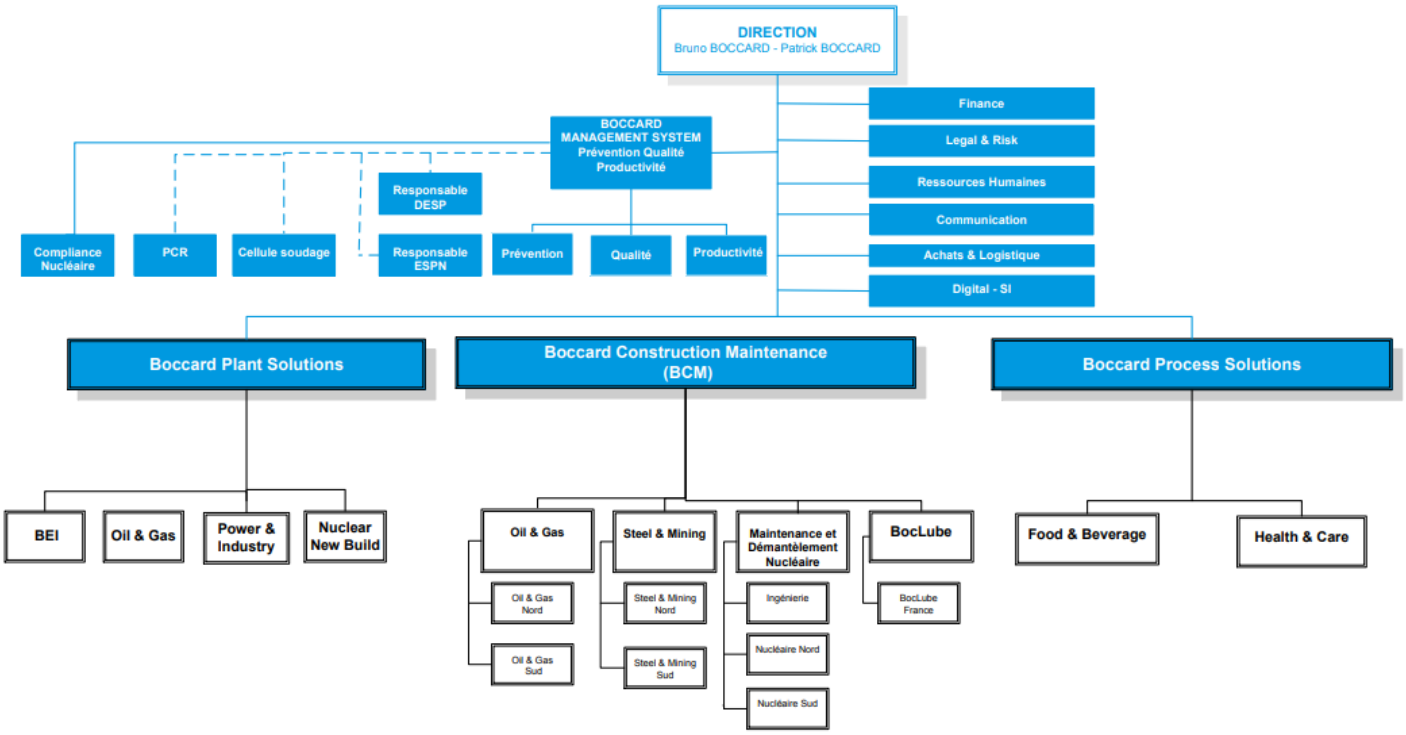
The **70'S** showed the international development of Boccard in fields that nowadays constitute the Business Area (BA) Plant Solutions. It's in the **90'S** that Boccard fully became an industrial assembler and developped markets of the BA Process Solutions. Since these years, Boccard did not stop growing and Bruno and Patrick Boccard are today the 4th generation of Boccard executives.

1.1.2. Boccard: major industrial assembler

Boccard is an industrial assembler based in Villeurbanne, France. The company offer key-handed industrial solutions around piping and boilerwork. Boccard manages the realisation of huge projects form engineering to maintenance through manufacturing in workshop and/or site construction. In 2017, the company had a turnover of 193€ million.

In 2018, the company is leaded by the Boccard brothers Bruno and Patrick. It counts 3500 employee through a large number of work fields. The flexibility of Boccard allows it to be present in 8 markets divided in two Business Area (Plant & Process Solutions). A third BA, Construction and Maintenance, is divided by geographical regions and acts in all fields of activity.

Boccard answers the demand of these different markets worldwide thanks to 60 Business Unit, spread in 35 countries. BU are generally specialized in one of the 8 fields like Meura in Belgium which is a brewery specialist. Nevertheless, some BU are poles of expertise like BPV which is one of the 3 boilerwork workshop of the company. The company organisation is detailed in the diagram here after.



1.1.3. Boccard Management System

The Boccard Management System (BMS) is the quality management system of Boccard. The BMS is based on 3 principles, **PREVENTION – QUALITY – PRODUCTIVITY**. It goes with the motto: *On time, On Spec, On Budget but Safety First*. The goal of all employees daily is to deliver products that satisfy the customer needs and the initial period, within a budget, while working in security.

We will talk of the BMS later in this report.

1.2. Boccard Process Vessels

1.2.1. The Constructions Soudées du Coteau become BPV

Founded in 1937, CSC is a small boilerwork firm based in Le Coteau near Roanne, Loire (France). First specialized in wine industry, CSC merged in Boccard in 1986 and developed itself around new fields like biotechnology, food, pharmaceutics, cosmetics and chemistry. They developed more and more complex vessels. This collaboration allowed Boccard to enlarge its offer.

In 2016, Boccard acquires fully CSC and make it a BU of the fir. After two years of mentoring with the BU Health & Care of Villeurbanne, BPV got the BU status on the 1st of January 2019.

Today the BU has an organisation based on projects and a horizontal hierarchy. Project leader are affected to different projects and each department works on each project.

1.2.2. BPV: "Precise container for precious content"

BPV is, along with Boc Argentina and Boc Polska, one of the boilerwork of Boccard. On the Le Coteau site, BPV works in 4 markets of the global firm: food, pharmaceutics, cosmetics, and nuclear. This entity has also a long-term contract with General Electric for manufacturing squared vessels which are containers for liquid products.

Boccard chose to make BPV a showcase of the know-how of the company. That is why BPV is always looking for new technical challenges. The latest one is the implantation of a welding robot which is gonna optimize the production time of some operations.

In a general way, two types of vessels are manufactured:

- Atmospheric silo of high capacity (Food & drinks)
- Vessels under pressure or process vessels (Pharma, cosmeto, nuclear)

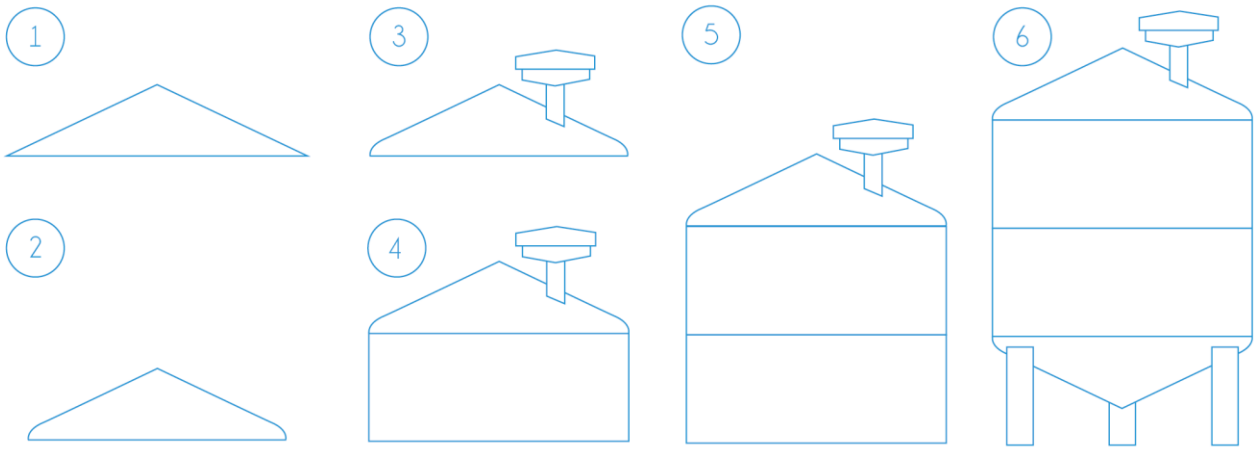
Each vessel has some specificities about production monitoring and manufacturing depending on geometry and field of application.

1.2.3. First of all, a manufacturing site

Based on the industrial zone of Le Coteau, the site is made for the different types of vessels. Buildings were made to match the characteristics and the obligations of each kind of vessels.

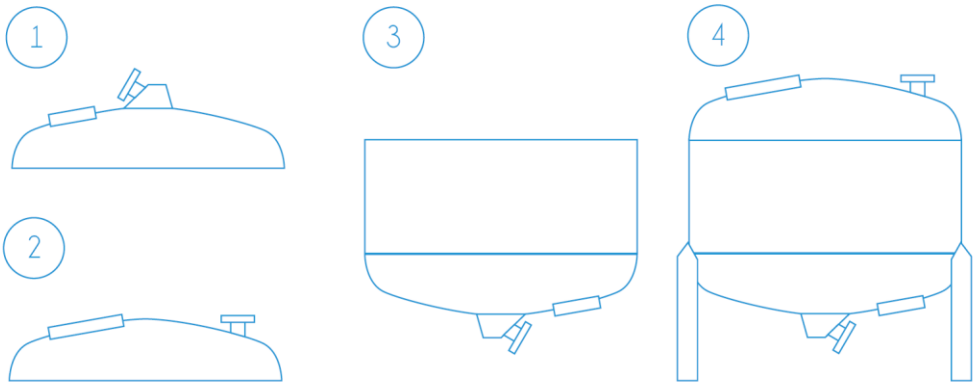
Manufacturing of atmospheric vessels

The atmospheric workshop has a huge height under the roof because the vessels are assembled in their vertical direction. In this workshop, the vessel moves along the manufacturing. The top part is made (1), edged (2), equipped (3) and then assemble to the shell (4). We move the parts up to assemble the next shell under (5) and we repeat this operation until the height of the vessel is good. Finally, we can assemble the bottom part which has also followed the three first steps. Some other operations of polishing are done along the production.



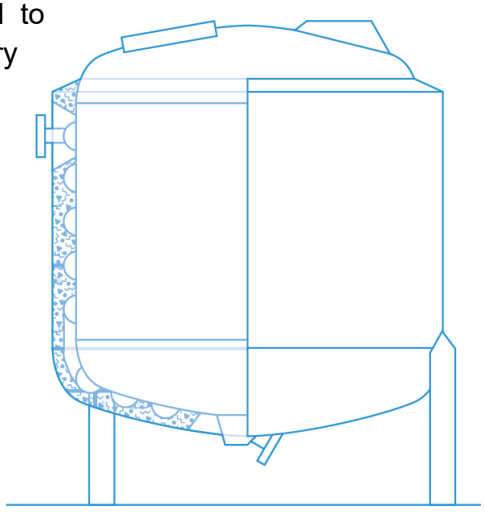
Manufacturing of pressurized vessels

Pressurized vessels are made in the opposite way, starting from the bottom. Although it is the manufacturing standard, some polishing steps or other constraints due to shaking parts can change the order of assembling..



The difference between pharmaceutics, cosmetics and nuclear vessels is made only by documentation and standards of finishing. The organisation is almost the same for pharmaceutics and cosmetics. The monitoring is obviously more important regarding the manufacturing of nuclear vessels. This translates in the workshop with a marking out of manufacturing spaces with partition walls.

Those descriptions of manufacturing standards are simplified to give an idea on how it is made. Nevertheless, almost every vessel has an insulation and/or a heating system (see schema). Moreover, a technical meeting is done for each vessel to define an adequate procedure to manufacture the vessel.



Manufacturing of GE vessels

General Electric's tanks are made on a specific line. The manufacturing of those vessels is out of my project's scope. Those vessels won't be mentioned in the report.

2. Project description

2.1. Main assignment

2.1.1. Context

The standards of wine vessels which made CSC a leader by excelling at manufacturing it are now far from pharmaceutics and cosmetics standards. Regarding nuclear activity, norms are even further away.

Nowadays, BPV tries to answer the need of those four industries (food, pharmaceutics, cosmetics and nuclear) with a single organisation. Yet, standards of these business sectors are very different from each others and each of them needs a specific organisation. Processus to monitore each sector should be specific and strict to avoid mistakes.

Moreover, delivery time standards are shortening. From 13 weeks between order and delivery in the past to 11 weeks today (for pharmaceutics vessels). The mean time of each department is somehow shorten too and actors shall find solutions to improve their organisation. Improvements are necessary since delays enhance tensions between actors.

From this analysis, BPV's board decided to create a production methods department. This department already exists at the beginning of my internship and contains 3 people:

- Jean-François Lombard: Manage all the macro planification with a complex Excel tool, taking into account every single project and the load of the whole company. He's also the leader of the atmospheric workshop. For those vessels, he makes a more detailed planification, depending on the manufacturing sequence. The scope of his planification is the week.

- Mark Fernandes: He is in charge of the General Electric line. He monitores supply and cares about the well working of the line. He can assist Mr Lombard if the load is too high.

- Gaëtan Pitiot: He is the link between production methods department and the warehouse. He manages all the supply of the workshop. He also has to draw some drawings for parts made by subcontractors.

Another issue comes in this context, a change of ERP software. BPV used Héraklès, a specific ERP for boilermakers which fully answered the needs of the company. Moreover, every single person has organized around this ERP. For standardisation needs, Boccard's board decided to buy a single ERP for all Business Units. This ERP is Magellan. It offers new possibilities regarding project management. Nevertheless, the launch step started before the end of development and some functions are not availale. It is therefore necessary to work with both ERP.

Furthermore, Magellan functioning is more secure than Héraklès and this translates with a lot of validation steps by managers. People were not used to this way of working and it needs time to adapt to this tool. This create delay add to delay due to organisations problems.

Finally, more generally, I was lucky to work in a context favourable towards change since everyone was fed up with organisation problems. Everyone was willing to change the organisation and remarks were always helpful.

2.1.2. Problem

In the context, the aim of my thesis was to create a real production methods department. This department had to pay a close attention to way of working of each department. It also had to help each department to create working tools. The final goal of this task was the establishment of strict process from offer to expedition, through design, supply and manufacturing.

The aim was a reduction of delays due to lack of organisation and the creation of a strong organisation sustained by the production methods department.

2.1.3. Bill of specifications

To answer the different problems, the company gave me these specifications:

"Description of the mission:

The goal of the internship is to develop a new department for Methods. This department would coordinate all steps of the supply chain and be at the center of the firm. The aim is to develop a methodology to process an order based on the main steps of a project (cost estimation, studies, purchase, and manufacturing)

The main missions are:

- *Technical feasibility*
- *Planification of critical milestones for each department*
- *Pre-manufacturing process / welding ability*
- *Control processes*
- *Specialized technics*
- *Writing of technical procedures*
- *Purchase needs*
- *Management of suppliers*
- *Workshop layout*

Working environment:

The student will join a team of 3 people to work on this project."

2.2. Other tasks: project monitoring

Alongside of my main assignment, I spent a lot of time to operational tasks. I mainly support the production responsible and project leaders based in Villeurbanne. Those leaders are attached to the Health&Care BU but they have to monitore projects in Le Coteau because eome global skids made in Villeurbanne contains a vessel. This monitoring is hard to make because project leader are not on the manufacturing site and they can't talk with all the departments like if they were on the site.

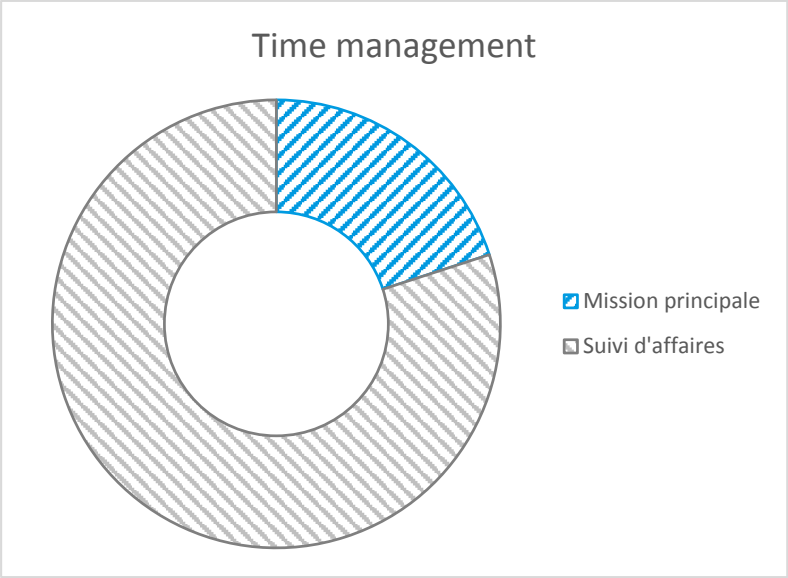
For this assignment, I had to:

- Participate to transfer meeting and technical meetings
- Plan the manufacturing
- Give requirements description
- Monitore subcontractors
- Monitore supply chain
- Monitore the manufactring
- Report to the project leader

I therefore made the typical work of a production methods department person. The aim of this work was to gain experience from the field so I could realise all the problems of the organisation.

3. Work management

My main difficulty was to manage my time between main assignment and project monitoring. In fact, it was hard to take time off the project monitoring for global thinking about the organisation. This is due to the fact that project monitoring presents always some emergencies.



Even if only 20% of my time was for the main assignment, I was really efficient thanks to the experience I had from project monitoring. In the report, I highlighted some specific cases that I had and from which I had some improvement ideas or indiations to create tools.

My contract supervisor was Mr Lombard, but in the reality, Mr Troester took this role and gave me all my work instructions and guided me in project monitoring. We had weekly meetings to talk about my progress and my problems.

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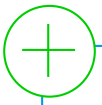
4. Work done

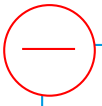
4.1. Observations

The first thing I did was an observation report. I noted during three weeks, all the things which seemed to be abnormal and all the one which had to be improved. I divided this report in two parts, pre-manufacturing and manufacturing.

4.1.1. Pre-manufacturing

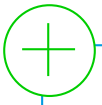


- Careful people
- High experience in each field
- Big network of contacts
- Workers involved in the pre-manufacturing process

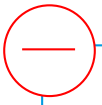


- Lack of communication
- Lack of teaching about ERP Magellan
- Information chain often broken (information is never splitted)
- No strict separation between department's tasks
- Rivalry between departments
- No management load/capacity

4.1.2. Manufacturing



- High involvment of workshop leaders
- Skilfulness of workers
- Improvment ideas from workshops



- Retirement → loosing experience
- High rate of absenteeism and lateness
- Shortage of boilermaker
- High dependency to subcontractors
- Unique organisation for all business sectors

4.2. Process mapping

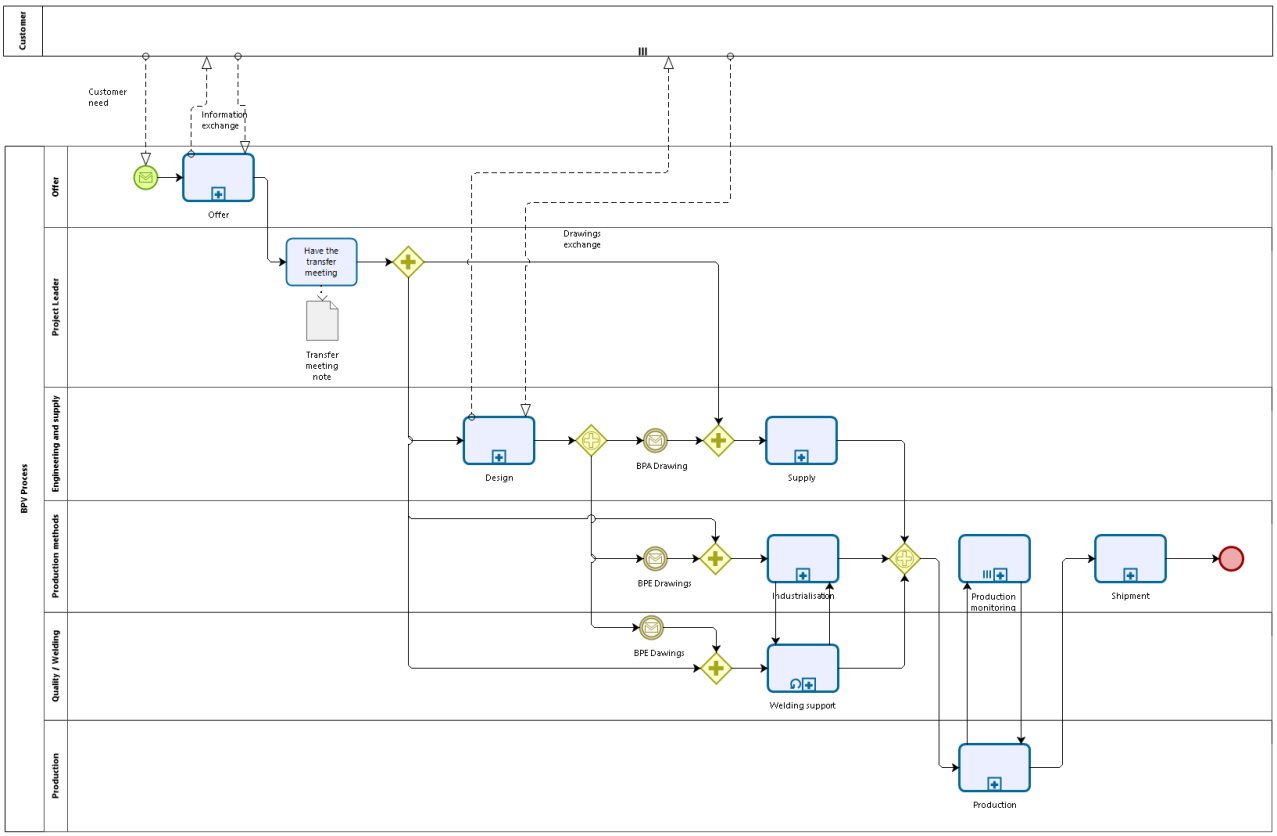
The company had already asked INSA Lyon to lead a study to improve its organisation. During a student project, a team of students of MSGI (Master Spécialisé en Génie Industriel) lead a study after visiting the company. After my arrival, I could consult their report. Nevertheless, the team didn't make a process mapping but a value stream map (VSM). This was not the best thing to do for me because most of operations made in pre-manufacturing process don't have physical value added.

From this point, I decided to make a process mapping, following advices of my INSA supervisor, Mr Daguet. By doing this, I could highlight incoherences in the ways of working. I chose to represent processes in a TO-BE version without modeling an AS-IS version. To do this, the experience I had from project monitoring was really important.

4.2.1. Global process

First, I modelled the global company process, from offer to expedition. This diagram, like the followings, are in appendix in a higher resolution to read.

This map shows the life cycle of a project and all interactions between departments.



The offer is a process which consists in writing a proposition regarding technical specifications, deadlines and price. This offer could be internal or external. Internal offers are made for other Boccard entities. External offers are made for direct customers, without other Boccard entities collaboration. The offer is the result of an exchange between the company and the customer who expresses his needs. At the end of this process, the company get the project or not. In this diagram, we always get the project. In reality, this happens only in 25% of cases.

When we get the offer, the project office manager appoint a project leader (PL). The PL has to give information about the project to every department. He got those information by the offer responsible. This information sharing happens during the transfer meeting where the project is presented. During this meeting, we identify main milestones and critical supplies. These supplies, not shown in the diagram, are supplies with a large delivery time and critical for the manufacturing process (e.g. needed at the beginning). The supply department order those parts before the validation of all drawings and the end of the designing process.

Then the pre-manufacturing process starts with the design of the vessel. This process gather all the sizing, designing and CAD tasks but also exchange with customers till his validation. This process allows three others to start, supplies after BPA drawing (BPA = Bon Pour Achat = Good For Buying) and industrialisation supported by the welding department after BPE drawing (BPE = Bon Pour Execution = Good To Execute). This sub process is a key for the project success.

Manufacturing is the main step of the global process because it is when the vesse lis made. So this task comes with a monitoring process that we will develop later. As we said before, manufacturing depends on the kind of vessel.

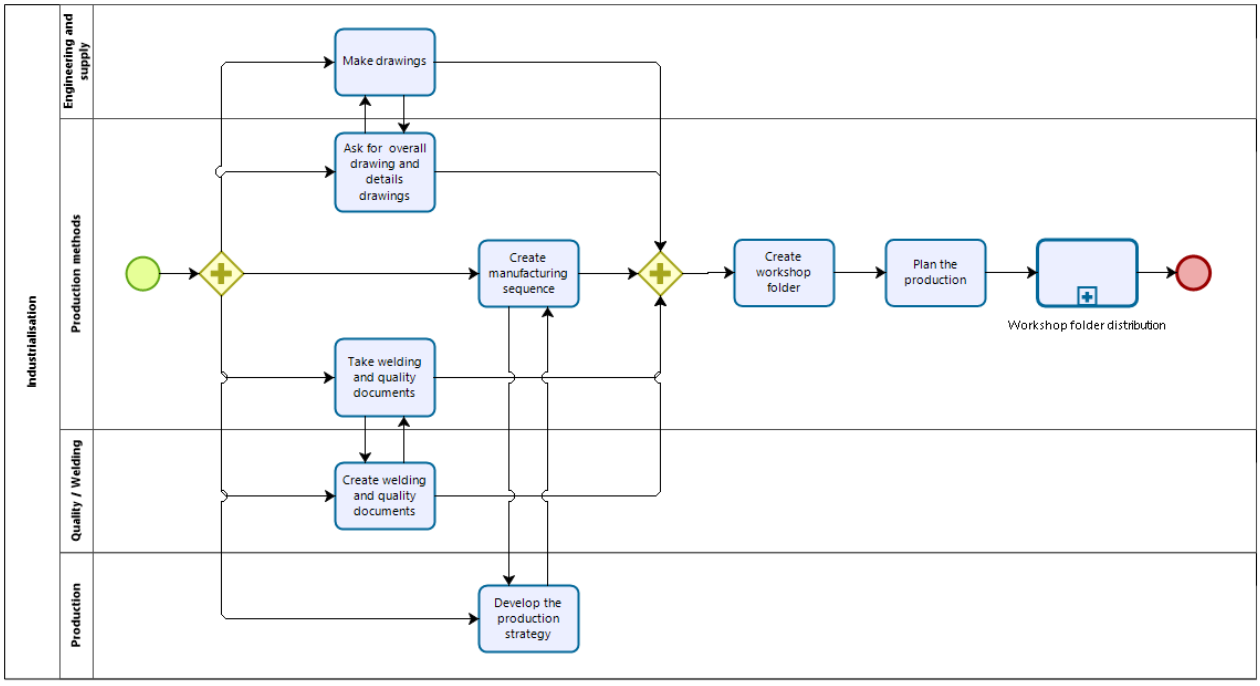
Finally, shipment is the end of the global process. Even if this seems quite simple, it is a complex process that should not be neglected because past experiences showed many mistakes.

4.2.2. Industrialisation

Industrialisation process aims to prepare drawings made by the engineering department for the manufacturing phase. In this context, the production methods department has a key role by conveying the information, avoiding any loss or misunderstanding.

As we can see on the previous diagram, this process starts after the customer validation of drawings. The overall drawing becomes BPE and each department can work on the project. If time constraints appear, this process could start before the validation but the company is taking a risk.

The main goal of this process is to give needed tools for a good manufacturing process. For that, the production methods department has to gather all documents to create a workshop folder. A second goal is to plan the manufacturing phase.



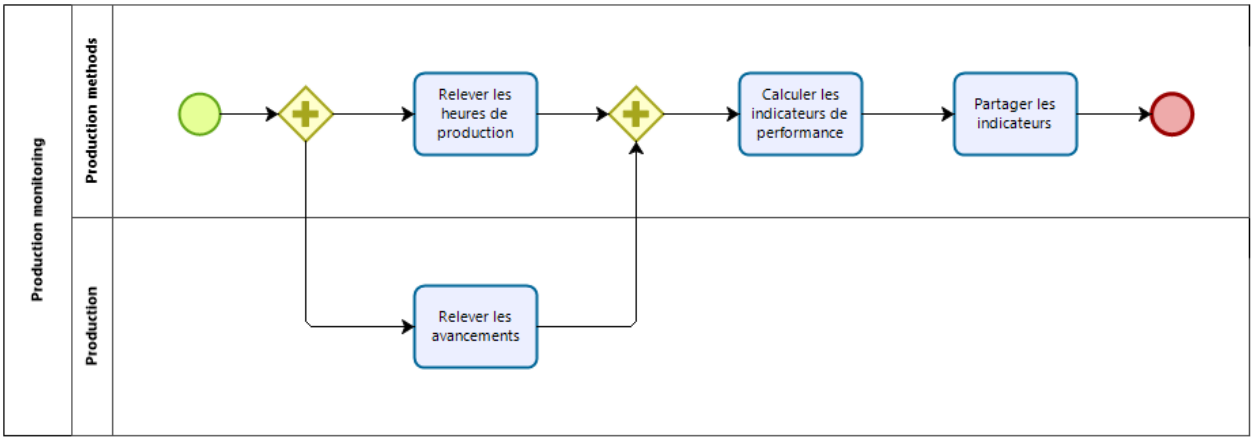
The final folder gathers all drawings (overall and details), the manufacturing sequence but also every documents about quality and welding procedures. The welding department gives all WPS (Welding Procedure Specification). About quality, we have different kind of documents depending on industry requirements. For food vessels, a single internal document is completed by welders of each sub assembly to ensure a basic tracking. For pharmaceutics and cosmetics, the standard document is LMOC (List of Manufacturing Operations and Control). It lists all manufacturing and control operations and is also completed by the welders. Finally for nuclear vessels, an expert gather all documents for peculiar requirements. The place where the vessel is going to be used could influence documentation and standards (e.g. ASME in North America).

As we can see in the main process, the welding department is a big support for the production methods department because it manages all the welding tools. It also has a critical point of view on industrialisation because this department is essentially made of experts.

Finally, the manufacturing department has also a key role because they got a knowledge from past similar vessels and they help to anticipate potential mistakes.

4.2.3. Manufacturing monitoring

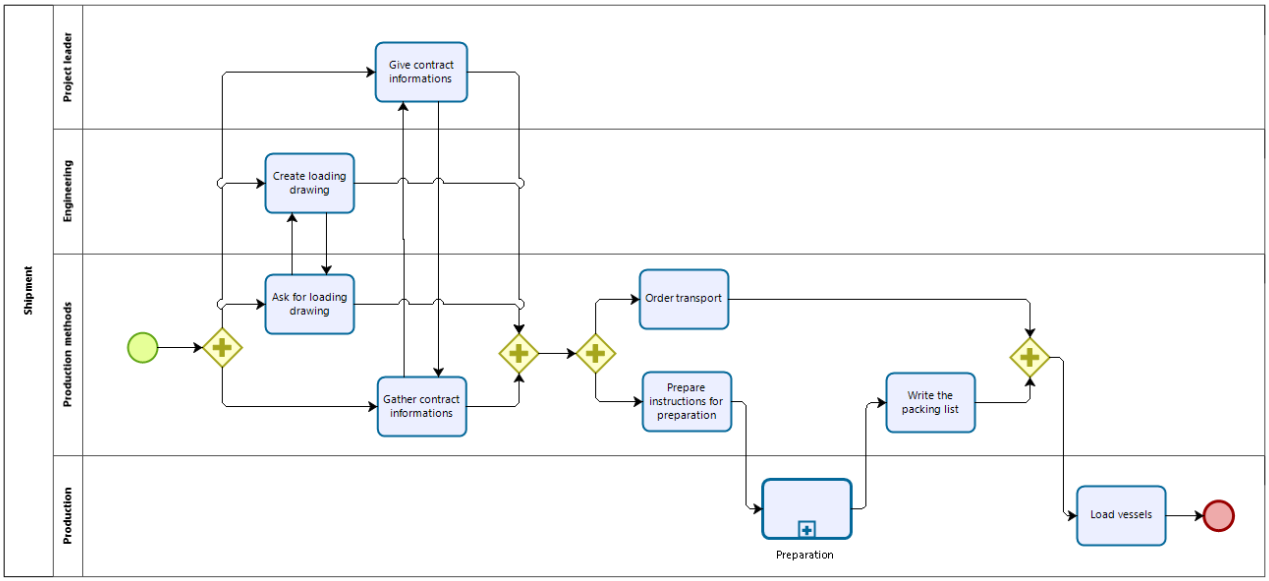
Manufacturing monitoring has to avoid time slides or high manufacturing costs. This process involves the prodcution methods department and both workshop leaders.



The monitoring is made weekly so the production methods department responsible can give an alert about planning slides, productivity or any other information during the coordination meeting happening each Monday. This meeting involves every department responsible and all project leaders. If problems appear, we should find solutions during this meeting.

4.2.4. Expedition

When I joined the company, shipment was not monitored and there was a lot of mistakes and misunderstanding between the methods department, operators in charge of loading vessels, truck drivers and customers. For these reasons, we decided to establish a clear process.



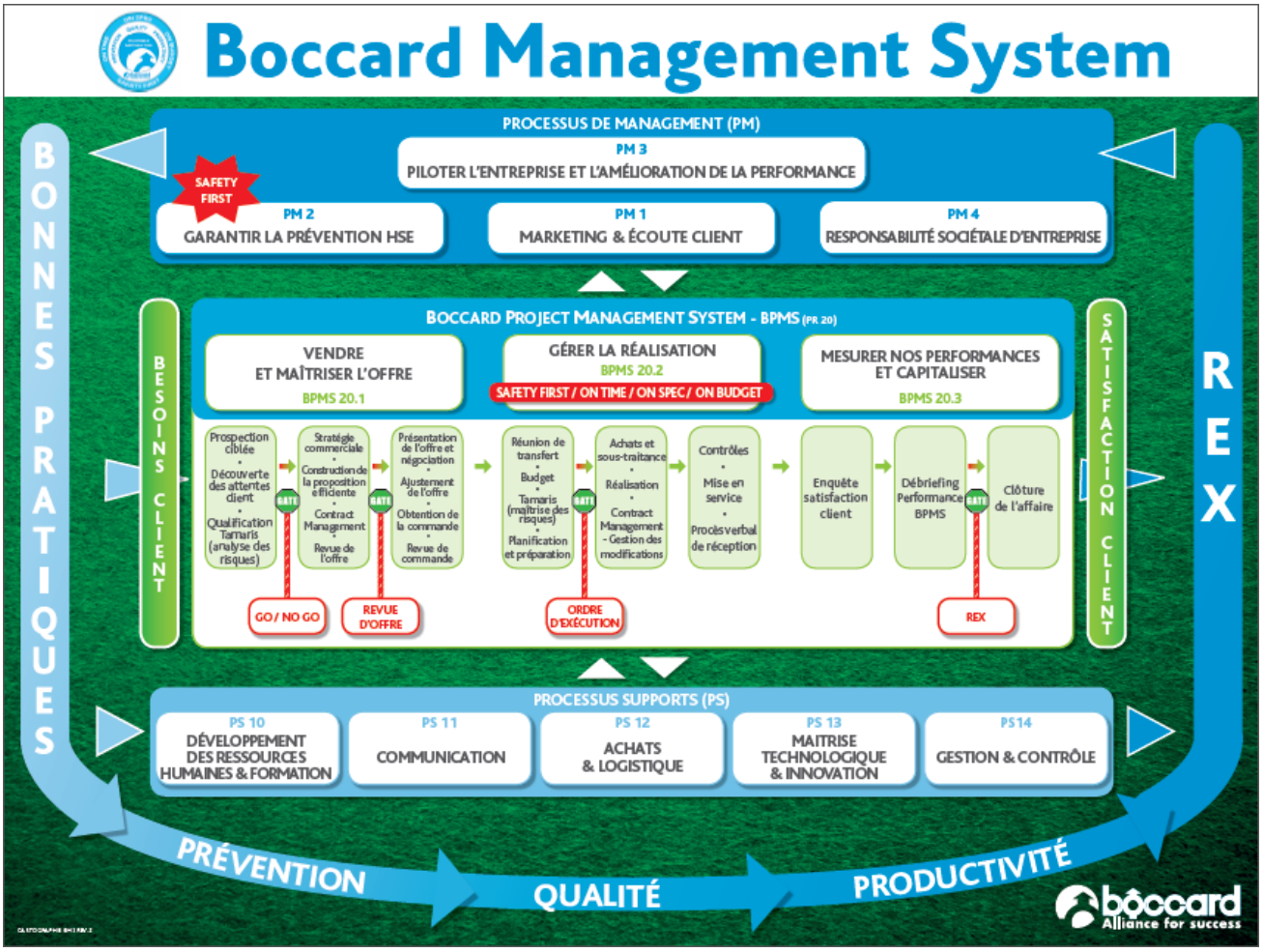
The production methods department (PMD) is in charge of this process and has to gather all needed informations. The PL gives contract informations (shipping address, time delivery, etc.) and the engineering department makes a loading drawing. To diminish the number of people involved, so to diminish the mistakes sources, the methods department order the truck instead of the supply department.

This department also creates a preparation procedure which is given to the operator in charge of shipments. This procedures tells which parts are equipped on the vessel or not and which ones are in a separated box.

Once the preparation is over, the PMD writes a packing list which is given to the driver and then to the customer.

4.2.5. Links with BMS

To unified processes inside of the whole company Boccard, we tried to realise a process mapping that goes well with the Boccard Management System.



The BMS is represented on a football pitch to show that all actors should go in the same direction, from customer requirements to customer satisfaction.

In the mapping we did, BPMS 20.1 is correspond to the offer and the rest to the BPMS 20.2. It is called “Gérer la réalsation” (monitore execution) which is exactly what PMD has to do.

Another important thing is the belief "Safety first, On time, On spec, On budget" because this statement concerns essentially the BPMS 20.2.

4.3. FMECA

During process mapping, I realised that a lot of tasks where achieved in bad conditions due to a lack of time. So I made a FMECA (Failure Modes, Effects and Criticality Analysis) to highlight the causes of all delays and to find solutions to act on those causes.

The principle of FMECA is to list all potential risks. We also try to find their causes and then we study ways to detect risks. Then we can create three indicators :

- Gravity (G) of their effects
- Frequency (F)
- Detectability (D)

Each indicator is rated on a scale from 1 to 10. Here after is a detail of the values to use.

Gravity	G grade
High delay on delivery date	10
Delay hard to overcome	5
Delay which could be balanced easily	1

Frequency or probability to occur	F grade
Always	10
Often	5
Impossible	1

Probability not to detect	D grade
Probability equal to 0	10
A detection system exists but is not sure	5
The detection system is certain	1

Once each indicator is rated, we compute a criticality indicator (C). In this case:

$$C = G * F * D$$

Depending on the value of the criticality criteria, we decide if an action is necessary. I chose the followings limits:

- C < 30: Unnecessary to act.
- 30 < C < 100: Necessary to act.
- C > 100: A solution should be found as soon as possible.

When it is necessary to act, we try to act first on the highest indicator.

The final FMECA is in appendix.

4.4. Actions and tools

Thanks to the observations report, to the analysis of process mapping and AMDEC, we saw four fields of actions:

- Human resources monitoring
- Manufacturing management
- Manufacturing monitoring
- Working standards

4.4.1. Human resources monitoring

One main cause of delay problems is human mistake. So our will is to monitore workshop workers to avoid mistakes. To do that, we will go in to directions. First, we would like to establish procedures. Having procedures ensure standards. The first two procedures we created are about material receipt and shipment.

Material receipt procedure

Reception of parts is something essential to ensure goog fundamentals for manufacturing. The lack of procedure is a big problem. In fact, the warehouse clerk takes delivery of all parts but he has no information about quality control.

The main problems are:

- Missing part (no quantity control)
- Damaged part (no quality control)

Example: *A project to manufacture 18 atmospheric vessels started in our workshop. On these vessels, some U-shaped sections are rolled up and welded around the vessel to hold the insulation shell. Two packages of near dimensions arrived at the same time. The supplier made a mistake in the number of section of each dimension. Since the diameter was not verified when we received them, the mistake was discovered at the moment they had to be welded. This caused a stop in the manufacturing process of two vessels during two weeks. This delay could have been avoided if we had discovered the mistake when the sections arrived almost three weeks earlier.*

Most of the time, operators discover problems when they need the parts. This generally creates a delay and then a money penalty. Our goal is to create a procedure to tell the warehouse clerk what he has to do depending on the part he receive.

This procedure is in appendix.

Shipment procedure

Regarding shipments, a procedure is needed to avoid misunderstanding and apply strict rules given by engineering department. Mistakes are always due to the truck driver or the person who load the vessel on the truck because they have no clear information.

Example: *During the loading of a vessel, a pipe which was on the side of the vessel should have been placed on the top to diminish the thickening of the truck. When they loaded, the shipment drawing was not uploaded and the pipe was not drawn. Moreover, even if the workshop leader tell the driver to turn the vessel, the vessel stayed on the truck with the pipe on the side. In fact, the driver was late and he wanted to go. When he arrive at the highway toll, the pipe hurted the installation and caused a lot of damages on the vessel and on the installations.*

This mistake could have been prevented if the drawing was corret and if a clear procedure told to verify the thickening of the truck.

The aim of this procedure is to disallow the driver to take any responsability. Even if he could give advice, no last minute changes should occur.

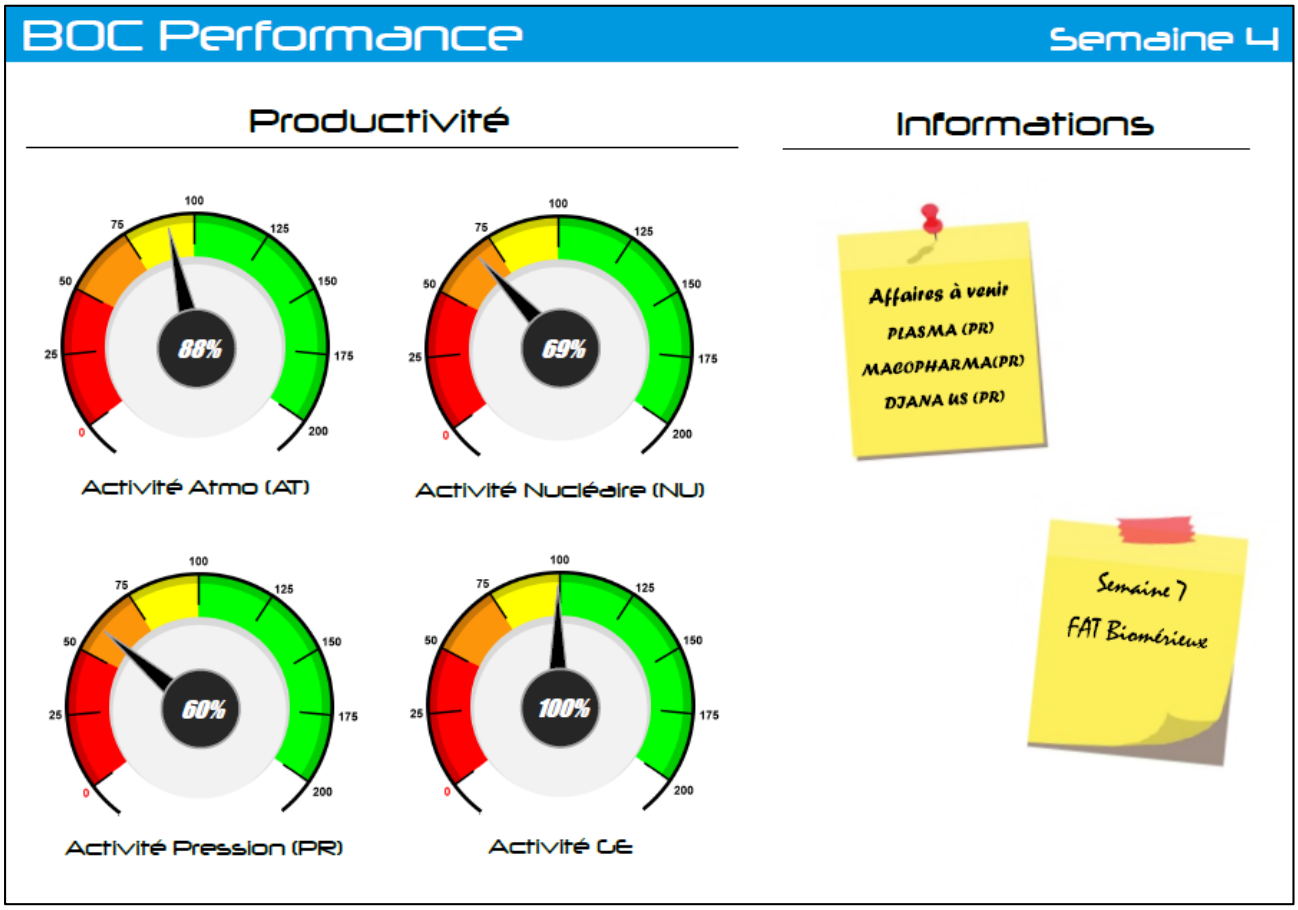
The shipment procedure is in appendix.

Staff involvment

The way operators care about their work is also really important. When staff is really involved, they can have a critical eye on what they do. Then, they can give advice for next vessels. They can also detect mistakes in drawings or documents they have.

To increase the interest of the staff, we worked on two things. The first decision was to involve operators in the pre-manufacturing process. So, the boilermaker in charge of a vessel is invited to the technical meeting. During this meeting, the drawing is studied to verify if customer requirements are respected. The operator can also give advices to make easier the manufacturing of the vessel.

The second thing is to communicate informations weekly about performance. So they can see if their work is good or not, or at least if it match what we expect of them. We also give them information about future projects or big events to come. The following display is set each week in the workshop.

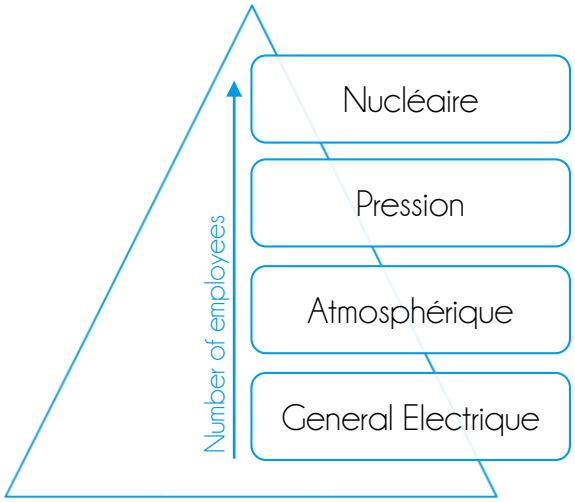


4.4.2. Manufacturing management

Main actions to lead are about project management. Even if the process seems to be clear, it is necessary to create tools to make the tasks easier.

Workload management

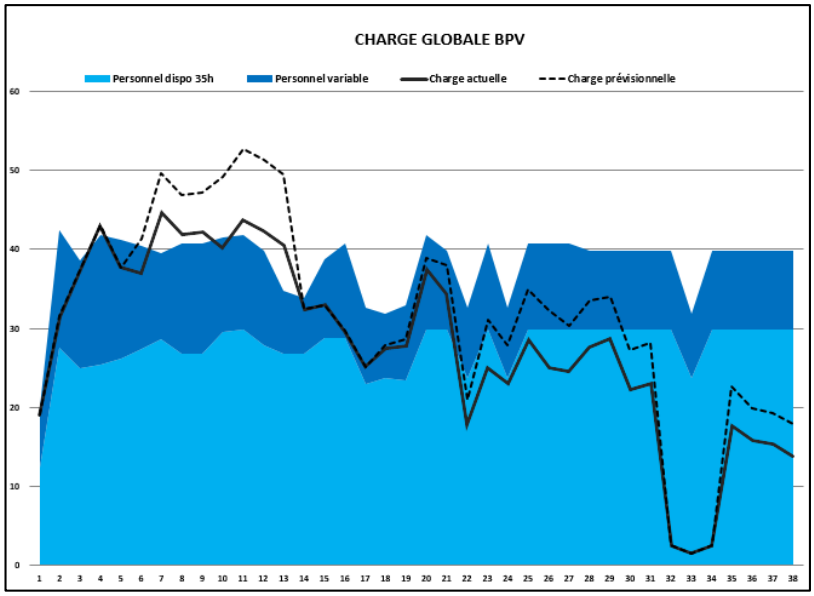
Before my internship, the workload was monitored only on the whole workshop without difference between fields of activity. Nevertheless, skills needed to manufacture a vessel are highly different depending on the vessel (pressurized or atmospheric). Differences of thickness, quality, assembly and know-how make difficult the skilfulness of all operators. The need of skills is summarized in the following diagram.



We decided to manage the workload depending on the four types of vessels, it also allows us to manage skills.

So we have five graphics of workload (a global one and one for each activity). Those graphics are linked to a macro planning. We have a black line which represents the workload and a pointed line which represents the workload with potential future projects. With these two lines we can tell the offer responsible about potential delivery delay. In the background, both colors represent workers and temporary workers.

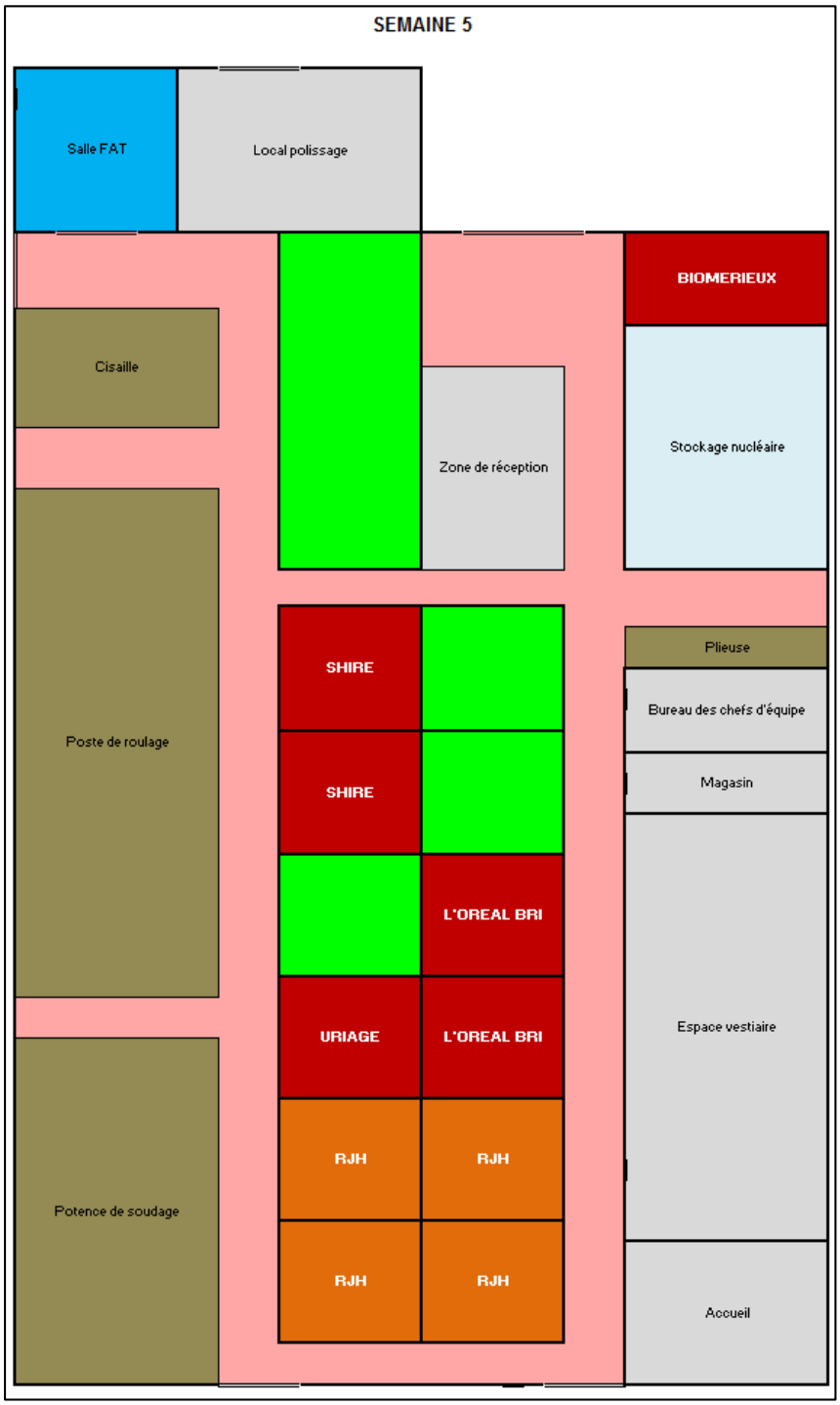
The following graphics, which was the only one at the beginning, is now divided in four sub-graphics.



Space management

It is essential to manage human resources but we should also be careful with other resources. So I chose to develop a tool to manage the workshop floor organisation.

In fact, when the workload is really high, if vessels are quite big, we could miss space. This plan is made to monitore the space four weeks in advance to ensure there is always enough space to manufacture each vessel.



Detailed planification

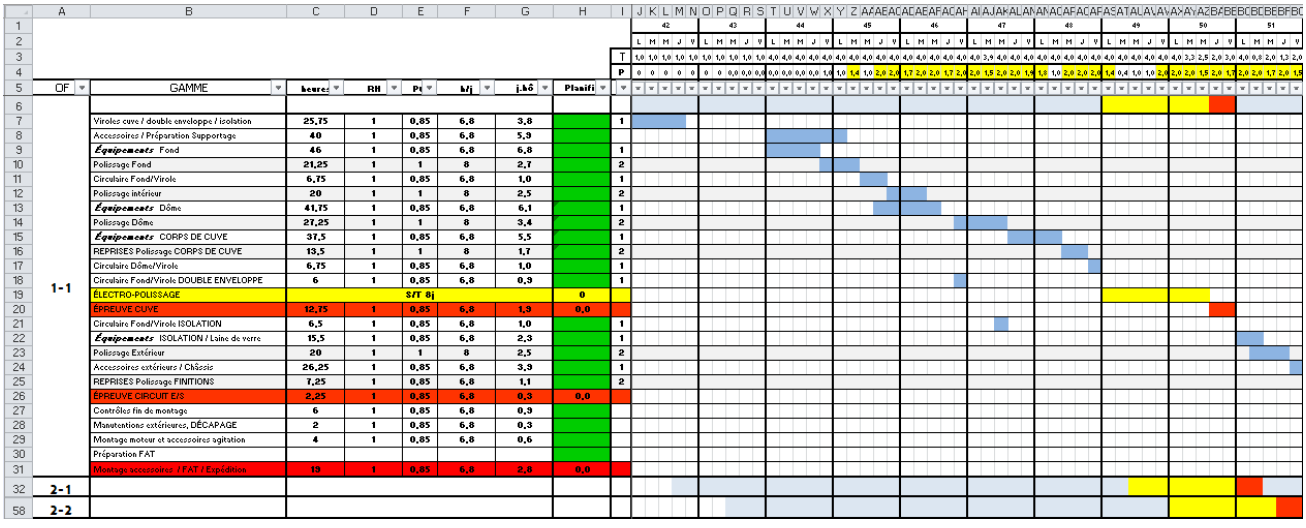
The main aspect of management is planification. At my arrival, I worked on a more detailed planification. Before, manufactured was planned weekly depending on the manufacturing sequence without taking skills into account.

Example: *During manufacturing, polishing occurs punctually in the middle of the assembly. When the workload is managed weekly and without taking skills into account, it is impossible to predict if the polishing workload will be too high. If the overload is not predicted, all vessels could have to be polished at the same time. Then, polishing workshop is not big enough and there is no more work for boilermakers.*

Our goal is to detail the planification daily to have a better view of the future workload. We also separated the tasks of polishing and boilermaking. The advantages are:

- A better workload management: it is possible to know exactly the number of people day by day and to anticipate load picks to smooth the workload.
- A better precision for subcontractors: we can work more efficiently with subcontractors in terms of delivery time.
- A better monitoring: we can easily see any slide or delay in the manufacturing phase and measure it.

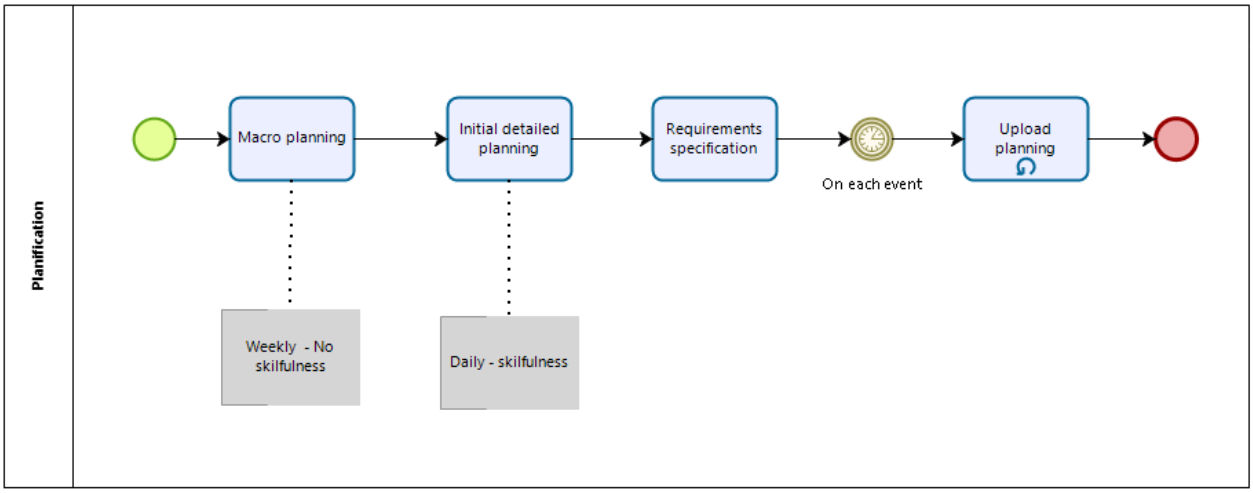
Today, this planification is done with Excel© as we can see on the following picture. Our goal is to do it with Microsoft Project© because the new ERP is linked with Project©. This would allow us to automate requirements specification.



OF	GAMME	heures	RH	Pt	h/j	j-hô	Planifi
1-1	Viroles cuve / double enveloppe / isolation	25,75	1	0,85	6,8	3,8	
	Accessoires / Préparation Supportage	40	1	0,85	6,8	5,9	
	Équipements Fond	46	1	0,85	6,8	6,8	
	Polissage Fond	21,25	1	1	8	2,7	
	Circulaire Fond/Virole	6,75	1	0,85	6,8	1,0	
	Polissage intérieur	20	1	1	8	2,5	
	Équipements Dôme	41,75	1	0,85	6,8	6,1	
	Polissage Dôme	27,25	1	1	8	3,4	
	Équipements CORPS DE CUVE	37,5	1	0,85	6,8	5,5	
	REPRISES Polissage CORPS DE CUVE	13,5	1	1	8	1,7	
	Circulaire Dôme/Virole	6,75	1	0,85	6,8	1,0	
	Circulaire Fond/Virole DOUBLE ENVELOPPE	6	1	0,85	6,8	0,9	
	ÉLECTRO-POLISSAGE			srt aj			0
	ÉPREUVE CUVE	12,75	1	0,85	6,8	1,9	0,0
	Circulaire Fond/Virole ISOLATION	6,5	1	0,85	6,8	1,0	
	Équipements ISOLATION / Laine de verre	15,5	1	0,85	6,8	2,3	
	Polissage Extérieur	20	1	1	8	2,5	
	Accessoires extérieurs / Châssis	26,25	1	0,85	6,8	3,9	
	REPRISES Polissage FINITIONS	7,25	1	0,85	6,8	1,1	
	ÉPREUVE CIRCUIT E/S	2,25	1	0,85	6,8	0,3	0,0
	Contrôles fin de montage	6	1	0,85	6,8	0,9	
	Manutentions extérieures, DÉCAPAGE	2	1	0,85	6,8	0,3	
	Montage moteur et accessoires agitation	4	1	0,85	6,8	0,6	
	Préparation FAT						
	Montage accessoires / FAT / Expédition	19	1	0,85	6,8	2,8	0,0
2-1							
2-2							

As we can see on the example, planification is based on a Gantt diagram where subcontractors tasks are highlighted (e.g Electropolissage = Electrolytic polishing). In the upper part, the number of polishing men and boilermaker is counted to be sure we don't use more resources than available ones.

The planning process is the following:



Subcontractors monitoring

We have a lot of subcontractors along the manufacturing process. They execute mainly polishing tasks or standard compliance tests. Those steps could happened in our workshop or in another company. All these cases should be monitored so subcontractors can intervene in time and in good conditions. Our belief is to be totally transparent with them. By exchanging informations we can organise each intervention to fully integrate the subcontractors in the manufacturing process.

To do so, we share as soon as possible our future projects with subcontractors. In this way, we can know their workload and the delivery time they can perform. Thos informations change along the process and we monitore each task till it is finished.

What we want is to standardize the sharing step with subcontractors by a simple planning with their tasks only. The aim is to erase any misunderstanding risks.

4.4.3. Manufacturing monitoring

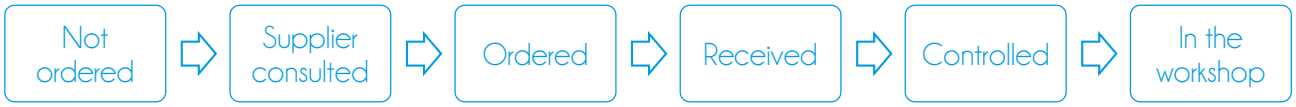
Supply monitoring

Today, supply is the first source of production shutdown. This has a strong impact on time delivery. Productivity is also damages because people wait for parts they don't have.

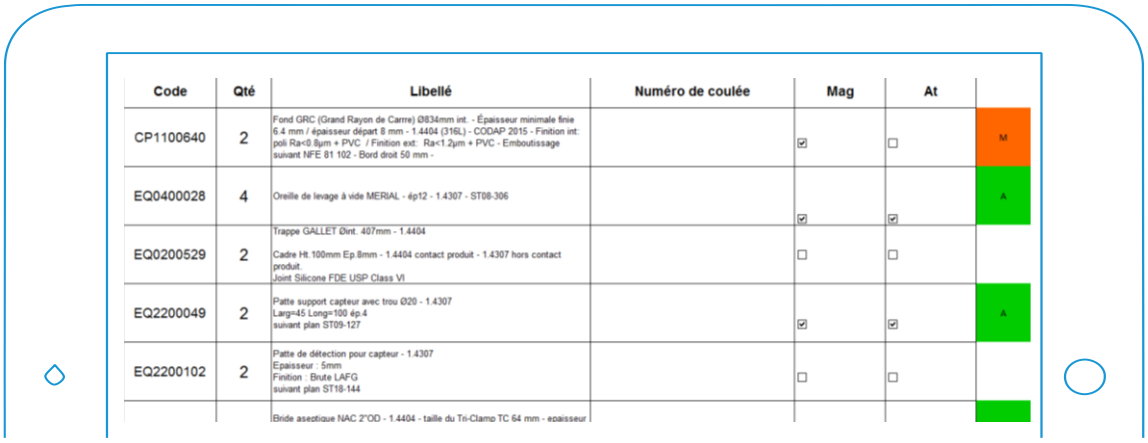
Moreover, regarding parts reception, the clerk receive the bill of material on paper at the beginning of the project. If the bill of materials change, he has no clue.

Example: *A 5-pharmaceutic vessels project should have started during week 45. After a contract problem, the start of the manufacturing process was delayed of four weeks. Those four weeks allowed us to get all parts before the beginning. Finally, the vessels were made very fast because therewas no stop. Vessels were ready two weeks before Final Applyance Test (FAT). This shows that if we have all parts when needed, the production goes well.*

So we decided to create a tool to check supply state of each part. This tool is a simple Excel© sheet with the Bill of Materials taken from the ERP and uploaded each time the table is open. Then the warehouse clerk can tick columns to see which state is done or not. The steps are these ones:



The production methods department can follow each part in the supply process and be sure that each part is here when needed. We can also alert the supply department if we see a slip in the delivery time.



Code	Qté	Libellé	Numéro de coulée	Mag	At	
CP1100640	2	Fond GRC (Grand Rayon de Carre) Ø834mm int. - Épaisseur minimale finie 6.4 mm / épaisseur départ 8 mm - 1.4404 (316L) - CODAP 2015 - Finition int: poli Ra<0.8µm + PVC / Finition ext: Ra<1.2µm + PVC - Emboutissage suivant NFE 81 102 - Bord droit 50 mm -		☑	☐	M
EQ0400028	4	Oreille de levage à vide MERIAL - ép12 - 1.4307 - ST08-306		☑	☑	A
EQ0200529	2	Trappe GALLET Øint. 407mm - 1.4404 Cadre Ht.100mm Ep.8mm - 1.4404 contact produit - 1.4307 hors contact produit. Joint Silicone FDE USP Class VI		☐	☐	
EQ2200049	2	Patte support capteur avec trou Ø20 - 1.4307 Larg=45 Long=100 ép.4 suivant plan ST09-127		☑	☑	A
EQ2200102	2	Patte de détection pour capteur - 1.4307 Epaisseur : 5mm Finition : Brute LAFG suivant plan ST18-144		☐	☐	
		Bride aseptique NAC 2"OD - 1.4404 - taille du Tri-Clamp TC 64 mm - epaisseur				

Performance monitoring

Initial performance monitoring was based on:

- Delay at the end of the project
- Respect of production hours allocated to the project

The delay on intial delivery date is observed at the end of the project which it has no sense. The excess of hours is computed weekly depending on manufacturing progress and time spent. This indicator presents a problem if we want to compare two projects.

Example: *This table shows a computation example*

Project	Manufacturing progress in hours	Hours spent	Difference
X	6	31	25
Y	2183	2288	105

During coordination meeting, the production methods responsible announces that for project X, 25 hours were lost, and for project Y, 105 were lost. With this indicator, we may think that project Y is more critical than project X.

So we decide to change both indicators to give them more sense. The two new indicators are the followings:

- Estimated delay at the end of the project
- Productivity

The estimated delay (or advantage) is computed depending on planned start and end dates and on the progress. Nevertheless, delay is based on a linear theoretical progress which is not always fully true. This indicator shall evolve again in the future.

Productivity is computed based on hours spent and hours realised (depending on the progress). It is a simple yield. In this way, the indicator has more sense when we have to compare two projects.

Example:

Project	Realised hours	Spent hours	Productivity
X	6	31	19% (6/31)
Y	2183	2288	95% (2183/2288)

Global monitoring tool

Before, PDM did not have a single monitoring tool but a lot of tools for progress, time check, performance monitoring, etc. The data was copied from a table to another weekly. This represented a high workload and a huge source of mistakes.

We decided to create a single global tool. This tools collects all the necessary data to compute indicators. Workshop leaders have to notify their progress each Friday depending on the manufacturing sequence.

To automate the computation, the production responsible wanted to have a computerized pointing instead of a sheet of paper for each worker. This makes our work easier because the tool gather all the data from pointing and progress.

Then the PDM has access to a main file where the first sheet shows the state and indicators of each vessel.

Ajouter une ligne suivant la gamme → Cuve/AG | STW

SUIVI DE PRODUCTION S 7

Clients	Code HERAKLES	Temps Gamme	Temps CAF	Temps consommé		Temps restant		Avancement physique		Reste	Théorique	Prod	Budget	Projection fin d'affaire
BIOMERIEUX	18000055/1-1	397,75	382,0	326,55	82,10%	71,20	17,90%	100,00%	382,00	0,00	116,05%	OK	IN	55,45
BIOMERIEUX	18000055/1-2	397,75	382,0	302,13	75,96%	95,62	24,04%	82,16%	313,86	68,14	75,00%	OK	IN	11,73
BIOMERIEUX	18000055/2-1	397,75	382,0	318,80	80,15%	78,95	19,85%	100,00%	382,00	0,00	116,05%	OK	IN	63,20
BIOMERIEUX	18000055/2-2	397,75	382,0	336,30	84,55%	61,45	15,45%	100,00%	382,00	0,00	116,05%	OK	IN	45,70
BIOMERIEUX	18000055/2-3	397,75	382,0	338,63	85,14%	59,12	14,86%	100,00%	382,00	0,00	75,00%	OK	IN	43,37
BIOMERIEUX	18000055-3	295,50	277,0	231,50	78,34%	64,00	21,66%	100,00%	277,00	0,00	84,21%	OK	IN	45,50
BIOMERIEUX	18000055-4	313,50	265,0	11,00	3,51%	302,50	96,49%	0,00%	0,00	265,00	26,42%	BAD	IN	-11,00
PEP CECAB	PJL372-01	481,25	505,0	27,50	5,71%	453,75	94,29%	8,84%	44,66	460,34	55,56%	OK	IN	17,16
PEP CECAB	PJL372-02	417,50	384,0	24,25	5,81%	393,25	94,19%	9,74%	37,40	346,60	51,14%	OK	IN	13,15
AG/PJL372-02		61,75	83,0	0,00	0,00%	61,75	100,00%	80,37%	67,21	15,79	36,00%	OK	IN	67,21
PEP CECAB	PJL372-03	1070,00	1412,0	106,25	9,93%	963,75	90,07%	31,73%	1295,16	116,84	84,21%	OK	IN	1188,91
PEP CECAB	PJL372-04	872,25	1047,0	100,50	11,52%	771,75	88,48%	79,79%	835,42	211,58	69,47%	OK	IN	734,92
AG/PJL372-04		185,25	234,0	0,00	0,00%	185,25	100,00%	80,37%	189,47	44,53	83,33%	OK	IN	189,47
PEP CECAB	PJL372-05	218,50	233,0	19,75	9,04%	198,75	90,96%	92,32%	215,10	17,90	108,11%	OK	IN	195,35
PEP CECAB	PJL372-06	1172,25	1101,0	119,00	10,15%	1053,25	89,85%	49,08%	540,34	560,66	67,05%	OK	IN	421,34
AG/PJL372-06		185,25	234,0	0,00	0,00%	185,25	100,00%	80,37%	189,47	44,53	80,68%	OK	IN	189,47
PEP CECAB	PJL372-08	302,00	212,0	25,00	8,28%	277,00	91,72%	82,86%	175,67	36,33	108,11%	OK	IN	150,67
PEP CECAB	PJL372-09	1255,00	1115,0	130,00	10,36%	1125,00	89,64%	20,58%	229,52	885,48	50,98%	OK	IN	99,52
AG/PJL372-09		238,00	272,0	0,00	0,00%	238,00	100,00%	80,25%	218,29	53,71	79,49%	OK	IN	218,29
PEP CECAB	PJL372-10	326,75	292,0	51,75	15,84%	275,00	84,16%	17,77%	51,89	240,11	59,09%	OK	IN	0,14
AG/PJL372-10		59,50	68,0	0,00	0,00%	59,50	100,00%	80,25%	54,57	13,43	124,00%	OK	IN	54,57
SHIRE	18000072-01	503,25	427,0	558,40	110,96%	-55,15	-10,96%	81,28%	347,07	79,93	64,20%	BAD	OUT	-211,33
SHIRE	18000072-02	455,00	385,0	503,00	110,55%	-48,00	-10,55%	85,19%	327,97	57,03	64,20%	BAD	OUT	-175,03
SHIRE	18000072-03	474,50	420,0	560,50	118,12%	-86,00	-18,12%	82,26%	345,49	74,51	64,20%	BAD	OUT	-215,01
L'ORÉAL BRI	18000123-01	606,50	525,0	241,50	39,82%	365,00	60,18%	27,25%	143,07	381,93	30,43%	BAD	IN	-98,43
AG/18000123-01		230,00	320,0	50,50	21,96%	179,50	78,04%	10,59%	33,88	286,12	35,23%	BAD	IN	-16,62

This sheet gives a global idea of the production. Then, there is a detailed sheet for each vessel for advanced researches in case of problem.

Exécuter — **GAMMES**

Clients	N° Affaire	NB		Titre	Temps	%	Temps consomé		Avancement réel	CUVE 1	Temps Restant
L'ORÉAL BRI	18000123-01	1	0027	Atelier Cintrage / Soudage Banc Plasma	23,50	4%	22,75	97%	100,00%	100,00%	0,75
			0029	Accessoires / Préparation Supportage	54,75	9%	3,00	5%	50,00%	50,00%	51,75
			0030	Équipements Fond	51,50	8%	54,25	105%	100,00%	100,00%	-2,75
			0031	Polissage Fond	29,75	5%	15,00	50%	100,00%	100,00%	14,75
			0032	Équipements Dôme	55,25	9%	71,25	129%	60,00%	60,00%	-16,00
			0033	Polissage Dôme	30,75	5%	0,00	0%	0,00%	0,00%	30,75
			0035	Amarage / Soudage circulaire	23,00	4%	0,00	0%	0,00%	0,00%	23,00
			0036	Montage agitation/Contre pales	17,25	3%	0,00	0%	0,00%	0,00%	17,25
			0037	Montage CLIM/ Coquilles	30,50	5%	26,75	88%	0,00%	0,00%	3,75
			0038	Équipements CORPS DE CUVE	104,75	17%	4,25	4%	0,00%	0,00%	100,50
			0039	Montage ISOLATION/ ACCESSOIRES	79,00	13%	2,00	3%	0,00%	0,00%	77,00
			0040	Polissage INT/EXT cuve	71,75	12%	0,00	0%	0,00%	0,00%	71,75
			0041	Contrôle/Montage accessoires / FAT / Expé	34,75	6%	19,25	55%	0,00%	0,00%	15,50
			0042	Préparateur/Chef Équipe/Contrôle			21,00	40%	27,25%	27,25%	365,00
		100,00%		Temps GAMME	606,50	100%	241,50				
AG			0043	Agitation	121,75	53%	50,50	41%	20,00%	20,00%	71
			0044	Polissage agitation	58,25	25%	0,00	0%	0,00%	0,00%	58
			0045	Montage moteur agitation	50,00	22%	0,00	0%	0,00%	0,00%	50
				Temps GAMME	230,00	100%	50,50	22%	10,59%	10,59%	180

4.4.4. Working standards

Finally, we set some good practices to improve the global way of working of the company.

Feedbacks

Feedbacks (Retour d'Expérience = REX) were standardised by the student project group of INSA. Nonetheless, feedbacks meeting never occur. In fact, this takes a long time, a time we don't always have. So feedbacks are not collected and the same mistakes happen again.

Example: *During my internship, there was two projects of 20 atmospheric vessels each. During the first project there was a lot of mistakes in the design of the vessels and also during the manufacturing process. The quality department highlighted many points. But no feedbacks meeting took place to analyse each point. Consequently, same mistakes happened for the second project.*

Warnings

A warning tool was created by another intern from INSA. This tool gather all milestones of a project, established during the transfer meeting. The tool gives weekly warnings to each department. This allows each project leader to monitore his project.

Liste des Taches Hebdomadaire A Faire ou En retard

Service: BE — **Semaine 7**

Réalisable?	Client	PJ	OF	Tache	Délais	Priorité	Avancement 0%	50%	100%
A faire RETARD	L'OREAL VICHY	PI18000191	OF1	Revue technique des plans d'ensemble	11/01/2019				
			OF2		11/01/2019				
			OF3	Envoi fiche de tôle au Client par CAF	21/12/2018				
			OF4		21/12/2018				
	NAOS	PI18000147	OF1	Note de calcul	04/02/2019				
			OF2		04/02/2019				
			OF3		04/02/2019				
	PLASMA INDUSTRIE	PI19000001	OF1	Réalisation des plans d'ensemble pour BPA	01/02/2019				
	L'OREAL BRI	PI18000123	OF1	Note de calcul	28/11/2018				
			OF11	Réalisation des plans de detail et nomenclature générale	07/12/2018				
			OF2	Note de calcul	28/11/2018				
			OF21	Réalisation des plans de detail et nomenclature générale	07/12/2018				
	NATUREX/DIANA US	PI19000002	OF1	Plan de détails et Nomenclature du reste des Achats	21/01/2019				
				Revue technique des plans d'ensemble	01/02/2019				
A faire	L'OREAL VICHY	PI18000191	OF10	Calcul encre IDT a faire (valider)	06/02/2019				
	MACOPHARMA	PI19000015	OF1	Réalisation des plans d'ensemble pour BPA	06/02/2019				
	PLASMA INDUSTRIE	PI19000001	OF2	Réalisation des plans d'ensemble pour BPA	08/02/2019				
			OF3	Envoi fiche de tôle au Client par CAF	08/02/2019				
			OF4		08/02/2019				
	RIH	PI1312	Tous	Mise à jour note de calcul + Plan de descente de charge + plan d'ensemble Selon FNC-994	15/02/2019				

Each Monday, project leaders check if all due tasks are done.

5. Results and options for improvement

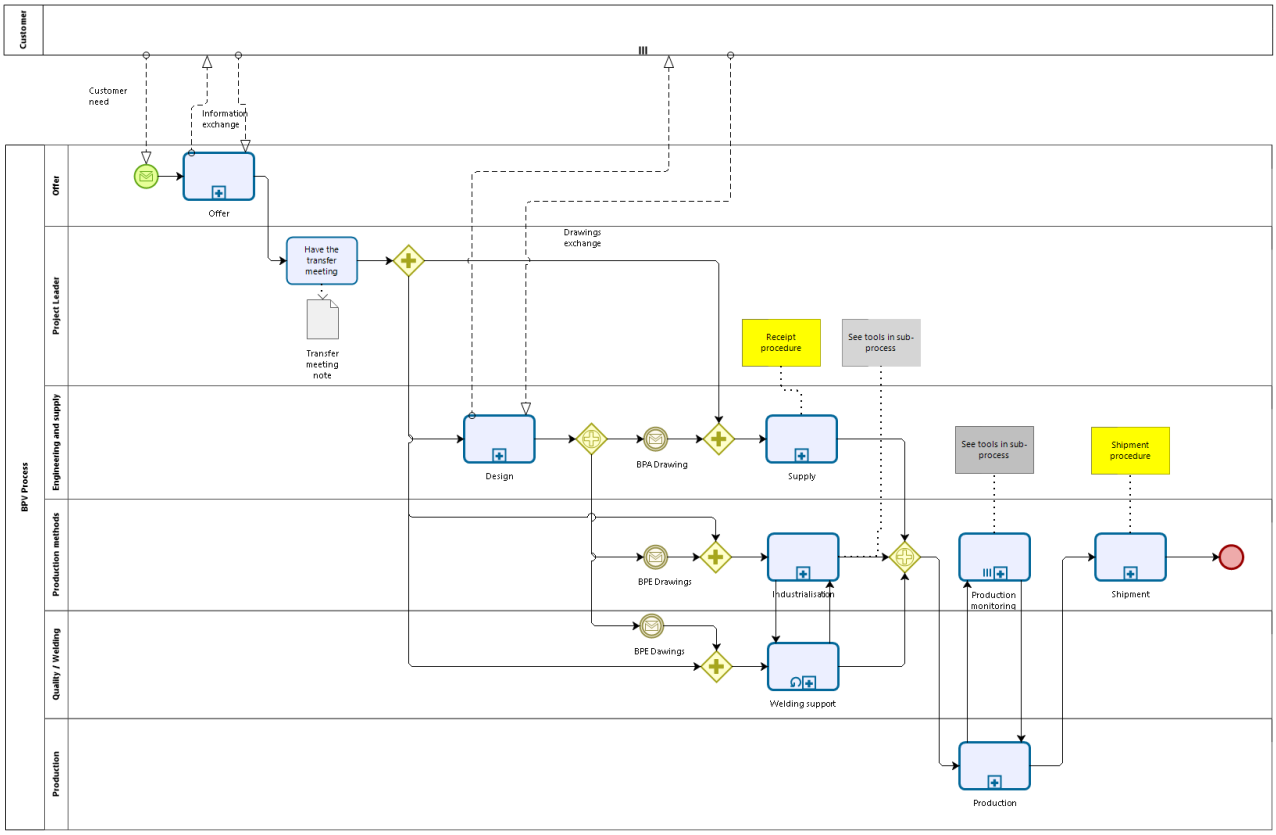
5.1. End of assignement results

Main assignement

The work I did during my thesis was only a first step to lighten the situation and create the production methods department. In fact, no results in time gains or money savings can be observed. All tools are not working and some others have to be created.

Nevertheless, we can observe good improvements in the organisation. For example, workload monitoring is really useful to evaluate risks and act to prevent them.

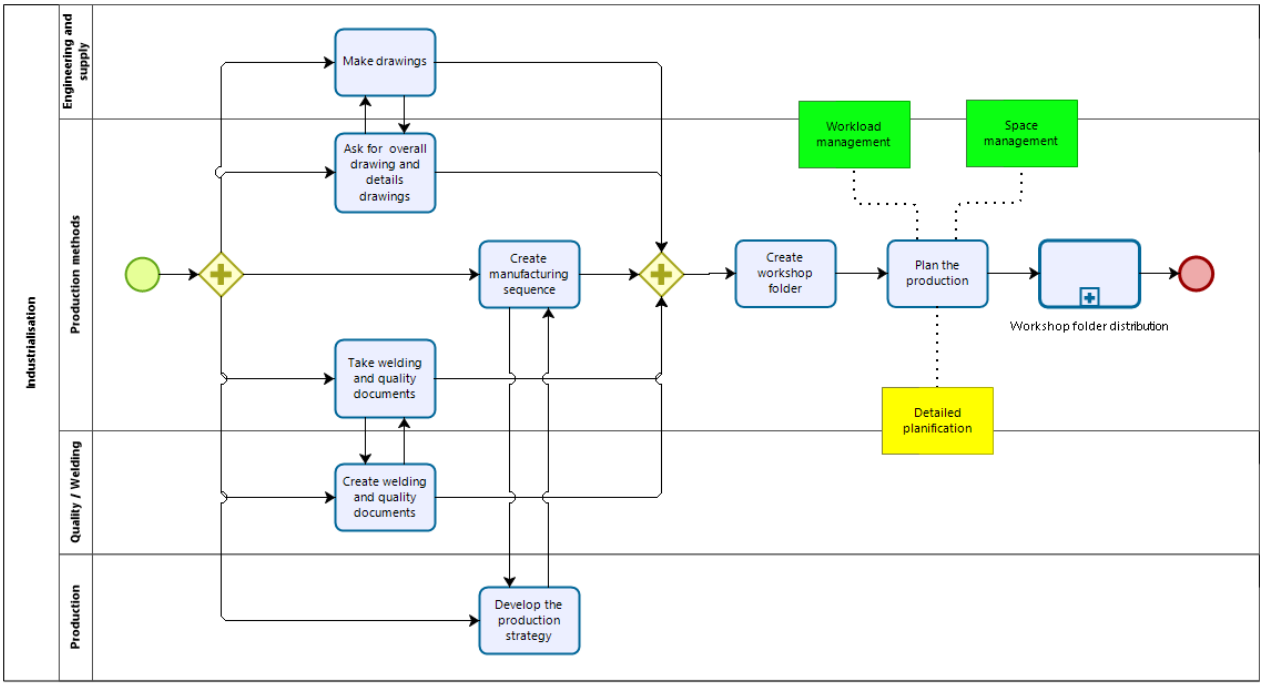
The following diagrams show each tools on the main processes and their current state. Tools already working are in green, tools currently developed are in yellow and tools to be created in red.



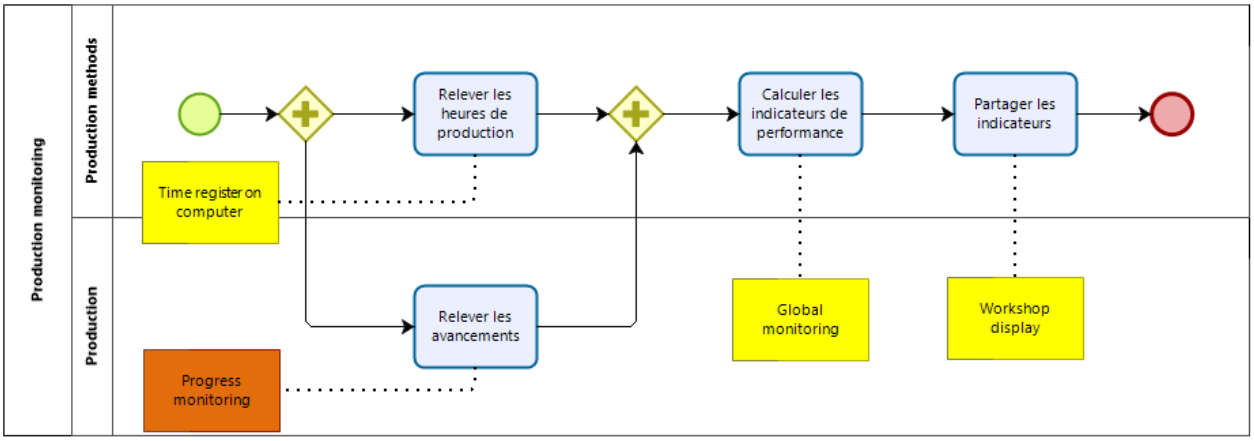
As we can see on global level, most of tools support the post design steps. The other INSA intern manage the upper part, before design.

The reception procedure, even if it is linked to the supply step, it helps any departments who wishes to monitore supplies.

The shipment sub-processus is totally managed by the shipment procedure.



Regarding industrialisation, we worked a lot on planning. This takes into account work sequences, detailed planning and workload management. Those tools make us earn time because we can monitore more precisely. Moreover the processus makes more sense because of the skilfulness aspect and the slicing in different activities.



Manufacturing monitoring also changed a lot. Indicators were modified and we now have a single monitoring tool. We are currently developing those tools to automate as much as possible data collection.

Other tasks

Results regards also the projects I monitored during my internship. I monitored four projects.

The first one (Unither, laboratory), was at manufacturing step at the beginning of my stage and was finished with a one week delay. It was arranged with the customer who was really satisfied with the quality of vessels.

The second one was a 7 vessels project for Biomérieux (Pharmaceutics). I monitored this project from transfer meeting to shipment. This project was a success for the company because the productivity was higher than 100%, this means a higher profit.

Another project I monitored from start to end, was the manufacturing of a tank for Uriage, a cosmetic company. This order was quite usual and presented no problems.

Finally, the last case was a 3 pressurized tanks project for Shire (Pharmaceutics). This project was a test for Boccard and the delivery time required was 9 weeks instead of 13. We set an action plan and boilerworkers worked with a day shift during critical step of production. Finally, the time delivery of 9 weeks was respected.

Regarding the monitoring tasks, the company has no peculiar expectations from me. The main goal was to teach me how to do it and to look with a critical eye on practices.

5.2. Options for improvement

As we saw it, the creation of clear and efficient processes is a long term work and my main assignement is far from over.

At medium terme, many impovements shall arrive in the production methods department to improve the work quality and the global organisation of the company. The long term goal is to develop a boilermaking factory 4.0. This is the will of Boccard to make the Le Coteau plant a showcase of know-how and skilfulness of the whole group. First, it is necessary to work on solid foundations and principally on resources. Then, the business unit responsible wants to lead a lean project.

Statement of the skills available

The first thing we did to take skilfulness into account is to slice the workshop in four (nuclear, pressurized, atmospheric, GE). This is a simple a way of working with skills but it was essential to make sense.

Nonetheless, we shall go further in managing skills. A future goal is to make a full assessment of skills. We should be able to know exactly what each worker is able to do or not. Finally, some people can also work on pharmaceutics vessels but only for some steps of the manufacturing phase so it should be taken into account.

Moreover, boilermaking requires a lot of experience. So, we need to be very attentive to the loss of skills when workers retire. Nevertheless, the GE contract is a good opportunity to teach young boilermakers because vessels are always the same and they can practice a lot.

Finally, the skills problem is linked with the wil of the comany to move from atmospheric to pressurized vessels. Standards are more complex in this fiels. This strategy will make merge the two workshops in a near future so every worker shall be able to make pressurized tanks.

Machines

Material resources are also a key to success. At the end of my internship, I could follow the installation of a welding robot which weld a GE vessel in 20 minutes instead of a day of work (8 hours) for a man.

But some homemade machines are becoming outdated and have to be modified to answer better our needs. We shall also create new ones. Our will is to automate some hard tasks where there is no need of skills. An example is the welding of insulation shells.

So we have to make an assessment of all material resources to know what we have, what we should modify and what we need to buy.

Lean project

Boilermaking is mainly a handcraft work and this presents a lot of inconvenients in terms of organisation.

Our director's will is to automate and standardise as much as possible to reduce the manufacturing time. The aim is to reduce costs and to increase customer satisfaction. This project is also an opportunity to develop new performance indicators that make more sense.

Finally, we would like to involve more the workshop leaders. The main goal is to reallocate each task to the right person or right department. The main tasks to reallocate are listed in the following table.

Tasks	Department currently in charge	Department to be in charge
Requirements statement	Engineering	Production Methods
Collect workshop data	Production Methods	Workshop leaders
Production management	Production Methods	Workshop leaders

As we can see, we would like to give the Production Methods Department more time to think about how we produce. We want to avoid any loss of time due to specific problems in workshops.

The second goal is to involve workshop leaders. The involvement they should have will be translated with display of indicators in each production space with more detailed than on the principal display. We can also imagine new display panels like TVs to reduce paper use that represents a lot of problem (loss, updates, etc.)

6. Personal review

The internship was a really good experience on personal plan. People I work with along my journey fully integrated me in their team and trusted me. In this way, it made myself really happy and I did my best by applying my knowledge.

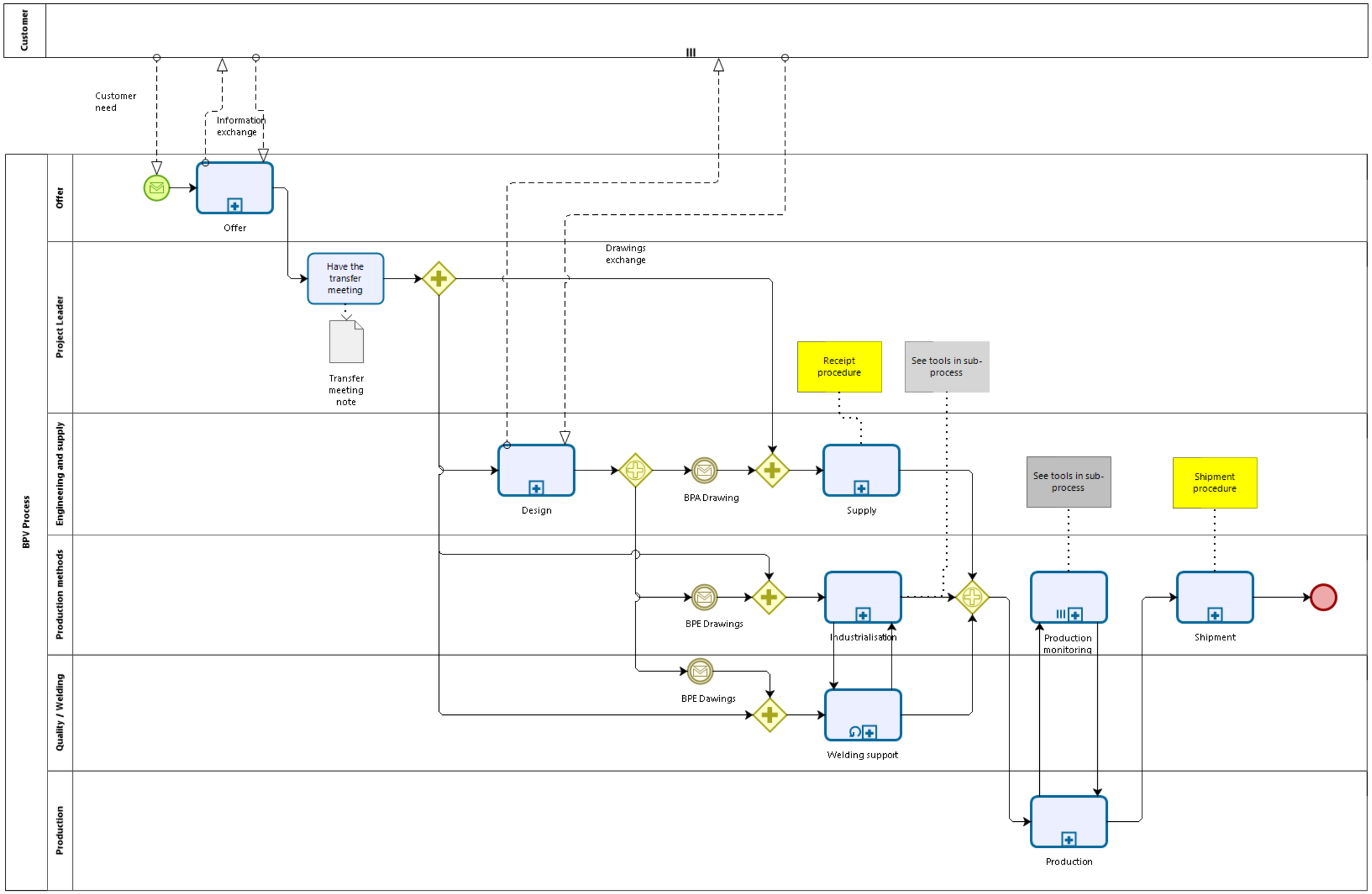
The best thing for me was the level of responsibility I had. Other workers treated me like any other team member and not as an intern.Sometimes I had to be more confident and to push myself to the forefront. This was a real ordeal at the beginning because I was used to work alone. Anyway, I learnt how to collaborate efficiently with my colleagues and I appreciated that a lot. This thesis is a success because I could share my ideas and be part of the work force.

Regarding learning, the internship was really important. I could apply my Industrial Engineering knowledge in terms of planning and make it stronger with concrete cases. I also discover boilermaking which is a peculiar industry, almost traditional and rustic. I saw the importance of experience and know-how. This industry is really interesting because it is far from organisation and production systems standards. It was like working in a big laboratory because there is almost no standards and we have to create everything.

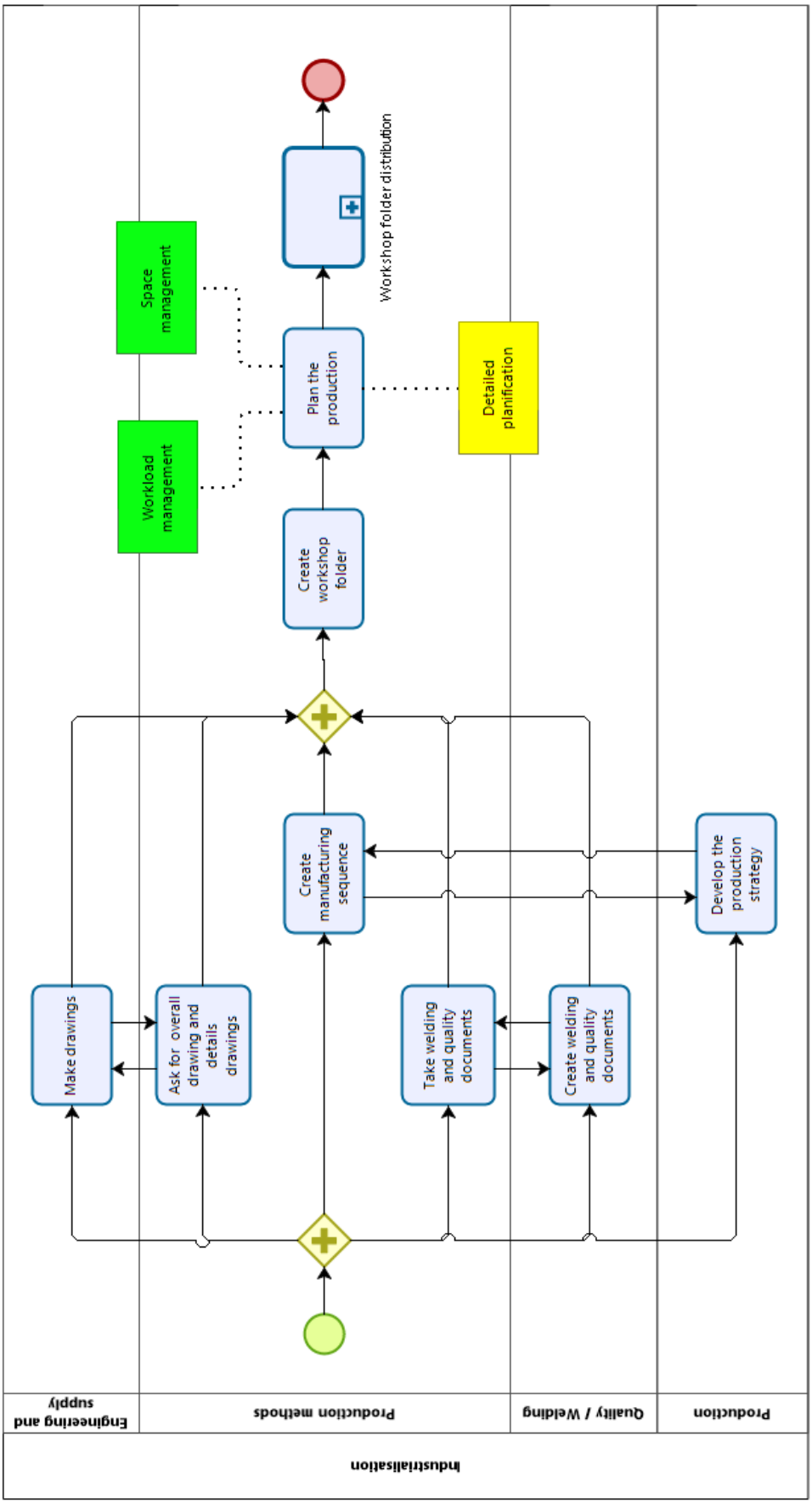
At the end of the internship, I stayed in the company as Methods Engineer. My responsibility is to monitore production in the pressurized workshop. The will of Boccard is to create a boilermaking factory 4.0 and I'm really happy to be part of this journey.

Appendices

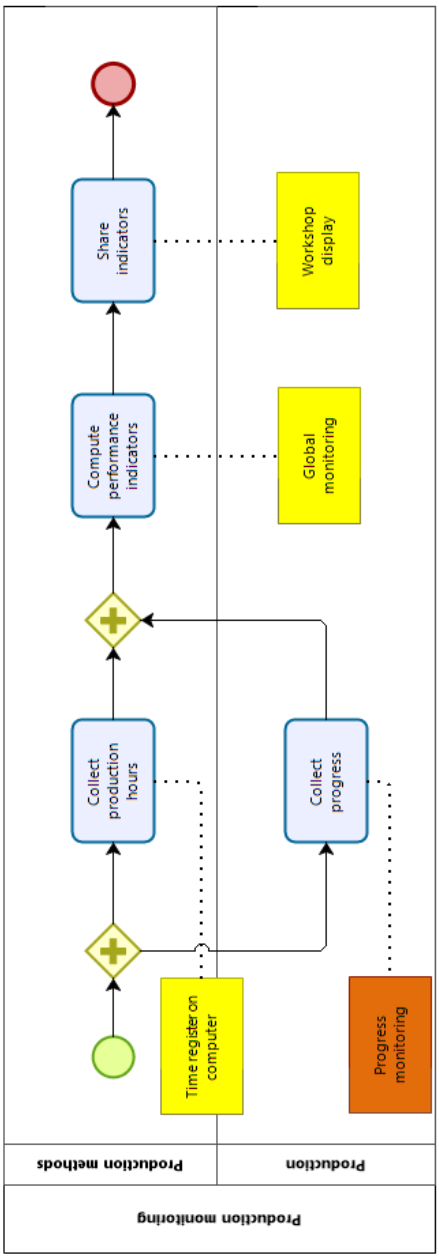
Appendix 1. Global process map



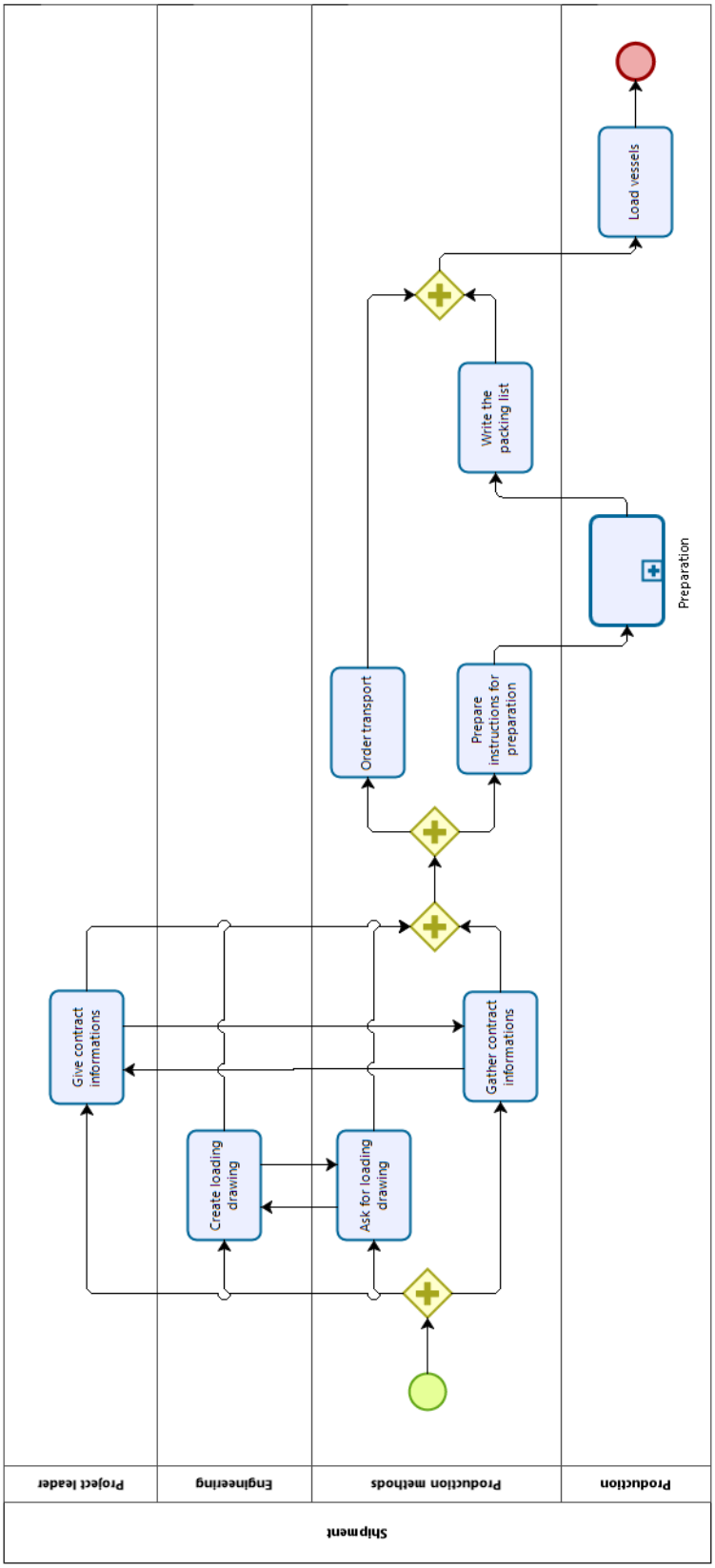
Appendix 2. Industrialisation process



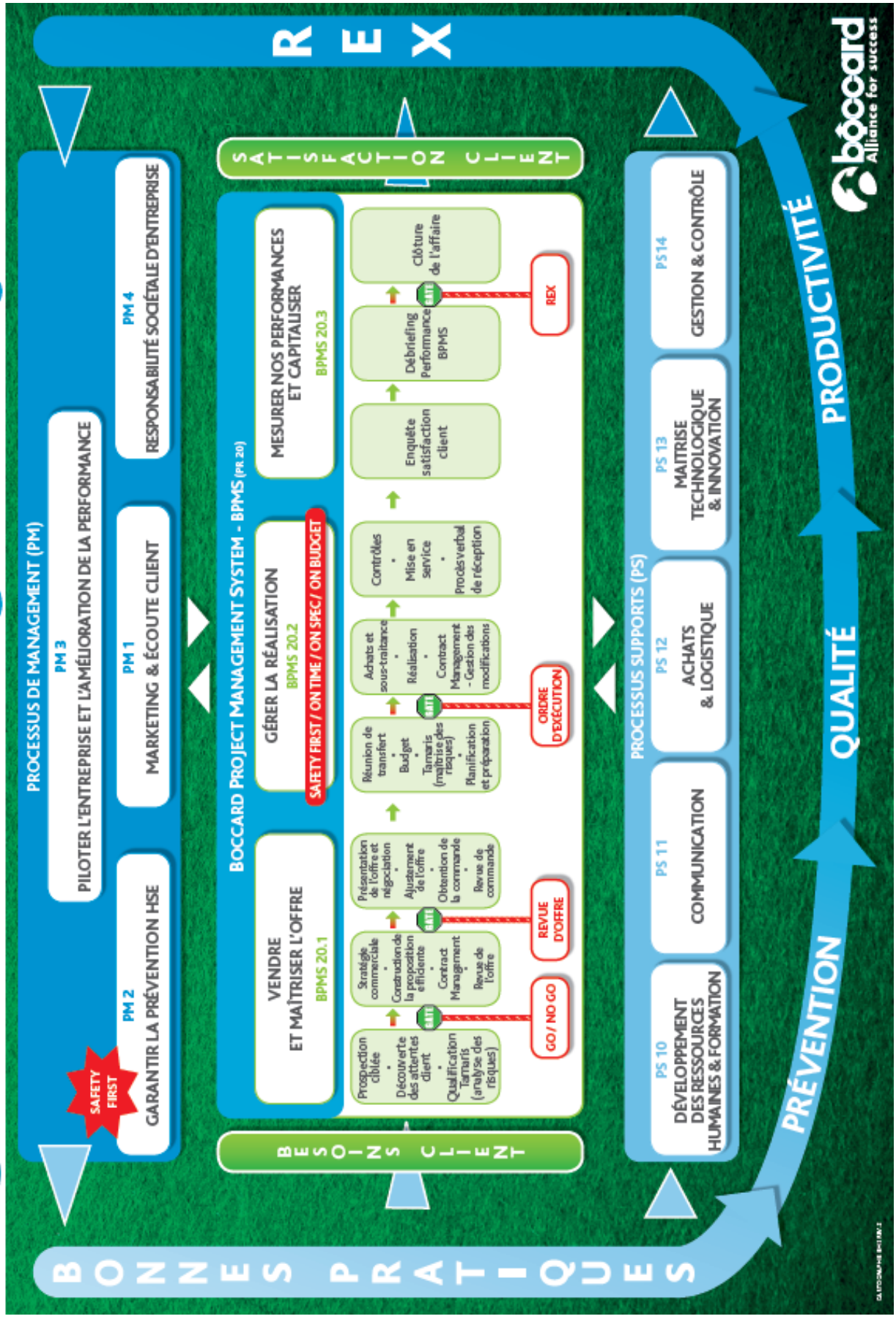
Appendix 3. Production monitoring process



Apppendix 4. Processus d'expédition



Appendix 5. Boccard Management System



Failure Modes, Effects and Criticality Analysis (FMECA)

Failure Modes	Effects		G	Causes	F	Detection process	D	Criticality	Action	G	F	D	Action G	Action F	Action D
Missing part in the manufacturing process	Production stopped	2 weeks max	4	Supply planned to late	5	Decision aid	4	80	Yes		✓	✓		Stock Use standard parts	Check supply
			4	Supply delay	7	Decision aid	3	84	Yes		✓	✓		Stock	Check supply
		Till 6 weeks	6	Missing supply (forgotten)	3	Decision aid	5	90	Yes			✓			Check supply
			6	Lost part	2	-	10	120	Imperious		✓			Receipt procedure	
			6	Damaged part	1	-	10	60	Yes		✓			Prevention	
		Undefined	7	Supplier blocked (unpayed)	3	Accounting	7	147	Imperious		✓			Payment	
	Possibility to wait and do other tasks	-	1	-		-		0	Unnecessary						
Difficult task unforecast	Delay in production		4	Complexity unseen	4	REX and design review	5	80	Yes		✓	✓		REX	REX
			4	Workers unqualified	3	Work plan	3	36	Yes	✓		✓	Skilfulness		Work plan with higher forecast
			4	No tools	4	REX and design review	5	80	Yes		✓	✓		Stock tools	REX
Missing workers	Production stopped		3	Maladie	3	-	10	90	Yes	✓			Skilfulness		
			3	Congés	3	Vacancies	1	9	Unnecessary						
			3	Non justifié	4	-	10	120	Imperious	✓	✓		Skilfulness	Workers involvment	
			3	Personnel qualifié affecté à une autre affaire	4	Work plan	3	36	Yes			✓			Work plan with higher forecast
			3	Personnel en formation	2	Work plan	1	6	Unnecessary						
Drawing change	Supply and modification	After manufacturing	7	Erreur BE	3	Design review	4	84	Yes		✓	✓		REX	REX
			7	Modification client	4	-	8	224	Imperious		✓			Rigidity after BPE	
	Supply	Before manufacturing	5	Erreur BE	3	Design review	4	60	Yes		✓	✓		REX	REX
			5	Modification client	4	-	8	160	Imperious		✓			Rigidity after BPE	
Lack of manufaturing space	Production stopped		7	Too much vessels planned at the same time	3	-	5	105	Imperious			✓			Work plan of space
			7	Delayed vessels	3	-	4	84	Yes			✓			Work plan of space
	Bad working conditions		3	Too much vessels planned at the same time	3	-	5	45	Yes			✓			Work plan of space
			3	Delayed vessels	3	-	4	36	Yes			✓			Work plan of space
FAT impossible on time	Delay penalty and impact on company image		6	Vessel unfinished	4	Production monitoring	2	48	Yes	✓	✓		Communication with customer	Action plan	
			6	Missing accessories	6	Decision aid	6	216	Imperious	✓	✓	✓	Communication with customer	Earlier order of accessories	Alert

Part receipt procedure

This detailed procedure aims to ensure a correct control of each kind of part. The goal is to avoid problem discovering in the manufacturing process.

Control levels

Elementary control (warehouse)

The warehouse clerk should realise these basic controls:

- Compliance with packing list: received parts are the same listed on the packing list.
- Visual control: there is no damages on parts

Complementary control (Quality)

When it is necessary, a complementary control has to be done by the quality department. This control could be:

- Dimensions
- Roughness
- Control according to specifications

Control to realise depending on parts

The Excel© file attached to the procedure lists each kind of parts and the control to be realised for each one. If a complementary control is necessary, the clerk has to alert the quality department.

Vessels shipping procedure

This detailed procedure aims to ensure a shipment without delay and missing parts.

Shipment drawing (Engineering)

The shipment drawing aims to anticipate the means of transport to forecast before shipping vessels to a subcontractor (e.g. chemical polishing) or to the final customer. This drawing should contain at least:

- Kind of packaging and bill of materials for this packaging (strap, cradle…)
- The overall dimensions of vessels
- The overall dimensions of big accessories (ladder, barriers…)

This drawing has to be sent right after edition to every concerned department (Methods, Quality, Production and Supply departments)

Shipping material supply (Supply, Methods)

When it receives the shipment drawing, the supply department has to buy all the bill of materials. The supply date has to be set by the Production Methods department according to planning. This date should be set 2 weeks before shipment.

Transport order (Methods, PL)

When the excat shipment date is known, the supplier must be chosen according to shipping criteria. The transport has to be ordered by Methods department.

Packing list (Methods, PL)

Before final shipment, the Project Leader has to give the Methods department a list of all accessories precising which ones have to be on the vessel or not. The PL precise also the kind of protection.

All accessories of a vessel should be sent on the same truck of the vessel to avoid problems during installation on plant.

The Methods department has to write the packing list and to print it in 3 copies. This must be done one week before shipment.

Shipment preparation (Packer, Methods)

The physical preparation starts one week before shipment and is done by only one packer.

The Production Methods department must give th packer:

- 2 drawings (global and shipment)
- Accessories list to be equipped or not
- 3 packing list (1 for customer, 1 for BPV, 1 for truck driver)

The packer has to equip the vessel according to those documents one day before shipment at least.

Reminder, at least one hole has to remain hallow to avoid deformation by suction.