POLITECNICO MILANO 1863

Faculty of Design
L.M. in Design & Engineering

Thesis title:

asUlike: Design concept of a mass customizable hard suitcase

Superadvisor_ Silvia Ferraris
Correlator_ Marco Febbo
Student_ Tommaso Briccola matr. 818610
A.A_ 2014/ 2015

Index

Immages index

ABSTRACT

The aim of this project is to develop a new concept of luggage focusing on the assembling phases in order to gives customers the possibility of easily customizing the suitecase. The goal it's to provide clients a high level of personalization mantaining the advantages of the mass production and improoving mounting, shipping and stocking.

This idea born after a three months internship in China at C&C Luggage, one of the biggest luggage suppliers in the market. During this experience I had the possibility to analyse all the steps involved in the production and I have noticed how even the most different suitcases were produced in the same way and with similar components. So why don't exploit this standardization in order to customize the final product?

Trough a work of Design & Engineering I don't want only to create a new luggage but a totally new system in which the semifinished pieces can be shipped and storaged with lower cost and the customer can be involved in a new shopping experience assembling his own product inside the store just with the help of unspecialized clerk. Today there are thousands of reality that already exploit the mass customization with great success, from the car market to a simple fashion bag. Experts say this trend will become a must have in the next years because thanks to the improvements of the production system it's possible to satisfy each customer dreams without losing the advantages of mass production.

"Every costumer deserves to have exactly what he wants at a price he's willing to pay, and companies must make that happen in a way that makes them money" (B. Joseph Pine, May 02,2011).



1. THE SUITCASE



1.1 THE MARKET

Opposite to it's simple appearance the suitcase it's quite a complex object composed by different pieces and assembled with several step. Its market is about 20000000 pieces per year and it is shared in 40% soft (made of fabric) and 60% hard (made with plastic shell). Since its first appearance in the end of the 1960's the plastic luggage became always more and more important compared to the soft fabrics one. The trend previews it's to reach 70% of the market in the next 2 years.
In order to better understand this product we need to make a second diversification. The 12 million hard suitcases produced this year can be split in two parts according to their closing method. 70% of them are zipper case while the remaining 30% are metal frame. It's important to remember that this ratio is based on a worldwide average but in some big markets like the Asian one it is 50%-50%.
Today all the main producers are located in China where there are hundreds companies with different quality level and prices. The main reason of this Chinese predominance it's the lower labour cost and the possibility of supplying all the necessary inside the country reducing the supply chain. All the processes involved follow the principles of the assembling line involving lots of workers.
The company I attended the internship in is located in Sanxiang, a small industrial village in the south of China (Guangdong province) and I spent there 3 month beeing involved in all the supply chain. C&C luggage is at the moment the first producer in terms of quality supplying hard suitcases for all the most important brands (Tumi, Bric's, Samsonite, Hartmann, TedBaker, Mandarina Duck...).
It has a production capacity of 1500 pieces a day thanks to a superb organization and 1300 workers.
During my staying I have noticed how all the products structure are similar. Even if the final appearance and shape are very different they are all produced in the same way using similar components and materials.
This standardization is can be considered a consequence of a quite unique utilization (travel) even if in the last decades some technical suitcases are appearing on the market.

1.2 HISTORY

Luggage history it's very old because since the beginning of time people had the necessity of transporting belongings with them.
It was born as big and heavy trunks made of wood usually loaded on ship or carriages even if an easy to carry alternative was a simple tissue bag. This structure remain almost unchanged for some millennia because in the ancient past people travelled just for works or necessity.

Fig.1_ Old trunks of the crusades period

Its real development started in the middle of the 1800 when the first travel agency was born and train transportation allowed people to moves with reduced cost.
In order to travel with train luggage dimension was reduced and soft bags made of leathers became more and more popular.
In 1896 Luis Vuitton launch the first brand trunk made of wood and covered with leather.
Other big changes for this product were pushed by the appearance of cars between the two world wars and lately with the utilization of planes for people transportation.
The dimension was reduced more and more and at the same time the right compromise between resistance and light weight became more and more important.

Fig.2_ Leather suitcase

Thinking about the modern development it's important to underline some fundamental step of the hard case evolution.
1950 Rimowa invented the first aluminium case starting the movement to light and stronger suitcase.

Fig.3_ Rimowa aluminium suitcase

1960/70 Thanks to the increasing popularity of polymers the plastic suitcases started to be produced in these years. The advantages of plastic suitcases compered to the wood trunks were the lightness and the durability. This plastic luggage wasn't made with the two classic shell but they was trunks with plastic sheets instead of wood one.

Fig.4_ Samsonite PP suitcase

1972 Even if since the Crusades there was trunks with wheels pulled by horses it's only in this year that U.S. patents wheeled luggage. It was Bernard Sadow, an executive at a luggage company that during one of his thousands working trip had the intuition. It's funny to think that it arrives before the man on the moon than the wheels on the luggage.

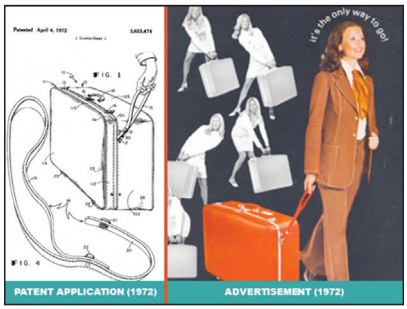


Fig.5_ Sadow's patent and advertisement (1972)

1987 Today's rolling luggage was invented by the pilot Bob Plath. He invented luggage on wheels with an extended handle. This invention was called the Rollaboard and was launched in a widescale production in 1989 with his company TravelPro.

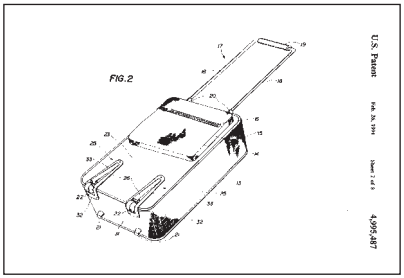


Fig.6_ Rollaboard patent drwing

1994 The collapsible tow handle was invented and patented by Don Ku.

2000 Rimowa introduced the first Polycarbonate suitcase. Lighter than aluminium and highly durable Polycarbonate set the stage for the hard-shell cases that are now made by many major players in the luggage industry.

Fig.7_ Rimowa first PC suitcase

2004 The first 4 wheels luggage appears on the market made by Samsonite. It can be pushed, pulled and literally spun in any direction.

Fig.8_ Samsonite 4 wheels suitecase

2007 Samsonite present an ultra light suitcase made with Curv® a patented composite material lighter and cheaper than Polycarbonate.

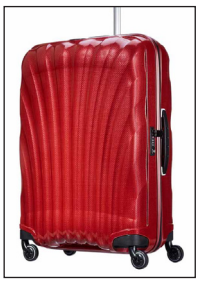
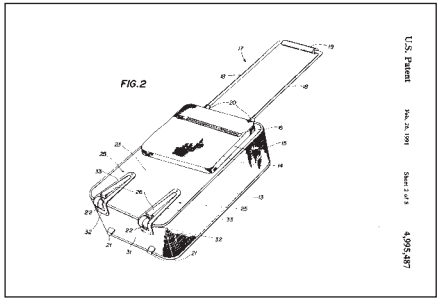


Fig.9_ Samsonite Cosmolite suitcase

Future According to Travel Goods Association (TGA) the upcoming trends will be more and more high tech like GPS technology for luggage tracking and integrated charger for electronic devices but also more ergonomic suitcase and backpack that simplify the way of travelling.

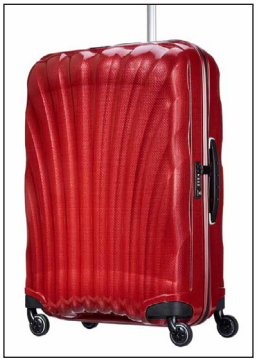
Fig.10_ From left to right, Climb UP concept, Samsonite Trottinette, Space case



Bernard Sadow wheeled luggage patanet

1st Aluminium case

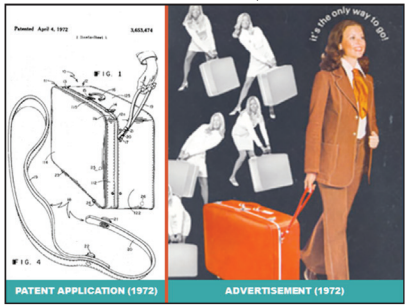
1st Polycarbonate thermoformed case



Samsonite Curve® material

1950 1965 1972 1987 1994 2000 2004 FUTURE

Polymeric case



Bob Path wheeled trolley patanet

4 wheels spinner case

Future concept

1.3 PRODUCT ANALYSIS

1.3.1 Parts and Components

Even zipper and metal frame case are characterized by some different parts the analysis will start with the common one.

1.3.1.1 Polymeric shell

It's the biggest part of the luggage and it has the funcion of containing all the goods we want to transport with us.
It must be structural and resistant to loads, impacts and abrasion but at the same time it must be as light as possible.
The most common materials are ABS and Polycarbonate with a predominance of PC in the high hand luggage. As I discovered during my internship the best material available on the market it's not 100% PC but it's a compund characterized by 2 external layer of PC with a secret foam layer in between them.
As it is the most visible part it must have also a good finishing and it's possible to paint it or to apply stickers even if it's not necessary because also the raw finishing has a good appearance.
Normal luggage usually has 2 shells and one it's little bit deeper than the other. In the last 5/10 years a third shell was installed on the cabin size suitcases in order to create a pocket with easy access.

Fig.11_ Cabin size shells structure

21.3.1.2 Trolley system

As it's possible to se the modern collapsible trolley system date back to 1994 and since them it has remain very similar.
It's funcion it's to provide a comfortable connection between the suitcase and the user but the exposed part must be hidden when the luggage it's checked in in order to avoid do be damanged.
The trolly system can be composed by a couple of collapsible structure or a single one. The coupled system it's more stable instead the single one it's lighter.
This item it's composed by 3 different parts:

TROLLEY HOUSING: It's the part that create the connection between the trolley and the shell and it's always produced by injection moulding because of its shape. It must be impact and scratch resistant because it's exposed and also good looking. The most used materials are ABS or a mixture of ABS and PC.

TELESCOPIC PIPES: It's a system of concentric pipes that allowds the handle a comfortable height in order to be grabbed more easily (usually 1100 mm). One of the constraint it's the maximum length of the bigger pipe (the one that must contain the others in the closed situation) because it must fit inside the shell. Usually there are two, three and five stages trolley system depending on the number of concentic pipes used to reach the desired height. The two stages for example it's composed by one pipe inside the other and it's used for big luggage where the big pipe can be minimum 650 mm long. It's important to know that the more are the stages the more it's the trolley system wobbling.
All the system can be installed inside the shell and remain hidden or outside the shell and becoming also an aesthetical element.
Inside the pipes there is a mechanism that permit to stop the pipes in some positions (usually closed, intermediate and extended). The most common common mechanisms are two, a lighter and simpler one with stick and a stronger one with a metal wire.
The most used material it's aluminium and it can be anodized or painted.

TROLLEY HANDLE: It's the real connection between the user and the product. It must

be comfortable and gives the right feeling.
On its top, side or bottom there must be a button that actuates the internal mechanism and for this reason it's usually made by two injection molding parts that joined with

screws or snap-fit. The most used set of material it's ABS structure overmoulded with a soft touch PU rubber but it is possible also to wrap the ABS with leather or textiles and in some cases it can have also metal parts.

Fig.12_ Different types of trolley systems.

1.3.1.3 Wheels

Wheels are one of the most important part of a suitcase they must be strong and resistant but even more they must run smoothly even under a big load in order to makes the user movements simplier.
Untill 2004 a luggage was supposed to have only two wheels and it was transported tilting it on the wheels side but in this way part of the weight burdens on the user harm. Samsonite had the great idea of installing 4 wheels allowing the movement just with a small pulling/pushing force leaving all the weight on the luggage base. The trend is to use 4 wheels more and more.
This components it's composed by two parts:

WHEEL HOUSING: It's the part that permit to connect the wheel to the bottom part of the shell. It's almost always produced by injection moulding and the most used material it's ABS. It must be very resistant in case the luggage drop off just on one wheel concentrating the load. It is fixed on the shell trough screws.

Its shape it's usually concave in order to reduce the waisting of space as more as possible.

WHEEL: It's the moving part of the wheels and in the case of a four wheels suitcase everyone can rotate around an orizontal axis like a normal wheel but also around a vertical axis in order to be spun and to turn easily.
Bearings are generally avoided to reduce price and weight therfore all the rotations are made around a low friction grased pivot.
Wheels are usually made by an ABS injected base plus a rubber overmoulding.
There are different tipe of wheels with different price and performance:

- **Single wheesl:** they are the most simple and cheap. Every pieces is composed by a single rotating wheel.

- **Double wheels:** this type it's very used on high hand suitcase because they provide more stability coupling two wheels per each wheels system

- **Silent wheels:** they are becoming more popular and used after some cityes restriction that forbid trolley suitcases use in the streets. This wheels can emit less noise thanks to some special patented rubber coating.

- **Braking wheels:** they are very usefull for train and boat travel when you need to leave your luggage in a free space. Thanks to an internal mechanism this type of wheels give you the possibility of blocking them trough a button or lever located on the wheel base, on the shell or sometimes directly connected to the trolley system.

Fig.13_ Different types of wheels.

1.3.1.4 Handle

Together with the trolly handle it's the other point of interaction with the user. Usually there are two handles per suitcase, a top and a side one, and their function it's to allowd to manage easily the luggage when it must be lifted. On the cabin size the side handle is avoided because the overall dimensions are quite small and it's not necessary.
It is usually fixed to the shell trough screws and it must be very strong in order to support a full load.
One very important point is its minumum exposition when it is not used because in this way it's possible to avoid to be hanged and damaged. Two different solution are used for this problem:

- Spring handle: it is rigid plastic handles that have the possibility to rotate around two pivot in order to be grabbed. An inner spring mantain the handle flat on one side when it's not used.

-Flat handle: it is a flat piece of plastic that has the possibility to slide a little bit inside the housing. In this way when the handle it's grabbed the space for the fingers it's created by the approach of the two extremities.

For both the case the most common material it's ABS and the process it's injection moulding. As for the trolley handle it is possible to cover the ABS core with overmoulded rubber or with wrapped leathere.
Some handle can have a metal core instead of a plastic one, it depends on the producer design but the general trend is to use a polymeric one.

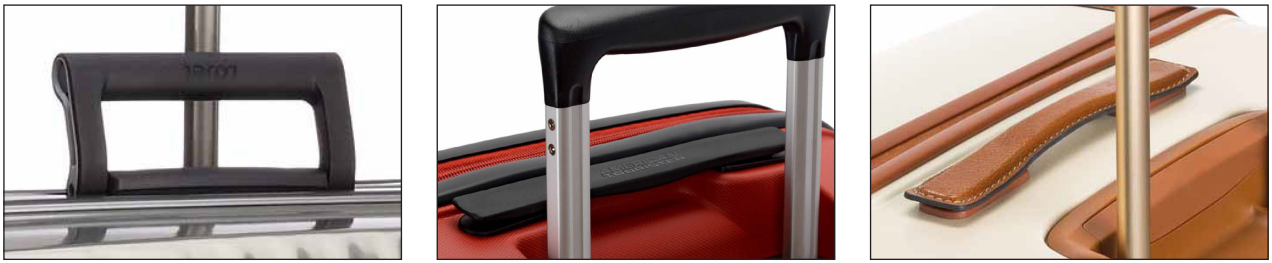


Fig.14_ Different types of handles.

1.3.1.5 Lining

The lining it's the internal part of the luggage usually made of synthetic fabric. It is different from one model to the other but usually there are two concave pieces that overlay the internal part of the shell plus one or two parts that permit to fix the clothes inside the shell and avoid to overturn them during the suitcase closure.
The producer can decide to add pocket, zip and separators to increase its usability.
It's important to remember that this part is the one in direct contact with the users goods and for this reason it must be suitable to hold them.
Regarding this part there is no innovation since years.

Fig.15_ Different suitcases lining

The components presented untill now are used in the same way on the zipper case and on the metal frame one. For the following components instead i will show the difference it has on this two type of luggage.

2.3.1.6 Closing System

ZIPPER CASE: the closing system of the zipper case consist in a simple zip that is stitched directly on the shell with some powerfull stitching machines. The zip must have a strong closing force to avoid unwanted openings.
Usually a rubber bumper is stiched on the shell borther together with the zip in order to absorb impact, protect the zip teeth and increase a bit the water resistance.
A piece of rubber, textile or leathere it's usually stitched in the back to hide the zip extremities

METAL FRAME CASE: as the name suggest this type of suitcase has two metal profile (male and female) fixed on the shells contour using metal staples. This closure it's more safe and strong than the zip one but it's heavier. Another problem that can occur with the metal frame is that if one of the two profiles is bended after a strong impact it will be impossible to close the luggage.
The most used material it's Aluminium because it's lighter and easier to work than steel. Another plus of Al it's his simple oxidation that allows the colour and the corrosion protective layers to permeate inside the material so that even in case of scratch the surface wont change colour. For cheap luggage oxidation it's replaced by spray painting.
A new trend for the hig hand product is to use Magnesium frame because it is lighter. As known Magnesium it's a very reactive material and this makes the frame production and storage more complex. The results it's a cost that can be up to 5 time a metal frame. Another negative point of Magnesium is that it can be anodized but this process doesn't provide colouration as for Aluminium so the only way to change colours is painting.
On one side of the suitcase two or three metal inges are fixed with rivets or screws in order to connect the two metal frames. It's importabt that the inges are not too exposed in order to avoid to be hitted and bended.

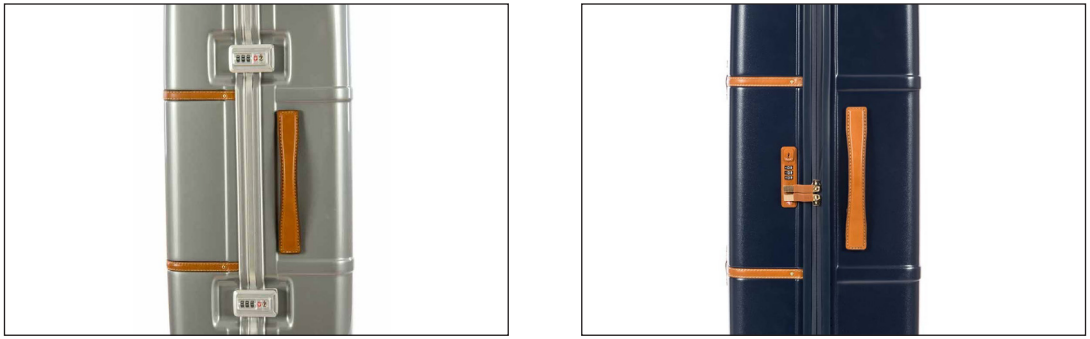


Fig.16_ From the left: zipper case and metal frame case

1.3.1.7 Locking System

ZIPPER CASE: The easiest way to lock a ziper case it's to block the two cursor. Until 10 years ago the most used solution was the padlock that joining together the zip puller or the slider avoid the luggage opening. The most updatet lock are instead fixed directly on the shell in order not to be lost and they have some housing in which the a properly shaped zip puller can be hanged and blocked.
When you buy a luggage, whatever it is with zip or metal frame, it's important that it has a TSA (Travel Security Agency) lock as this type of lock is required for travelling in USA. It's peculiarity is that it can be open with some special codificated key provided to the airport security.

METAL FRAME CASE: In a totally different way from the zipper one the easiest way to close this type of suitcase is to lock the two frames in the closed position with the male part of the frame joined with the female one. This can be done with a hanging mechanism that can be different according to the frame shape and to the producer design. What joins the different tipe of metal frame case locks is to block the two frame together usually in two or three points.

Fig.17_ Different suitcases locking system

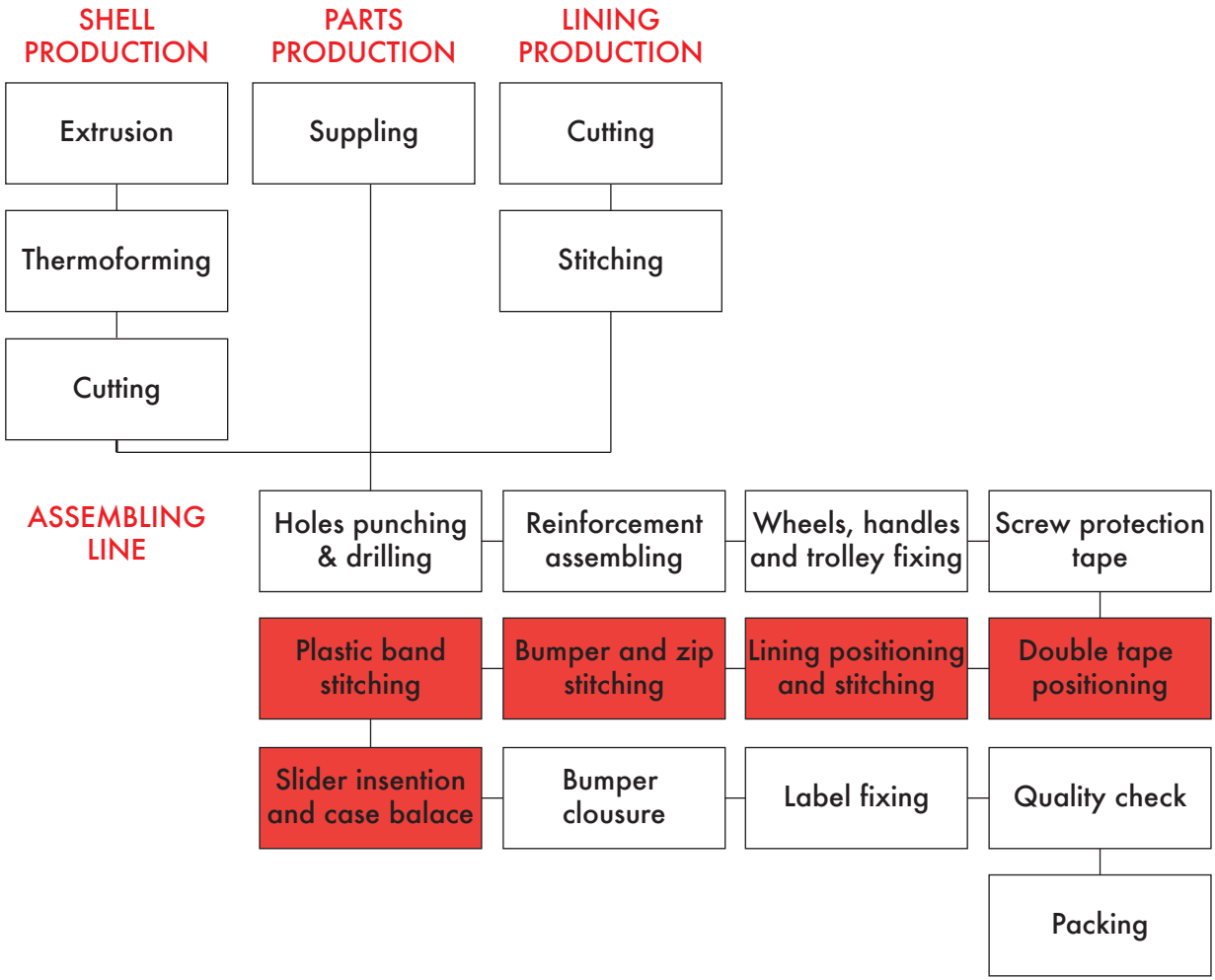
1.3.2 Production analysis

The suitcase production it's not easy because it requires a huge number of step and an incredible ability of coordinating all the processes and people involved in it.
As said at the beginning the most of the production is made in China in some enormous produces that work for several brands. All this companies are really big because in order to save money they try to do all the necessary inside themself limiting the purchasing from external supplier only for those components that requires a partcular know-how.
Just to makes better understand the dimension of what I am talking about the factory I attended the internship in (C&C luggage) has a plant area of 120149 m^2 and 1300 people works there with a huge number of tools: 3 injection moulding machines, 6 extrusion machines, 15 vacuum forming machines, 10 robotic arms, 15 assembling line and 7 bending machines. They have 13 different department (accounting, sales, design, mould, frame bending, extrusion, forming, painting/stickers, injection, lining, assembling, quality check, production line control and hybrid case) that have to cooperate perfectly in order to avoid waste of time.
Both for zipper and metal frame case the first part of the production it's in parallel so everythings must run smoothly and synchronized in order to have all the necessary ready when the assembling have to start.
A rough procedure of the factory is the following:

- Customer Idea
- Design
- Research & Developement (R&D)
- Customer approval
- Mould shaping
- Sample approvatione and test
- Pre-mass production meeting
- Cost analysis
- Custumer order
- Production line study
- Raw material order
- Production
- Shipping

From the idea presentation to the delivery it usually pass minimum 3 month. It's important to consider that a finished suitcase occupies a big volume so it's necessary that the production of one batch runs smoothly without interruption in order to be shipped as soon as it is finish avoiding to store it.

1.3.2.1 Zipper case production



As it is possible to see from the chart the production is divided in two phases. The first one is in parallel and it is used to prepare all the necessary for the second one that it's in line and it is used to assemble all the semifinished pieces together.
Here following some details for every step.

SHELL PRODUCTION: The shell production it's based on 3 different processes that are usually done inside the factory. The first one is the extrusion of polymeric sheets.
All the process starts from the raw material, small clear grain of Polycarbonate material. In the past in C&C was extruded also some ABS but since this material it's nowdays used monstly on cheap product they stopped doing it.
The Polycarbonate comes from different supplier depending on the quality the costumer request; the best one is Makrolon from Bayer chemicals.
The grains are first dried in some heated towers because humidity could create bubbles in the plastic sheet. From the drier they pass directly to the extrusion machine, a long machine in which the grain are first melt and mixed trough friction and heat into s without end screw, than the fluid is forced to pass in the extrusion head in order to create a film.
Additive and colours are added meanwhile the grains melt inside the screw cylinder in order to reach the desired standard of the plastic sheet.
Once the thermoplastic film comes out pushed trough the head it falls down under G-force in between two rolling cylinder, the first one has a chromed and smooth surface in order to have ely flat face in the back of the sheet; instead the second one has engraved the female part of the emboss the costumer wants to obtain on his product.
A third cylinder is used to pull the film meanwhile it cools down and becomes rigid.
At the end of the line there is an automatic cutting machine that cut the film into sheets.

Fig.18_ C&C Luggage extrusion machine

On the market it's possible to find 3 type of extruded PC material but the one used in C&C it's definitely better thanks to its particular structure.

- The cheapest Polycarbonate based material used for luggage consists of a thick layer of recycled PC covered with a new PC film. The appearance it's the same of the new PC but the mechanical proprieties are the one of the recycled material so they are worst.
- The medium quality one consists of 2 layers but it doesn't use recycled material. The extruded part is a mixture of 60% PC and 40% ABS on which a film of PC is stuck. It has better mechanical proprieties than the previous one but the colour it's only in the film so it's very easy to be scratched.
- C&C material involves high investments because it needs a 3 screws extruder meanwhile the previous ones just need a single one and a film. The structure is based on 3 layers, the two external are made of 100% PC and represent 60% of the thickness. They are the only coloured part in order to save colour pigments but they are way thicker than a film so it's harder to scratch them till the uncoloured part. The inner layer it's a secret mixture creating a flexible compound. It's the results of a 10 years research and creating a flexible cousin in between two rigid PC layers it allows to have thinner shell with high resistance.

A possible process variant it's used when the plastic must be coloured using texture. The only way to do it is trough the use of printed PC film supplied from an external factory. The process consist in placing the film coil just above the extrusion head and attaching it on the soft polymer trough the pressure of the cylinder. Since the film is made with a compatible polymer it will remain attached to the base PC film once it cool down.
It's important to check the all the sheets produced to reject the defected one before they becomes a luggage. In C&C the quality check is done on 100% of the pieces. Once the sheets are all checked it's bossible to shape them using the vacuum forming. The process is based on 4 steps: heating, blowing, forming and cooling. In the single forming machine all the steps take place in the same place; the worker place the PC sheet and fix it, the machine heat it up for 50-60s, some hot air is blown from below in order to stretch the polymer, the vacuum pump sucks the air and makes the polymer overlap perfectly on the mould and finally the workers wait until the shell is cool

before removing it.
In the rotational machine like the most updated one they have in C&C there are 3 different stationing on the vertex of a eqilateral triangolum and a triangular platform with 3 sheet housing rotates on them. The worker stuck just in one station (the one in which the sheet installation and the shell cooling happens); once the sheet is installed the upper part rotate and the sheet is moved on the second station in which it's heated up meanwhile the workers can load another sheet in another housing; after another 120°rotation the first sheet reach the 3rd station where it gets formed meanwhile the second sheet is heated and the worker can load a third sheet. This cycle continuously repeats itself.
In order to exploit the forming process in the best way it's important to set the right air temperature and maintain it constant. The temperature it's not a standard but depends on the material, on the sheet thickness and on the mould complexity and shape. A deeper mould requires higher T.
Another rule it's to avoid straight vertical wall on the mould because they create friction both during polymer flowing and shell extraction. It's always better to have at least 2-3° draft angles.
Even big flat faces must be avoided because they can create unexpected curvature once formed. Usually there must be at least a height difference of 6mm between the central part of a flat face and its border.
For the lightest suitcase it's possible to have a1mm thickness after the forming process but it can be increased if it results not strong enough to pass the test. Since adding material means adding weight sometimes it's preferred to try other possible solution before doing it, for example it's possible to increase the radius of the sharp parts in order to makes them more tough.
Once the shell is formed it is possible to pass to the third and last step where it is shared from the remaining part of the sheet. There are two ways to do it. The first one is based on a mechanical cutter that rotate around a profile remaining parallel to the ground. To increase the cutting precision the formed sheet is placed on a wood mould with the perfect shape of the shell but for a recess profile where the cutter pass. The other process is used for high precision cut, usually when the cutting line is not on a single plane and it's based on a CNC robotic arm. In this case it's also possible to create the holes needed for the components installation with high precision.

PARTS PRODUCTION: As I told before luggages factories try to do everything internally but this is almost impossible because some parts requires a high know-how and big investments thats the reason why in China it's easy to find companies specialized just on some luggage components.
Usually, as it was done also in C&C, wheels, trolley systems, lock and handels are purchased from outside.
During the internship I learnt how important is to choose the right supplier. Barry Chang (C&C owner) explained me how important is to create a trust relationship instead of jumping from one to another following the most competitive offer. You lose less money with a supplier that sells you little bit more expensive wheels but you know it always deliver in time than with ona that is cheaper but makes you stop the production because of delays.

LINING PRODUCTION: Cutting and stitching are the two main processes required in order to produce the internal parts of the suitcase.
In C&C this is one of the departments that involve more workers, around 450 people. It is divided in two parts, one in which the lining and the fabric is received, checked, stocked and cut and an another where the different parts are stitched together.
Everything starts from the lining purchasing from an external supplier or directly from the costumers. Once received some people from the QC department check every meters of the lining using a machine that unroll it, making it pass into a checking zone and re-roll it up. At the same time the R&D staffs looks for the best way of cutting with fewer scarps as possible. They first need to design the best silhouettes needed to create all the luggage's internal parts and second they need to positioning all of them in order to save as much material as possible.
All the lining cuts are usually made by pressing machine using metal mould. In this way is possible to cut more layers at the same time increasing the productivity. The use of metal cutting mould also reduces the possibility of committing mistakes.
After having being cut all the pieces are moved to the stitching department that works like an assembling line.
Once the pre-production pieces are ready they are positioned in the right station of the production line and the assembling process can start. Every part is stitched step by step in order to create semi-finished pieces that are joined together in the last part of the chain. They use mechanical stitching machines but controlled by hands, the only

automatic stitching machines are the one used for some logos fixing. The R&D department studies all the stitching type the workers need to do and they make research in order to understand which needle is better for each one of the steps. Needle situation is strictly checked and if one gets broken they need to draft a report underlining: who was the worker, which was the machine, which was the case and after how many working hours it happened. In addition at the end of every working day one employer check each needle with a ultrasound scanner that can find micro-crack in the interior part.
Usually are mostly women that works on the lining production because these kinds of processes require more precision and less strength.

Fig.19_ C&C Luggage lining department

ASSEMBLING LINE: All the final products come out from here. According to the principles of the production chain different production stations are located along a line and the cuitcase it's assembled with consecutives steps. In C&C there was 15 assembling line with more or less 20 workers for each one spreaded in a huge 3 floors building. Every line is developed along a running tape and the semi-finished piece moves on it and get worked in every station. Punching machines, drillers, screwdrivers and a lot of others tools are spreaded along the line.
Since all the luggage are very different each line is specialized in assembling one particular kind of case. The main difference is between Zip ones and metal frame ones because the process is quite different. Inside this division it is possible to find subcategory like front pocket case, pilot case and so on. Every station activity is repetitive so it's easy for the workers to get used to it and increase the productivity during the process.

assemble department heads during the pre-production meeting.
Usually the process is the following but it can changes according to the case characteristics.

1- Assemble line preparation: all the pieces are located in the right station and checked in order to find defect.

2- Manual holes: if required some holes are made manually using a drill. The holes position is highlighted by some bas-relief spot shaped during the forming process.

Fig.20_ Manual holes drilling

3- Reinforcement assembling: if the luggage has some reinforcement or details they are fixed at the beginning of the assembling process. The most common way to fasten these pieces is with rivets. A pneumatic machine is used for this process.

Fig.21_ Leather fixing with rivets

4- Trolley system and lock holes: a punching machine creates all the holes required for the trolley installation. The holes shape is given using a mould.

5- Reinforcement gluing: some plastic thermoformed reinforcements are glued inside the shell on the wheels housing. If needed some plastic sheets are stuck as handle reinforcement. The glue type is heated mastic sprayed by a machine.

Fig.22_ Reinforcement gluing

6- Holes punching: like for the trolley system punching machines using proper moulds to makes the holes. These holes are needed to install wheels, side feet, logo, lock and handles.

7- Wheels fixing: the wheels are fixed using screw, washer and screwdriver.

Fig.23_ Wheel fixing with self_threading screws

8- Trolley system fixing: the trolley system is fixed on the shell using screw, washer and a pneumatic screwdriver. It's important to have sensitive hands not to damage the plastic parts clutching the screw too much.

Fig.24_ Trolley system fixing

9- Side feet fixing: same as wheels and trolley system.

10- Logo fixing: same process as previous.

11- TSA lock fixing: same process as previous.

12- Handle fixing: same process as previous.

13- Screw head protection: small parts of soft tape are stuck on the screw's head in order to avoid lining hooking

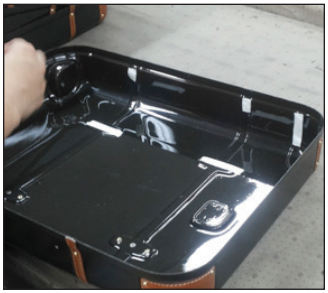


Fig.25_ Protection tape positioning

14- Double tape positioning: a loop of double tape is stuck around all the inner top profile of the shell.

15- Lining positioning: the internal lining is positioned using the double tape. This process is useful to maintain it fixed during the stitching process.

Fig.26_ Lining positioning

16- Lining stitching: Using a stitching machine with very hard needles the lining is stitched directly on the PC shell. This process is quite difficult and requires lots of expe-

Fig.27_ Lining stitching

17- Bumper and zip stitching: both the plastic bumper and the zip are stitched directly on the shell with manual machines. The bumper is pre-heated to makes it softer. This step is even more difficult than the lining stitching because you need to control 3 pieces at the same moment.

Fig.28_ Bumper and zip stitching

18- Plastic band stitching (first side): it's a PVC piece that connects the two parts of the luggage and honeycomb reinforcement is inserted under it. It is first stitched on just one shell and it must be positioned as close to the bumper as you can but without going under it or it will creates wrinkles.

19- Zip slider installation: it's one of the most difficult operations because it needs patient and precision. The two sliders must be installed on the zip. First they insert one, they close all the zip and insert the other one from the other side. Once done they need to check that all the 4 wheels touch perfectly the ground. If not they need to remove the slider and try another time sliding the zip closure by one tooth.

Fig.29_ Slider installation on the zip

20- Plastic band 2nd stitching: once the luggage is balanced with the zip closed it's possible to stich the plastic band also on the other shell.

21- Bumper fixing holes: a punching machine is used to create 4 holes (2 on each shell) that pass through the shell and the bumper at the bumper end. The holes position is identify just trough the experience of the worker.

Fig.30_ Punching holes

22- Bumper fixing: a plastic pieces with two screw housing it's placed on the bumper and fixed using two screw inserted from the internal part. These pieces avoid showing the bumper seam and maintaining it fixed.

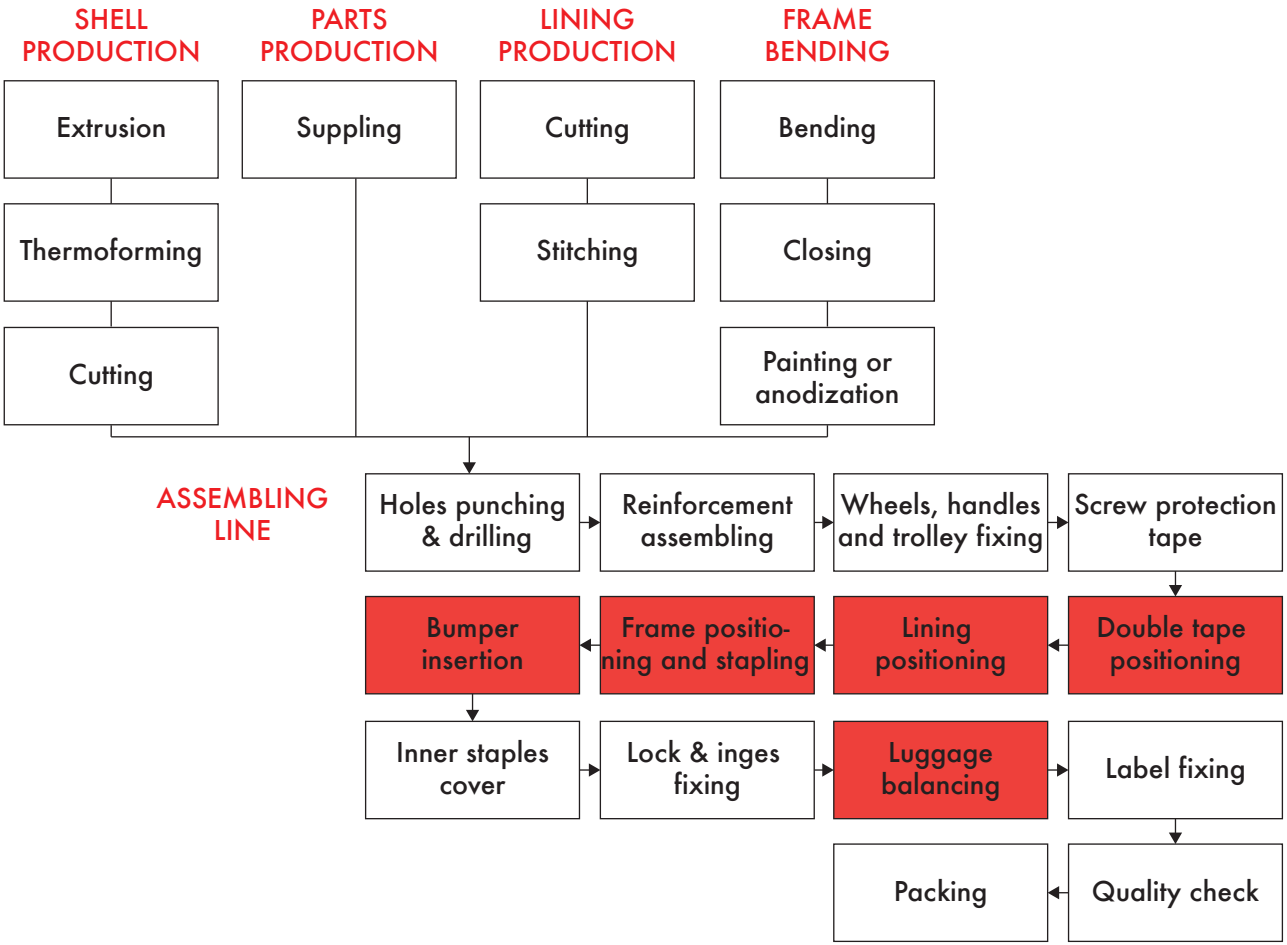
23- Bumper aligning: the two plastic joint are aligned hitting them with a rubber hammer.

24- Label fixing: the cardboard information label are added using some woven or elastic wire.

Fig.31_ Labels fixing

25- Quality check: quality check people occupy the last 4 stations. The first one check the overall quality of the luggage, the second one cuts all the stitching wire in excess, the third one cleans all the luggage's part and the last one makes a final check.

1.3.2.2 Metal frame case production



In a similar way to the zipper case the first part of the production of the metal frame luggage it's in parallel meanwhile the assembly it's in line. Shell extrusion, parts production and lining production are made exactly in the same way of the zip case for this reason i won't present them another time.

FRAME BENDING: The compnies usually purchase from outside some metal bar that

are processed in order to create the metal frame. As said in the point 2.3.1.6 the material used are Aluminium and Magnesium and they are usually shaped in two different buildings because Magnesium bars require higher security standards.
In C&C verything starts from the raw material; the warehouse is fulfilled by thousands of metal profile supplied by an external factory. The QC department usually check the quality of each piece but when the order is very big they just check random ones.
In order to create the frame the first step is punching the metal profile to create the holes for the screw. A punching machine controlled by a worker makes this process.
The second step is the bending in which a bending machine is used to fold with four 90° angle the profile, in order to create a loop. Since every profile is made by to part (one male and one female) it's important to bend it meanwhile the two pieces are perfectly connected. This will help the luggage to get close in a proper way.
Sometimes two recesses are made with a puncher in order to create a recess for the lock housing.
In order to maintain closed the loop the shape is fixed using rivets.
Now we have the final shape of the frame but the process is not already finish. All Aluminium frame must be cooked in order to quench them and increase their stiffness and hardness. This step is very important because during the load on the plane the luggage can be hit very hard and if the frame get damaged the luggage won't be usable anymore.
Only after the quenching it's possible to paint the frame. Not all of them are painted; it depends on the costumer request. In the factory they can use powder painting even for aluminium anodization is the best solution. They have a separate building with 12 consecutive baths. The anodization process consists in sinking the frame in all the bath, from number 1 to number 12. The sequence of the bath is one wash and one anodization. This process is the best for Al frame painting because thanks to some electrolytic reaction the paint goes all inside the metal and not only on the skin. In this way even the frame it's scratched it still maintain its colour.
For some special treatment like chroming the frames are send to external supplier. To avoid colour mistake all the pieces that goes out of the factory is marked with laser engraving.
For the magnesium frame the process it's quite similar. The first big difference is that to work magnesium you mas have an isolated building because is high flammable. The temperature is strictly checked and it must not go over 30 °C.

Opposite to Al that is very ductile Mg is very hard. It needs to be preheated at 260 °C for 20 minutes to avoid crack during the bending process.
Since the profile id very hot after being heated both punching and bending are made with an automatic CNC machine.
As previusly said this metal is naturally hard so no quenching is needed.
Even if metal frame luggage represents the smallest part of hard case market (30-35%) they are very important because they are preferred in Asian and Indian countries that are growing market. In addition, since the technology is allowing producing lighter and lighter frame it is growing up even in western countries.
The main production is based on Al because it's easier to work and paint. Mg is used on top products; it's 30% lighter than Al but 5 times more expensive and in attrition it cannot be anodized.

Fig.32_ Aluminium extruded profiles for metal frame

ASSEMBLING LINE: The assembling line of a metal frame case works exactly as one of a zipper case but involving some different processes like stapling instead of stitching.
The steps that are identical to the zip one will be cited in order to gives an overall idea of the assembling process but they won't be descripted.

1- Assemble line preparation

2- Shell protection fixing

3- Reinforcement assembling

4- Trolley system holes

5- Trolley system fixing

6- Wheels, handles, side feet and hinges holes

7- Wheels, handles, side feet and hinges fixing

8- Screw's head protection

9- Double tape positioning

10- Lining positioning

11- Lining stitching

12- Frame fixing: the frame is fixed on the shell using some staple that can pass trough the Al or Mg

13-Bumper insertion: a rubber bumper is inserted in a rabbet around the external part of the frame in order to cover the backside of the staple. The rubber is pre-heated to makes the process more easy.

14- Internal staple cover: a fabric band is fixed with tape on the internal part of the luggage in order to cover the bottom side of the staple. Some rivets are added to fix it strongly.

15- Hinges installation: 2 or 3 metal hinges are fixed with rivets or screw on one side of the shells in order to connect the two parts of the luggage.

16- Lock installation: two metal hooks are fixed on one shell meanwhile two combination TSA lock are installed on the other. Everything is fastened with screws.

17- Luggage calibration: it is the most important step of the line and it's unbelievable how they do it. Since the male part of the frame must fit perfectly in the female part and all the wheels must touch the ground simultaneously one very experienced man hit the frame and the hinges with a rubber hammer. This little distortions he creates in the frame are fundamental for good luggage usability.

18- Label fixing

19- Quality check

20-Packing

1.3.2.3 Quality test

Suitcases often pass trough the hands of airport workers that maltreated them throwing them during the airplane loading, making them fall down and squeezing them under big mountains of luggage. Even the users can stress wheels and closing sistem overloading the product. For these reasons one of the most important part of a luggage development is the quality test.
In C&C it's mandatory that a suitcase pass all the tests befor going on production. In this way a high quality level is guaranteed. The same tests are made also on some random pieces during the production in order to be sure that the standards are satisfied.
In C&C the test lab is the most technologic room in the factory. Some machine are newer while others are older but they have all the necessary to guarantee high quality products.
Even if usually the parts supplied outside are already tested as singularity they retest them but assembled on the luggage in order to avoid any possible risk.
Tests are made always in the same order in order not to compromise some parts before testing them. It would be useless to let the wheels run on the running machine after having drop the luggage 500 times on them because fore sure they will have some problem.
Every test is made until the goal it's reached and than it is stopped. Testing the item till failure it's avoided because it would take too much time.

Here following all the tests are presented with their specifications. The set of tests is the same for all the dimesnion, the only changes is the load inside (the loads indicater are the one for the cabin size suitcase).

-2 wheels running test: a 20Kg load is insert in the luggage which is inclined in the typical 2 wheels carrying position and fixed on a running machine. It has to run 4Km with a speed of 4Km/h.

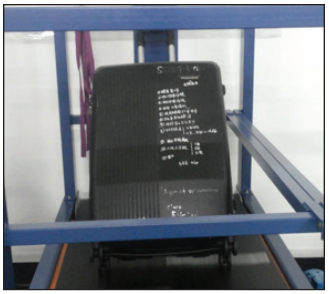


Fig.33_ Two wheels running test

-4 wheels running test: after the two wheels running test the luggage is fixed with all the 4 wheels on the running tape. Load, distance and speed are the same of the previous test.

Fig.34_ Four wheels running test

-Trolley open/Close test: a robotic harm simulates the gesture of extending and contracting the trolley system for 500 times.

Fig.35_ Trolley open/close test

-Handle snatch test: The luggage is loaded with 20Kg and it's fixed on a hanger through the handle. A pneumatic arm connected to the hanger snatch it up and down for 500 times. Both the handle and the shell must not present damages.

Fig.36_ Snatch test machine

-Trolley handle snatch test: after having finished the handle snatch tests (both on top and side handle) the same is done on the trolley system in the extended position. The goal is still 500 times with 20Kg load. The trolley system must work properly after the test.

-4 wheels drop test: the luggage with a 20Kg load inside is drop down on the 4 wheels from a 90cm platform. The test it's repeated 3 times and there must be no damage on the wheels and on the shell.

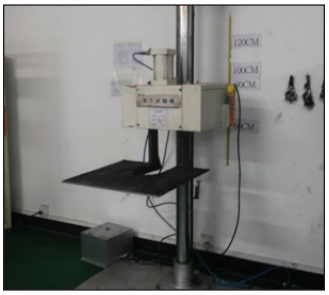


Fig.37_ Drop test machine

-Side feet drop test: it's similar to the previous one but the luggage is laid down on the side with the plastic feet. The drop height is 90 cm and the test is done for 3 times.

-Handle drop test: similar to the other drop test but the luggage is dropped of directly on the handle. Load and height are the same but the test is done just one time per handle.

-Trolley drop test: Same as before but dropped for just one time on the trolley system in the close position. 90cm height and 20Kg load.

-Shell faces drop: The luggage is dropped one time on the front face and one on the back one with the same starting conditions as the previous drop test.

-8 corner drop test: the drop test it's done one by one on all the corner for one time. The load is always 20Kg but the height is reduced at 60cm.

-Tumbling test: it consist in let the luggage stay inside a big rolling machine with some sharp and hard obstacles fixed on the rolling side. The luggage it's loaded with 20 Kg and must resist at 25 cycles.

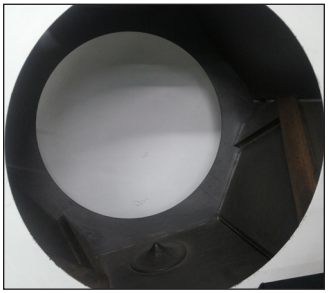


Fig.38_ Tumbling test machine

Once the luggage has pass all the test the production can start otherwise there will be a meeting in which product development discuss on the best way to solve the problems faced.
There are two additional tests that the costumer can require. It's not mandatory to pass them to go on production because they are not structural requirements.

-Waterproof test: a mechanic pipe moves around the suitcase spraying on it some water jets. The goal is not to have water inside the luggage after 10 minutes testing. This test is useful only if the luggage it's designed to be waterproof. If it is not for sure the water would pass trough handle, wheels and trolley holes and trough zip stitches.

Fig.39_ Waterproof test

-Zip opening test: two opposite part of the zip are fixed on two pneumatic arms. An increasing force is applied on both the arms but with opposite direction attempting to separate the joint between the zip teeth.
For this test there is no goal but they have some standard to which the results can be compared.

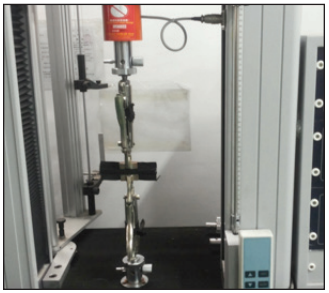


Fig.40_ Zip resistance test

1.7 CONSIDERATIONS

At the end of this detailed analysis of the hard shell suitcase it's easy to notice how this product it's standardized. From one luggage to another it changes the outline but materials, components and assembling processes are almost always the same.
After my internship experience I thought about how this homogeneity could be exploited and what comes out in my mind was: if people don't expect from one product to another to be technically different why don't use customization and provide customers different solutions that come out from a single one.
Customizing a suitcase can be a perfect solution both for the customers and the producers. The first would be involved in a new shopping experience that can bring a breath of novelty in the plane world of the luggage instead the second can reduce the cost investing on a single product that can cover more solutions. Practically it means less mould investment, less SKU (Stock Keeping Unit) to manage and less storaged goods.

2. MASS CUSTOMIZATION

2.1 DEFINITION

According to the Business dictionary the definition of the mass customization is: "Production of personalized or custom-tailored goods or services to meet consumers' diverse and changing needs at near massproduction prices. Enabled by technologies such as computerization, internet, product modularization, and lean production, it portends the ultimate stage in market segmentation where every customer can have exactly what he or she wants."

2.2 INTRODUCTION

"Mass customization relates to the ability to provide customized products or services trough flexible processes in high volumes and at reasonably low cost. The concept has emerged in the late 1980s and may be viewed as a natural follow up to processes that have become increasingly flexible and optimized regarding quality and costs. In addition mass customization appears as an alternative to differentiate companies in a highly competitive and segmented market" (Mass customization: Literature review and research directions, 2000).

Mass customization (MC) concept was first presented by Stan Davis (1989) who believes that MC system must reach customers as in the mass economy but treating them as in the pre-industrial economies. Although this idea was the beginning of a trend that is nowdays one of the most used we have to consider narrower concept that think trough the existence of internet and more recent innovation that characterize the personalization world.
A more useful concept is the one that consider MC as a system that use information, technology, flexible processes and organizational structures to deliver a wide range of products and services that meet specific needs of individual customers. In this way MC reach the customers trough the mass production criteria but exploiting new techonologies provides personalized solution.

2.3 SUCCESS FACTORS

It's easy to imagine how people have appreciated MC after being thrown from crafts products to standardized one trough the industrial revolution. With the customization of the products the system return customer focused and not product focused. It's the product that must be able to satisfy clients needs and not vice versa.
In literature experts present 6 main success factors that justify the use of MC as a competitive strategy.

1. Customers demand for variety and customization must exist. The clients demands of innovative and customized solution it's the first fundamental justification for MC. A good MC system it's characterized by a tight equilibrium between customer sacrifices (price increase, waiting time...) and company's ability to produce and deliver personalized products within an acceptable time and with a reasonable cost.
2. Market condition must be appropriate. In order to exploit 100% MC power it's important to present the system in the market when competitors hasn't done it yet.
3. Value chain should be ready. All the value chain from (supplier, distributors, retailers...) must be linked and involved in the MC system creating an efficient network very close to the company.
4. Technology must be available. In order to create a good MC system companies must implement the advanced manufacturing technologies and match them with the information technology in the value chain.
5. Products should be customizable. Companies must be able to rapidly personalize and develop new product in front of an always wider and diversified demand that shorten the products life.
6.Knoledges must be shared. The aim of creating new product in front of new customers demand must be supported by the spreading of the knowledge in all the network cited in the point 3 (value chain).

Trough this point it's easy to notice the complexity of creating a MC system because it involves an increased product configuration, the organization and the direct control of the value chain and the use of new technology mixed with the information collection. In any case despite all this complexity MC can be one of the best strategy that companies can exploit if the requirements are satisfied.

2.4 FOUR FACES OF CUSTOMIZATION

After several years in which there was no frameworks with the increasing success of MC experts started studying this phenomenon. They identify 4 different approaches that are adopted in MC strategy: collaborative, adaptive, cosmetic, and transparent. All this approaches are slightly different but they represent 4 possible ways that companies can undertake in order to serve costumers in a proper way. In some case a single approach will dominate the design but more often it's a mix.

2.4.1 Collaborative Customization

Collaborative customizer conducts a dialogue with the individual customers in order to help them finding their needs and solve them with the best customized solution.
It is generally associated with the term mass customization and it's appropriate in these kind of business in which the customers has in front plethora of options and the company guides them to the best solution.

The easiest example it's the car sale in which the seller helps the buyer in the configuration of the new car from the engine selection to small details such as the material of the gear shift knob.

Fig.41_ Online car configurator

In the collaborative customization the client has to make a onetime decision based on difficulty combinations and compromises like comfort for fit, or complexity for functionality and the company has to work directly with him in order to determine the best configuration. The key point it's the dialogue between this two part and since the complexity of the options it's quite high the assistant is usually a real person.
A good point of the collaborative customization is the customer involvement in the designing process. In this way the perception of the personalization rise up and clients feels like they really made the right choice to solve their needs.

Looking in the market there are thousands of companies that exploit MC in a collaborative way. One of the most influenced sectors it's the "tailor made" where the products must physically change in order to fit on the customer.
Paris Miki, an eyewear retailer with the largest number of stores in the world, developed Eye Tailor, a system that analyse the customers face and trough a set of statements on the desired look suggest lens shape and size showing them on a digital platform. After that the optician adjust the lenses until the desired result is reached. In the same way the customer can select all the other parts of the glasses.
Another company is Santoni, a shoes brand that creates tailor made products trough measurement and feet scan in order to have the best fit as possible.

2.4.2 Adaptive Customization

"Adaptive customizer offers a standard but customizable product designed so that users can modify it themselves." (The four faces of mass customization, Harvard business review.)
This approach is good when customers want the product to perform in different ways in different occasions.
The goal it's to create a standard product that can be easily modified and reconfigured without the direct interaction of the company, in this case it's the product itself, rather than the provider, that interacts with the customers.
It's the case of Lutron Electronics products, an illumination company, that thanks to the technology enable customers to crate different lighting settings. The product it's only one but the user can set it choosing from a normal light to an atmosphere one just trough a control panel.

Fig.42_ Lutron Electronics control panel

The collaborative one is the right approach when customers have to choose from a vast number of elements or components to get the desired functionality or design. But when all the possible combinations can be included into the product, adaptive customization becomes a promising alternative for efficiently making many different options available to each customer.
Differently from collaborative customization that makes the client interact in the designing and configuration phase, the adaptive one gives to the user an active role in adapting the product to his needs.

Fig.43_ GoPro camera and accessories for configurations

One of the main characteristic of the adaptive product it's the modularity. The company designs the product with the possibility of using it in different configuration.
The GoPro it's a perfect example of adaptive product. It's a standard sport camera with a modular construction that allows changing the fixing system according to your needs.
It's important to underline how in order to be considered adaptive a modular product must be designed and thought to have different configuration. The GoPro for example it's shaped and thought to fit on several accessories in a different way an iPhone it's not designed to be insert inside a cover but it's the cover maker that shape it's product to fit on it. That's the reason why the iPhone it's not adaptive.

2.4.3 Cosmetic Customization

Cosmetic customizers present a standard product differently to different customers.
It is used when the product works always in the same way but the customer wants it to be presented differently.
When a company decide to work on the product appearance it's important to be sure that its characteristic satisfies almost every customer. Once the standard product it's suitable for all the market it's very easy to modify its aesthetic aspect.
Some luxury brands like Luis Vuitton customize their bags just printing on them the customer name.
When performed well, cosmetic customization replaces piecemeal and inefficient responses to customers' requests with a cost-effective capability to offer every customer the exact form of the standard product he or she wants.

Fig.44_ Louis Vuitton customized bag

NikeID allows the customer to customize a standard pair of shoes with a small extra price. Trough an online configurator the client can select different colors and materials in between some pre-set options and visualize an image of the final result.
Similar cosmetic customized product can be the O'Neil customized surf suite, on which you can select the color of some parts; the O-Bag, a plastic bag you can easily customize inside the shop selecting different handles, linings and accessories; the custom Oakley, you can color and choose the lenses; and more others.
Often this type of personalization can be made directly by the costumers trough other object or accessories that have no relations with the product to customize. The mobile phone cases are for example selected more for their appearance than for their protection level so that they can be considered a cosmetic customizer. Other products like laptop stickers or helmet suckers works in the same way decorating the base product.

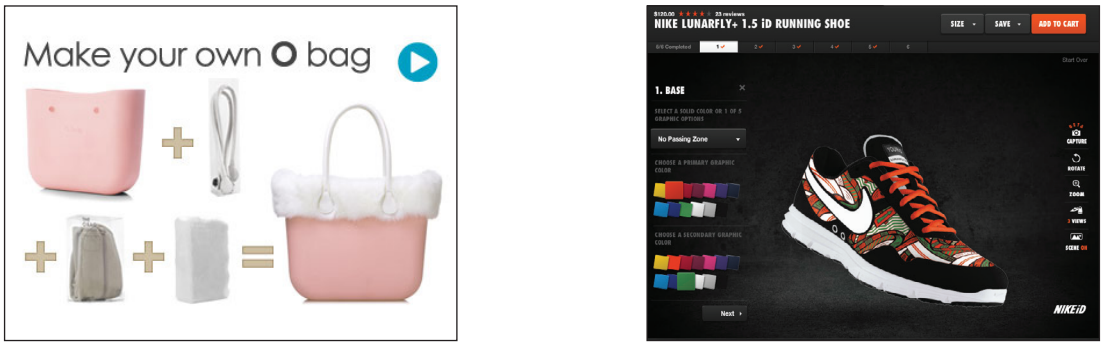


Fig.45_ O-bag and Nike ID configurator

2.4.4 Transparent Customization

"Transparent customizer provides individual customers with unique goods or services without letting them know explicitly that those products have been customized for them." (The four faces of mass customization, Harvard business review.)
Even if it appears more invisible than transparent it is easier to apply more on services than on products. It works where the customer doesn't want to repeat his needs continuously or they are obvious. It happens often that clients buy transparent customized products or services without even knowing they are not standard.
A Ritz-Carlton client books a room with a standard package but in reality it is not standard at all. The hotel system has registered all his preferences recorded during his previous staying so that his pillow won't be a normal pillow but the one desired without asking.

Fig.46_ The Ritz-Carlton logo

The most difficult part for this type of personalization is to reach a deep knowledge of the users in order to move progressively closer to meeting all the individual preferences.
In a totally opposite way to the cosmetic approach in this one the tailor made product it's presented in a standard package in order to hide its oneness.
Another example is ChemStation in Ohio which under the continuous monitoring of the customers thank provides to the customers new car soap before it finish and personalise the Chemical formula according to the car wash customers habits.
Transparent customization it's the result of a continuous research on customers personal needs.

2.5 MARKET TRENDS

According to some surveys made from Anderson analytics "MENG Marketing Trends Surveys" customization it's on the lower step of the podium since 2007. Provide personalized products and solutions it's a trend that it's growing up always more and more.

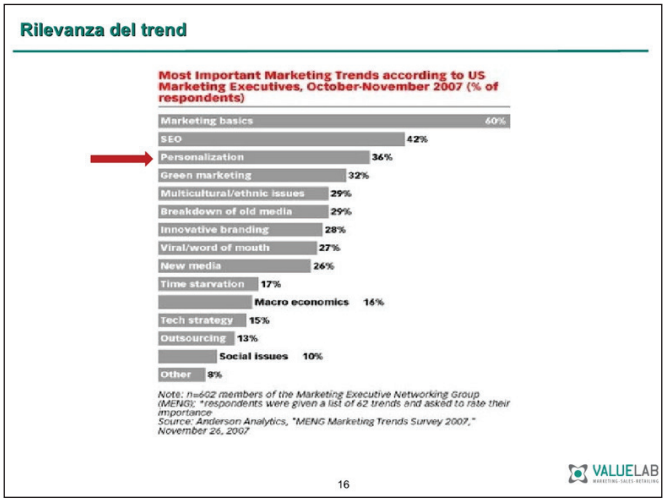


Fig.47_ Marketing trends chart for US market (Anderson analytics, MENG Marketing Trends Survey.)

Looking at nowadays market it's easy to find thousands of customizable products from cars to electronic devices, from bags to furniture... Producers understood that users have different needs and it's possible to increase the success of a product adapting it to each clients dream. Different studies show how the market has been split from a single mass to different segment represented by group of customers or sometimes even from a singularity. The companies' challenge it's to provide the best solution to all them maintaining the advantages of the mass production. For a mass customization oriented company it's important to understand the "common uniqueness" of its customers in order to understand the differences between what they are offering and what customer desire and identify which are the options that people would like to have. Once the company has understand what clients want it can work on the four faces of customization in order to provide the best solution. For sure altering the product itself it's a solution but experience has shown that even changing the only appearance work as well. Different products and situation requires different solution and companies must

be able to find the best one trough market research.
It's important to underline that speaking of product changing means the customization of functional parts, the one that modify its function, performance or utilization. The appearance change modify instead only the item imagine in front of the customer, its aesthetical aspect.

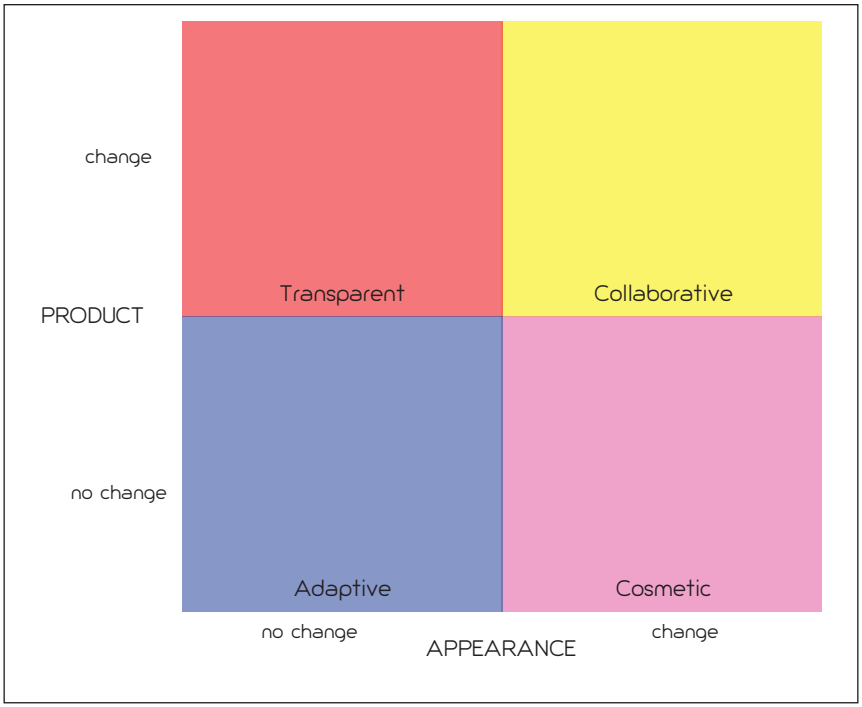


Fig.48_ Four faces of customization chart

This chart shows how each approach has a different influence on the product.

Collaborative customization it's the most invasive choice, it changes both the product and the appearance. Since the customization it's that deep the customers usually need a guide helping them to find the best solution.
In the car market the client it's helped in selecting options that modifies both the product and the aspect. For example he has to choose the engine type and size, selecting the performance of the product, but also the external colour, customizing only its appearance.

Adaptive customization it's opposed to the collaborative one, the company provides a standard product that can be easily modified by the customers. As the word standard suggest the product must remains always the same. It's easy to think about it in the case of Luton's illumination system where the same product with the same light source can change the result. It's more difficult if we think at the GoPro, at the first look it seems that the product change every time users change the support but the key point is that we have to consider as an unique product the camera plus all the support as it as been thought and designed. The modular concept it's something that born to be adaptive and all the components must be considered as a whole object for this reason.

Cosmetic it's maybe the most used one because it's also the simplest one. It brings no changing to the product but makes customer believe to have something personalized changing its appearance trough packaging, materials, products names...
Even you can find 5 to 10 different coloration of a Nike shoes model is it also possible to select the parts colour by yourself increasing the number of options thousands of time. The product it's exactly the standard one with same shape and characteristics making the customization even easier to be produced trough the mass customization process.
Another advantage of changing just the product appearance it's that the client knows he is not changing important details so he can sustain the personalization process without any help, usually trough digital platforms that show a product preview.

Transparent customization it's instead the opposite of cosmetic one. With a transparent approach the company provides inside a single packaging that makes the product (or more often the service) appears standard different solutions.
Ritz-Carlton wants that its customers can book a room in a standard way in order to simplify their work, the personalization it's hidden from outside but the users knows he will find a customized solution with his favourite pillows, newspapers and other small details.

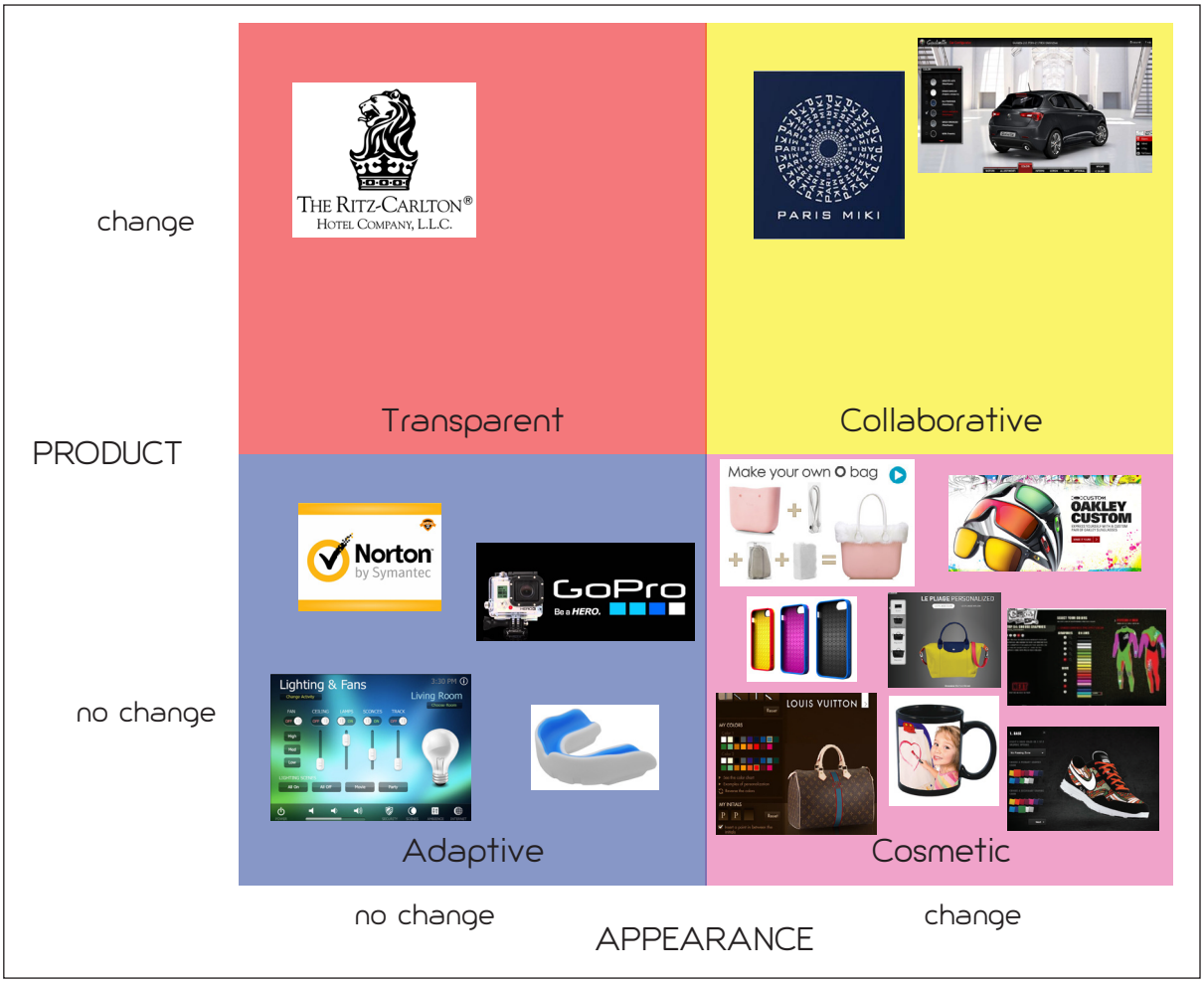


Fig.49_ Products identification of the customization type

After a quick market analysis it has been possible to see how the cosmetic customization it's the most used if we consider just the product and not services. It has been already explained why this approach it's simpler than the others but gives equally good results and since the luggage has a quite standard utilization that satisfy almost on the customers the focus will be on the appearance of the new product.

2.6 USER INTERACTION

In addition to the four faces of customization, that represent some possible solution for the companies, it's important to analyse the interaction between customer and product. It's very important to understand when does the personalization occurs and how it is made.
In order to better understand this situation it is possible to split in two different periods the product life and to differentiate the way to customize in order to group the existing products in different subgroups.
The product life will be divided in 2 different parts: before-sale customization (BSC) and after-sale customization (ASC), instead the way to customize will be shared in personal customization and mass customization, the thin division line between this two parts is the type of production: mass production or craft production.

2.6.1 Time Interaction

2.6.1.1 Before Sale Customization (BSC)

As the name suggests all the products that can be customized before being bought belong to this group. Looking at the market the majority of the mass-produced items exploit the BSC because in this way it's possible to reduce production cost and increase the level of the personalization.

Companies generally choose a package of possible features that can be modified and customer take part actively in the configuration of the product. Providing a sort of pre-set customizable levels the companies choose the variability of the pieces according to the production cost. It's very important to provide the more options as possible with the lower cost, as simila as possible to the cost of a standard production.
One important point of the BSC it that since what the client is creating doesn't already exist it's possible to reach a deeper level of customization modifying also structural and functional parts. During a car configuration it's possible to choose the engine type because the car isn't assembled yet or in the Nike-ID it's possible to select the tissue

colour because it hasn't been stitched yet.
The downside of this point is that clients are buying a product without having it in his hands. Here intervene the companies providing tools that help the client in the shopping experience.
The most used it's the virtual configurator which trough renders and photos show the final result reassuring the client on his choice. In some Asian big city since spaces are very tight Audi opened some dealership in which there are just a few cars and a big virtual configurator that shows all the characteristic in 1:1 scale. It is even possible to hear the sound of the different engines.
95% of the configurator are online and allows people to create their own product and buy it by themself. For sure this solution appears "colder" because there is no human interaction but it permit to extend the shopping experience 24h on 24 giving an immediate feedback and reducing managerial costs.
Opposite to the web configurator there is the direct shopping experience where the clients interact with people helping them in the creation of the product. Even more expensive the direct experience it's better when the client need to touch ad feel the product. O-bag has a web configurator but they opened also a lot of shops in order bring the clients near their product. In the shops it's possible to wear the bag, to touch the different materials, to try the different accessories...

Fig.50_ From the left: O-Bag stor, Audi City virtual shop

In the direct experience the feedback moves from virtual to real, maybe it wont be 100% equal to the desired configuration but it can give a real idea of the final choice. Whereas virtual or direct providing an appropriate feedback it's one of the most important things for two reasons: the first one is that people are paying for something they won't have immediately and they have not seen and tried for real; the second one it's the irreversibility of the customization in most of the cases. BSC allows in fact reaching a deep level of personalization, that deep that is supposed customers doesn't need to modify it anymore. Apart from some few products in which a second modification is presupposed what is produced with a BSC it's not reconfigurable anymore. Sometimes it's possible to make changes but it's very expensive.
The more companies can reassure on the final results the more will be easy to sell.

2.6.1.2 After Sale Customization (ASC)

Despite it can be considered a second level of customization it's possible to personalize the product even after sale. In this case the difference consist in the fact that customization it's external to the product itself and usually it works in an additive or substitu tion way.
Even if it's possible to customize it with a BFC choosing between 3 different colours the iPone still looks standard, how can people make it more personal? Here comes the ASC, in the market it's possible to find some products that has no meaning by themselves but they are made in order to customize other item. An empty iPhone case it's useless but once fit on the mobile it becomes a protector but even more a way to customize it.
It's very interesting how customization has the power to create a market outside the product itself.
As for the BSC ASC can be used just to modify the appearance of the object (cosmetic customization) but also to modify its characteristics; some cases can makes a mobile waterproof.
The plus of the ASC is that the products already exist and clients have it in their hands. This allows creating additive or interchangeable "customizators" that can bring a reversible personalization in order to leave the possibility of coming back to the standard situation.
ASC represent the people desire of making the products unique and personal because in 99% it is superfluous since items are made to work even without it. Clients can pay even up to 20€ for some particular laces that can customize a white Superga paid 50€.

2.6.2 Emotional Interaction

2.6.2.1 Standard Customization

Under the term standard customization we indicate all the products customized trough the principle of mass production. IPhone colours, cars engine and shoes lace are all items produced in series and they provides a kind of "standard" personalization. All the variables, colours, materials and so on are chosen by the companies and give the clients the only possibility to match them. The results can appear unique because customization follows combinatorics and with a small number of editable parts it's possible to have several configuration but it wont never be the direct expression of the customer.
It's the maximum level of personalization because it goes out from the concept of mass production. The aim it's to customize a mass product in order to make it 100% unique. Converse All-Star made a limited edition with total white shoes and fabric marker in order to create a personal product. Is the customer who decides how to make it and since the process it's handmade even if someone will try to copy it the results will be different.

2.6.2.2 Personal Customization

Opposite to the standard one we consider as personal customization all the personalization that comes out directly from the client. It is not something standard to choose from but conversely it's 100% personal.
The personal customization represent 100% the customer desire instead of getting closer to it giving the product uniqueness.
The easiest way to have a personal customization it's trough handcraft and self-made. Converse All Star sold a special package with total white shoes and some coloured pencil to colour them. This dimension goes deeply in the client feelings and has the aim to show his personality.
Thanks to technology it's possible to have personal customization even exploiting the mass production. Using some printer it's possible to provide Burton a picture and they will print it on a standard snowboard. It's the same principle of the nikeID but in this case customers don't have to reach the desired result mixing some pre-set parameters

but he can achieve it in a totally free way.
Through personal customization it's possible to reach the deepest level of personalization connecting the product to the user in a exclusive way trough his feeling.

2.6.3 Market Chart

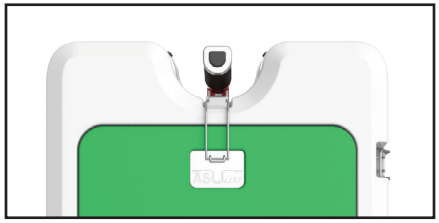
Fig.51_ Product positioning in a BSC Vs. ASC and standard Vs personal chart

Trough this chart it's possible to plot a two axis diagram that intersects the time interaction with the sentimental one in 4 different quadrants.
The top left zone it's the one characterized by a before sale standard customization.

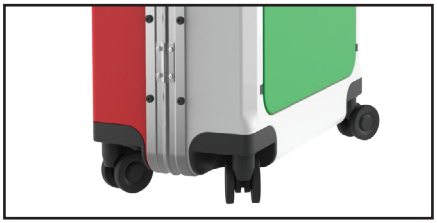
It's one of the most used sections because it easily matches with the mass customization requirements.
Bottom left represent instead the before sale personal customization and the most of the product in this zone are characterized by a cosmetic personalization because it's the most simple and cheap way to give customers an appearance of exclusivity.
Going on in a counter-clockwise way there is the personal after sale quadrants. Here there is the maximum expression of the customization. Product's here are usually personally personalized or they are results of a crafts work. Mass production becomes less important in this zone because the differences between users needs are too wide and it's impossible to find common solutions.
Last but not least is the standard after sale zone, very important because it permits a market expansion. For the creation of a single product this zone give the possibility of the designing of tens of product to customize it.

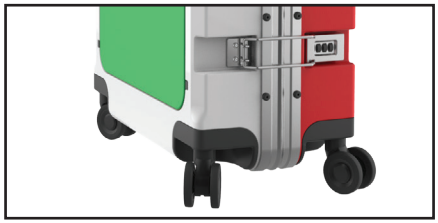
2.7 CONSIDERATIONS

Here at this point both the parts of the analysis are done and it is possibe to wonder wich is the best way to customize a suitcase and how is it possible to do it mantaining the advanges of a mass production.
In order to answer to these questions it's important to consider that customers are usually unprepared on this type of product. They usually don't know which material is better, which wheel is more fluent and which trolley is more strong so it's important not to give them the responsability of making choice they are not 100% able to support.
In my opinion the kaypoint of a suitcase personalization must be the COSMETIC customization that can work on the shells colours and finishing. It would be amazing to give the clients the possibility of modify individually all the shells.
Beside the cosmetic customization I think it would be important to provide an ADAPTIVE one for the closing system in order not to lose a market segment just because it has one of the two possibility.
Being the luggage a technical product it's more suitable to work on a standard customization rather than a personal one. This approach is very popular in between technical goods because trough a simple cosmetic customization it is possible to makes the product more suitable approaching it to the world of fashion and design.


3. PROJECT





3.1 BRIEF

The aim of the project is to design a customizable luggage that can be partially assembled directly in the shop without particulary complex tools and specialized clerks. The goal is to reach a deep level of cosmetic customization on the shells and to find a simple and unique way of assembling the two closing system on them.
During the desing phase the focus was on the mounting phase in order to simplify it mantaining all the characteristic of the hard shell suitcases.
The idea is based on a cabin size suitcase because this size is the most complex situation since it is the only size that present the front, easy accessible pocket. Anyway all the parts can be adapted in order to fit on the bigger size.

3.1.1 Keypoints & constraints

As described in the part 2 the suitcase can be considered a durable product that has to sustain high efforts when used. Its life cycle is around 5 years due to the low rate of development of this kind of goods and it is usually replaces with a more performable one even if it is still working.
The quite long life it's a point in favour for the CUSTOMIZATION because people are willing to spend the increase of price required by the custumization if they know that the item will last in time.
In order to be deeply customizable the customer must have the possibility to modify the parts that most change the lugage appearance like the shells and the closing system.
The PERSONALIZATION EXPERIENCE must be mostly direct. It can be supported by a digital platform but the direct contact is important because customers are usually not expert about this kind of item and for this reason before buying it they want to feel it, to open it, to check the details and the size...
All these things bring the project to create a product that can be partially assembled in front of the client but this results impossible with the processes currently used inside the factories. Stitching and stapling requires expensive and dangerous tools and quilified peolple. An EASY & STANDARD final ASSEMBLY it's required and in order no to cover just one part of the market both the closing method must be adapted to a single

installation process in order to fit them on the same shell in the same way.
The semplification of the most complex assembling process can be exploited to STREAMLINING THE ENTIRE SUPPLY CHAIN. Nowdays the suitcases produced in china are packed one by one but in this way 95% of the volume in the box it's empty. Immagine how much semifinished shells could fit in the same box decresing drastically the transportation cost.
Even more important is that importing some semifinished parts that have nosense unassembled it is possible to put the label ASSEMBLED IN ... when all the pieces are fixed together. The origin of the product can be really an important factor in the luggage market where the biggest part of the products comes from the same country.
The shells and all the componens can be produced in China with lower costs and shipped to the other countries storaged in a proper way reducing the volumes up to the 90%. At this point the company can assemble in its country all the components that are also now easy to fix but it would be useless to do it if the two shell were already joined together. As last step the company can deliver to the shops the semifinished pieces that will be assembled at the moment of the deal. In this way the shops wearhouse could storage more unassembled suitcases compared to a finished one.
The new product must also have a high USABILITY beeing at the same time PRACTICAL and TECHNICAL. As it will be the first of its kind on the market but thanks to its customizability it will appear in different ways the product must have some DISTINCTIVE CHARACTERISTICS that permit to recognize it.
It's important to consider also two important DIMENSIONAL constraints, one set by the market while the other by the nature of the user.
As the project is based on a cabin size suitcase it must respect the IATA (International Air Transport Association) dimension restrtictions that set a maximum size of 5500x4000x2000 mm door the carry on bags. It's important that the product stays on the limit and not within because as the luggage it's used for transporting goods the more space you have the more things you can fit inside.
Keep talking about dimensions all the suitcase's parts must be ergonomical so there won't be aspect that can collide with the anthropometric characteristics of the users.
The weight of the product must be limited in order not to be excluded a priori after having been compared with others products by the clients. (This constraint it's more important on the bigger size because on the cabin one the restrictions are usually the dimesions)

Summarizing in a more schematic way the keypoint and constraints are:

-CUSTOMIZATION: The product must be customizable before sale.

-CUSTOMIZATION EXPERIENCE: The personalization process must involve the customer in a new experience. The real direct approach is preferred to the virtual one.

-EASY & STANDARD FINAL ASSEBLY: The final assembly must be made by unspecialized workers and without complex tools. It's important to have a single standard proce dure both for zipper and metal frame closure.

-STREAMLINING THE SUPPLY CHAIN: Having semifinished products untill the final sale can be exploited to improve the supply chain reducing shipping and stocking costs.

-DISTINCTIVE CHARACTERISTICS: The product must have some standard identifica - tive point that allows people to recognize it since it will appear in many different ways thanks to its customizability.

-DIMENSION: The cabin size must observe the IATA restrictions and all the parts must not collide with the anthropometric characteristics of the users.

3.2 CONCEPT

The concept phase was fundamental for the project as it rapresented a climax trough the final product.
It was extremely usefull in finding a proper aesthetical aspect but even more in studying the best ways to solve all the issue that came out from the standardization of the different closing and locking system installation. It is incredible how hard can be to mix two simple solution.
One of the issue I spent more time on was closing system. I believe it's important to give the customers the possibility of choosing between zip or metal frame but how this two solution can be standardized? In the current production the metal frame is stapled while the zip is stiched and in addition they requires two different locking system because the first needs a mechanism that mantain tight the two part of the frame instead the second one needs to block the zip puller.
All this problems was made even more hard by my not beeing able to think about the luggage as an object i didn't know nothing about. The knowledge aquired during the internship on the suitcases parts and production did not allow me to dare and going far from the current idea of luggage.
Moving far from my experience and approaching this type of product just under the point of view of a designer the idea of the rotaded trolley handle cames out. This idea is the result of a mixed analysis between user interaction and product structure and it gives an innovative appearance to the product.
As the core of this work is the customization developing concepts helped me in choosing the sets of part that can be personalized, the colours & finishing and the assembly ways.
The final result comes out analyzing the pros and the cons of each solution and creating a match that doesn't go too far from the current products.

3.3 FINAL PROJECT

3.3.1 Dimension

The final product was dimensioned according to the anthropometric and the IATA constraint. Its overall dimension fit exactly the 5500x4000x2000 mm requirements in order to be inserted in the metal cage airplanes companies use to check the dimensions. It is possible to stay on the limit and not within it because the polymeric shells are a little bit flexible so that even in case of overloading the luggage can be sqeezed. All the components are integrated as more as possible in order to exploit in the best way all the usable volume but always considering also the function.
The trolley handle is positioned in order to waste as less space as possible but it's function requires at least 30 mm of empty space around it in order to be grabbed. The same compromise was made on the wheels. Integrating the housing inside the shell it's possible to exploit the empty volume in between the 4 wheels but the function requires that the suitcase has to runs also on rough surfaces so there will be a minimum gap of 30 mm between the lower part of the shell and the ground. This dimension was taken by from other existing luggage on the market, in particular from Rimowa that was the first company to exploit the recessed wheels.

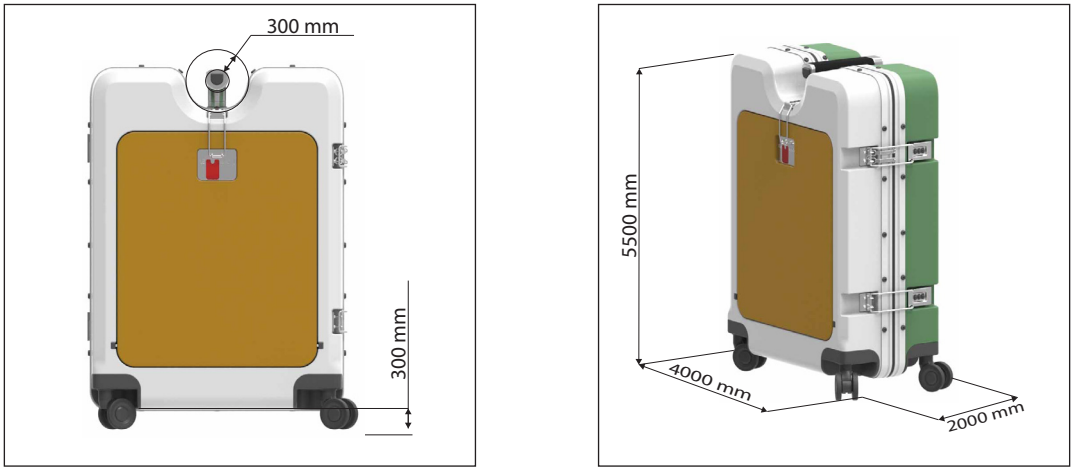


Fig.52_ Product overall dimensions

3.3.2 Parts and components

3.3.2.1 Shells

The most visible part of the suitcase are the shells. There are 3 of them: a back, a front and a pocket one but on the bigger size their number could decrease to two (back and front).
As the goal was to create a customizable and easy assembled luggage I dind't push to find particullary new materials or processes outside the polymeric world but i simply analize it finding the most suitable solution.
Considering a batch of 10000 pieces the best things was to choos the PC as it allows to create thinner shells compared o ABS that is more stiff but less flexible.
For such a batch the best process is thermoforming because the initial investments are really low compared to the injection moulding even because the mould dimension is not that small. The choice of the process creates me some constraint during the desi-gning phase of this parts obliging me to put draft angles on all the vertical walls.
Even in all the shells the cutting lines are all on the same plane this process will be made by a robotic arm because of the high number of holes that the back and front part has. The robotic arm cutting was choosen also becuse the holes position must be very accurate in order to easily install the frame.
All the shells will be provided 3 continuous colours plus 3 seasonal ones following the current luggage's market trend. For each color there will be two finishing: one with a small granular emboss that will appear more matt and a shiny one with no emboss.

Fig.53_ Shells and finishing

3.3.2.2 Trolley system

The trolley system is very similar to the existing single pipe one but for the handle that is oriented in a completely new position.
Due to the short cabin size height the product requires a system of 3 concentic pipes to allow the telescopic system to reach 1000 mm height.
What is new here is the assigning of a new fuction to the trolley handle infact that is used not only to carry the suitcase in the extended position but also to lift it in the closed one.
In reality this new function is not that new because sometimes people already do this gesture of lifting the luggage from the trolley instead that from the handle even if it is a mistake since the designers usually place additional handles for lifting the suitcase.
This improper use helped me a lot because it brings the trolley system producers to create mechanism that can resist to this type of traction loads so that i just need to redesign the handle exploiting the existing pin mechanism.
The pipes are standard pieces but usually trolley system producer extrude customers pipes with the desired shape without big problems. They are made of Aluminium 6060 because it is the best compromise in between weight, resistence and price and they are shaped trough an extrusion process. An anodization treatment is done on all the pieces in order to avoid corrosion and colour the metal.
The two main parts of trolley handle are instead made of Zamak and shaped with die casting. For this part metal has been preferred to plastic even if it is heavier in order to makes percipt to the customers a feeling of resistance. Even these parts are treated wirth a galvanic process that avoid oxidation.
The cold perception of the metal will be avoided threading a vulcanized rubber cilinder over the handle made with injection moulding.
Also the mechanism button and all the plug are made with injection moulding but using ABS.
The trolley handle is fixed on the pipes structure using self_threading screws. Similar screws are used also to close the two parts of the handle once the mechanism is installed.

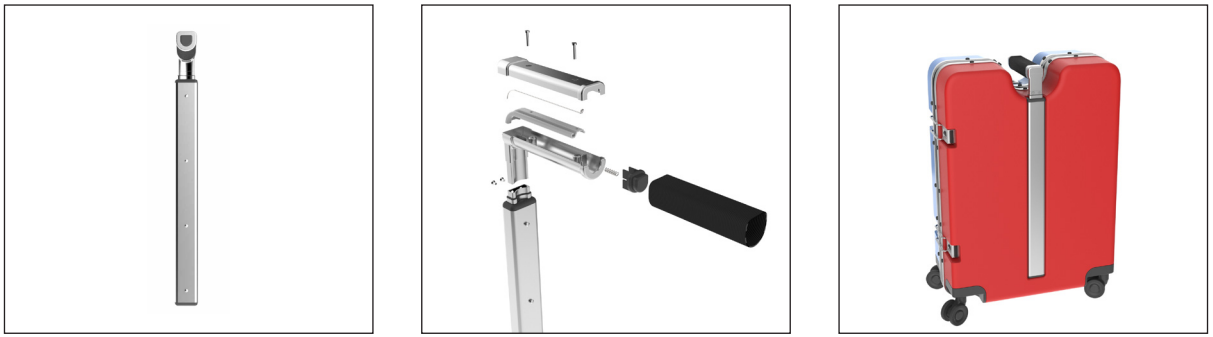


Fig.54_ Trolley system and trolley handle exploded view

3.3.2.3 Closing system

The closing system is quite innovative and is the results of lots of reflections.
The metal frame is very similar to the one already used, as similar that the two profiles are standard pieces made of Aluminium on wich are drilled several holes that will be used for the fixing. The holes positioning must be very accurate because it will influence the luggage balancing. Two stainless steel AISI 316 inges are pre assembled on the frame with rivets.
The zipper closoure is instead totally different. A standard high resistance zip is stitched on a flexible PVC extruded frame. A set of 18 holes are punched on the two parts of the frame exactly in the same position of the ones made on the metal profiles. The assembling metod of both metal or plastic frame is very easy since it is done using snapfit so that it can be easily processed inside a shop.

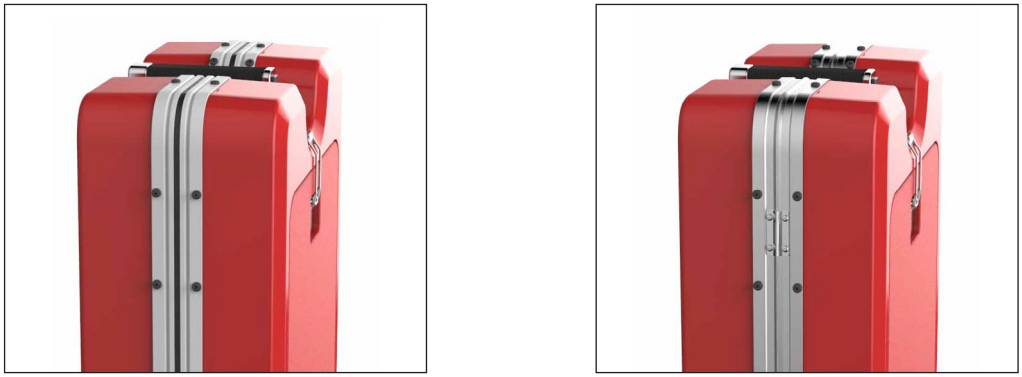


Fig.55_ From left: Plastic frame zipper closoure and metal frame closoure

3.3.2.4 Locking system

The locking sistem is based on an extension of the classic metal frame lock. Exploiting a standard mechanism but changing the hanger it has been possible to have a single locker that works for both the frame. The system tighten the front and back shells in the closed position providing also a location where the zip puller can be blocked. In order to guarantee a good closing force the case needs two locks.
A similar solution but without the zip puller housing is used to close the front pocket.
The hangers are made of slightly brushed die casted stainless steel AISI 316 and are fixed on the shells using rivets. The same fixing method is used also for the combination locks.
The locking mechanism exploit Z shaped sistem of joints in order to tilt troward the hanger in the opened position. This little movement allows the bar to pass over the two hooks so that during the locking pase it slide back creating a interlocking. The combination can be setted rolling the numbered cylinders and once it is right the user can push the button on the back side to open it.

Fig.56_ From left: Plastic frame lock, metal frame lock and front pocket lock

3.3.2.5 Wheels

The wheels are a standar double whells but in order to fix them on the shell the housing must be adapted to the new outline. This kind of wheels is the most used in the market because they provide great stability and a smooth sliding.
The housing is made with ABS and produced with injection moulding. It is not a complex piece because it doesn't requires movements for undercuts. The top part is characterized by some reinforcing ribs that increase the stiffness and distribute the weight on the shell. It is fixed using self-threading screws inserted from the inside.
The housing design is concave in order to reduce the loss of space as much as possible. This shapes helps also to protect the wheels and lowers the center of gravity increasing the transportability.
The wheels are purchased from Hinomoto, the best wheels producer in China. As the housing they are also made mainly with ABS but for the parts that lays on the ground that are overmoulded with a PU ruber. There are some metal components for the internal joints but no bearings are used in order to reduce the weight. The smoothness is guaranteed by the low friction and some grease.
One plus of this type of wheels is that they can be unassembled from the housing without removing it from the shell simply using a screwdriver.

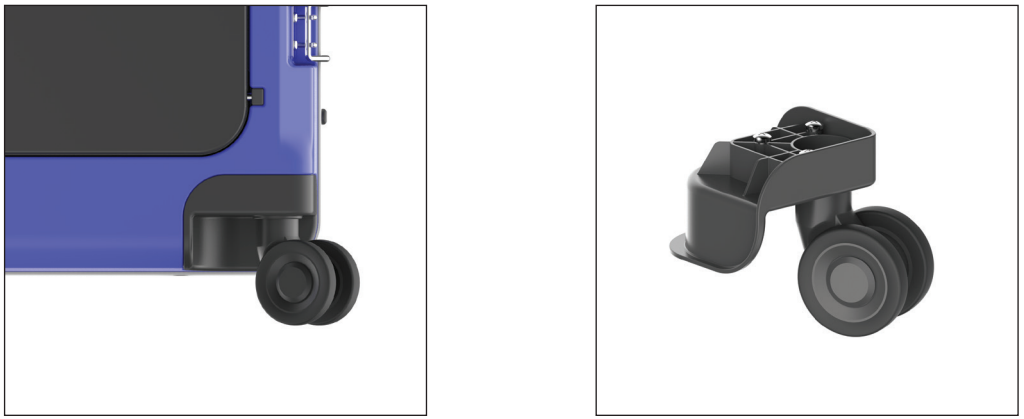


Fig.57_ Whells housing and wheels

3.3.2.6 Front pocket

The front pocket is nowdays a must have for the new cabin size hard suitcases because it permits to have an easy accessible compartment without open the whole luggage. This part is usually fixed on the main shell with a zip but in my opinion this is not the best solution because the user has to bends down in an uncomfortable position in order to unzip all the profile.
The solution i found is more intuitive and permits also to assemble the front pocket without using tools so that it can be done inside the shop.
The system is very easy: two injection moulded ABS pieces are pre assembled on the front shell using self-threading screws. This two parts works as housing for two pins that are previously installed on the pocket shell. The joint can be created deforming a little bit the pocket shell that is flexible thanks to PC proprieties and the tight thickness.
A flexible PVC extruded gasket is stitched on the contour of the pocket shell together with a part of the lining and the locking system is the one described at the point 3.3.2.4.
I decide to use this mechanism for the procket because it allows an easy installation but also because it is more comfortable as the user jus hast to reach the top of the suitcase and not the bottom like with the zip system.

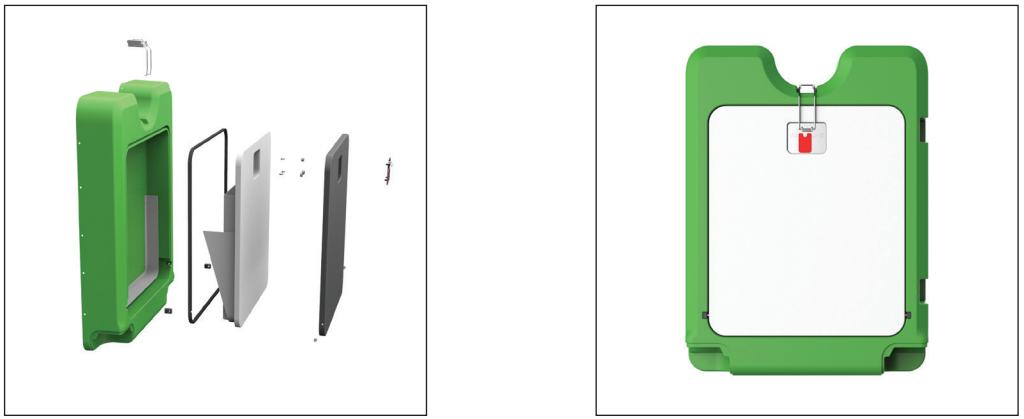


Fig.58_ Pocket system exploded view and front view

3.3.2.7 Lining

The lining of this product are thinked to be easy mountable. They are characterized by 3 main textile shells shaped thermoforming a laminated famibric. The two materials used are a thin layer of expanded Polyethylene matched with a layer of Nylon fabric. Having a thermoformed fabric is very usefull because it can be installed simply positioning it inside the polymeric shells. Its position will be fixed in the two main shell by the frame and by the stitched profile in the front pocket.
Another advantage of using the laminated fabric is that the shells can be used as bases on which additional parts like the separators and hangers can be stitched on.
The material is waterproof to that it can be easily cleaned with a wet sponge in case it gets dirty.

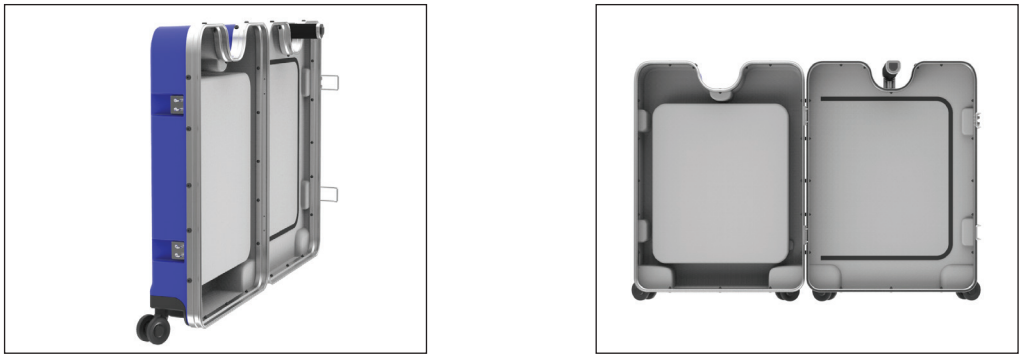


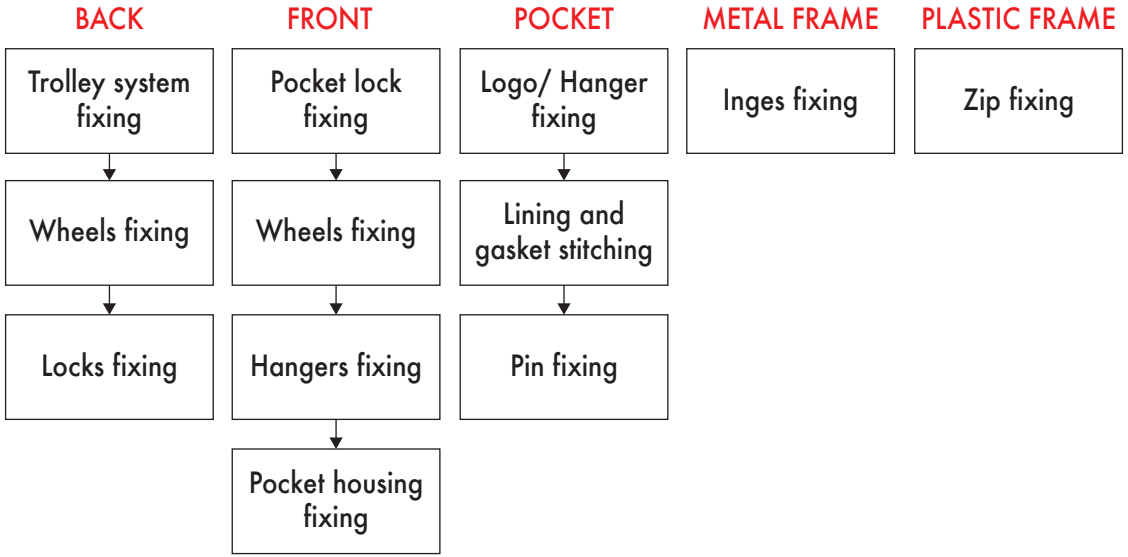
Fig.59_ Front and back lining

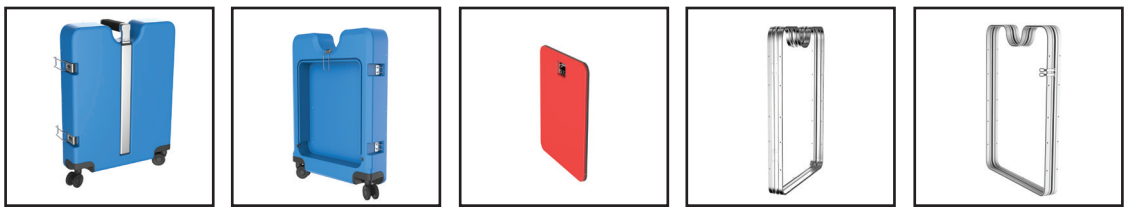
3.3.3 Assembly phases

As explained in the point 3.3.1 this project has been developed focusing on the assembly in order to permit an easy customization and improove the supply chain.
The mounting phase can be divided in two parts. The first one is the one that is done inside the factory by qualified workers and with different machines; the secon one is insted the one that allows the customization and it occurs inside the shop without using tools.

3.3.3.1 Factory assembly

The factory phase is the one that involves the most complex assembly phases in order to create semifinished parts that can be easy joined together and become the final product.
Once all the parts has been produced and shipped to the factory the assembly can start in order to creates 6 main subassembly on which is possible to operate in parallel reducing the production time.





BACK: The back subassembly is based on the back shell on which the trolley system, the lock and the back wheels are assembled.
The 3 parts are not connected within themsels so that there is no a precise order of the operations but they will be presented in the same order of the previous chart.
As first step the trolly system is assembled on the back shell using self-threading screws and a simple automatic screwdriver.
The same tools is used also to fixing the wheels housing. Even the screws are the same but with a longer thread.
Regarding the locks they are installed using rivets that are inserted from the inner part of the shell not to damage the lock mechanism.

Fig.60_ Back subassembly exploded views

FRONT: Similar to the back one the front subassembly is based on the front shell on which the hangers, the wheels, the pocket lock and the pocket housing are installed.
As before everythings can be done using a screwdriver with self-threading screws or rivets making all the phases very quick.
Both the pocket lock and the hangers are fixed using rivets but if on the first one they are inserted from inside the opposite is done for the second one in order to leave visible the part that doesn't get deformed.
The pocket housing and the wheels are instead installed using the screws.

Fig.61_ Front subassembly exploded views

POCKET: The pocket subassembly is the most complex as it requires a stitching process in order to fix the pocket lining and the gasket on the pocket shell. Even if I considered the stitching process very complex in the part 1 I decided to mantain it here because of the small dimensions of the pocket shell that simplify the operation (the depth in particular).
Other parts involved in this subassembly are the two pins that works as fulcrum for the opening and closing movement and the metal plate with the hanger and the logo.
Both the pins and the plate are fixed with screws. As the plate is very tight some cupped washer are used to increase the thickness and avoid the screw to deform the external surface.

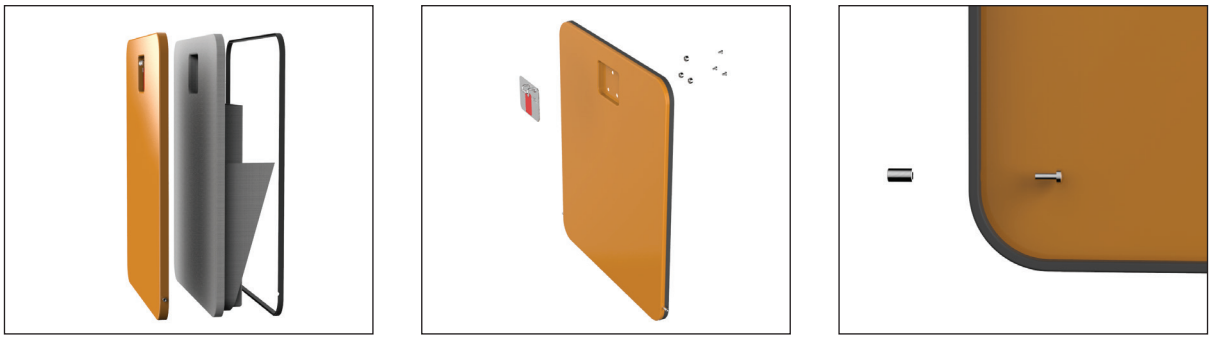


Fig.62_ Pocket subassembly exploded views

METAL FRAME: The metal frame subassembly is very easy to make because the process just consinst in fixing the two inges on the Aluminium profiles using rivets.
It is better to make this operation fixing the frame in the close position with some tape in order to avoid some possible distortion.

Fig.63_ Metal frame subassembly exploded views

PLASTIC FRAME: The plastic frame subassembly is an example of how a good design can simplify a complex process. The fixing is made stitching the zip on the plastic frame instead of doing it directly on the shell. Proceding in this way is possible to stitch the two part of the zip in the closed position so that the difficult step of insert the slider and balance the suitcase ca be avoided. Even the sewing is totally more easy because it can be made in plane as the extruded plastic frame is flat before fixing it on the shells.

Fig.64_ Plastic frame subassembly exploded views

3.3.3.2 Final assembly

The final assembly is the one in which the final product is composed and it must be done when the customer has decided the configuration of his product. As previously said it means that this operation must has to be don in the shop and without tools. This last part is based on the matching of the three shell subassembly plus one frame subassembly plus two separated parts of lining.

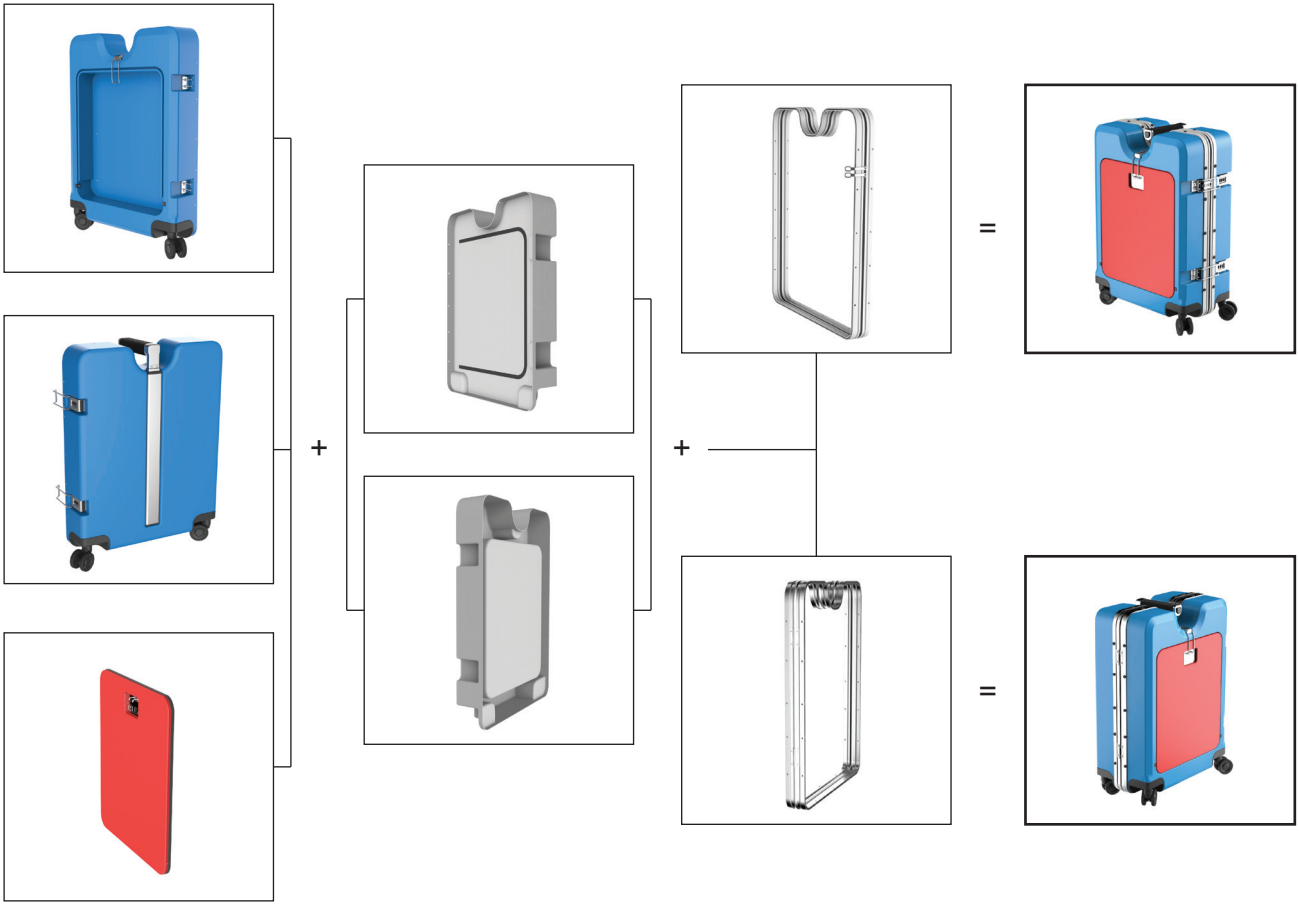


Fig.65_ Final assembly process

The keypoint of the final assembly phase are some ABS irreversible snap pfit that works as rivets but they don't need tools to be fixed as the simple force applied by the clecrk is enough.
Recapping the final assebling phases are:

- Installing the pocket subassembly on the front subassembly forcing the two metal pins inside the housing and joining the two parts of the lining using the zip.

- Place the front lining inside the front subassembly.

- Install one side of the metal/plastic frame on the front subassembly inserting into the slot also the lining.

- Fix the frame using the snap fit.

- Insert the back lining inside the back subassembly.

- Slide both the back subassembly and the back lining profiles inside the other part of the frame

- Fix the second part of rhe frame using the snap fit.

Fig.66_ Snap fit

As it is possible to see all the steps are very easy and can be made in quite a short time so that it is possible for the customers to wait for his product creation.

3.3.3.3 Supply chain streamlining

It is well knowed that customization increase the production costs because almost always it requires more expensive solutions and processes involving often an increased number of components. In the new product for example the zipper version will have two locks even if just one is needed to stop the zip puller movement or also the lining are matched with a foam in order to be shaped in shells and simplify their assembly. Here it comes the good designing that must be used to face the increase of some costs reducing some others.
For the new product the keypoint is that the supply chain is based on easy mountable subassembly untill the final deal and it's possible to exploit this situation to reduce the transport and storaging costs. This situation can be used also as a market strategy because it is possible to give assign the MADE IN... label in the country where the processes that reveals the real character of the product occurs.
Thinking about the transport and storaging in the part 1 it has been said that nowdays the suitcases are shipped from the supplier to the company inside single box that are 90% full of air because the luggage is empty. The product is already fully assembled so that the label MADE IN CHINA is mandatory even if it is not appreciated.
For the new item I immagine a totally new situation where a company with a worldwide market want to sell a product that cames from each country.
The supply chain start with the purchasing of the semifinished parts directly from the supplier. The trolley supplier will send trolley and handles, another one the wheels, another the shells and so on. In this way it's possible to reduce drastically the volumes decreasing the price. Immagine how unmounted shells can be shipped inside the same volume used for a finished luggage.
Once all the parts are recived in the company they can be worked in order to creates the 5 subassembly. As previously described all the parts has been studied to semplify the assembly phase and everything can be fixed using rivets or screws. Proceding in this way it is possible to assign the production origin where these operation occurs.

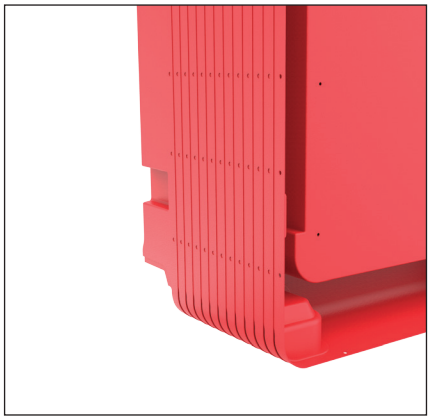


Fig.67_ Storaged shells and assembled suitcase

Once all the subassembly are compleated it's possible to stock them reducing the number of SKU that has to been managed. At this point everything is ready to be sent to the shops where it will be storage in the wearhouse untill the final assembly.

3.3.4 Colors and finishing proposal

One of the most important parts during the developement of a customizable product is choosing the set of the personalizable parts.
I have previously explained which are the parts that can be modified and that the shells will be produced both with an embossed and a shiny flat finishing but it's important to choose the right set of colours in order to cover as much type of customers as possible. The ideal situation is the one that satisfy all the users with the smallest number of variable because it simplify both the production and the management.
The starting point was looking at the product on the market in order to find some paramaters that are common between more products. After an online research I have seen that almost all the brands usually present a set of standard colors based on blue, grey, red, black, white and green, plus some seasonal one like yellow and orange for the summer or brown and bordoux for winter. In addition I noticed that in the last years the printed version has increased their popularity beacuse they approach this items to the world of fashion and design.
It is easy to understand that it would have no sense to produce all this list of colors because the new product can creates more solution matching different set so that is possible to reduce the parameters. Let's immagine to have black and orange shells. With just two colors it's possible to have 3 different solution: a full black one more elegant and business oriented, a full orange one more seasonal and sunny and a mixed black and orange more strong and young.

Fig.68_ Example of colors matching

This example shows how it is important to identify some types of users and find the best solution to satisfy all of them.
In addition it's fundamental to consider the character of the product in order to makes everithings coerent. The squared shape, the visible metal lock, the new trolley handle gives to the new suitcase a strong technical feeling that is intrinsic in its nature and must be kept in mind during the parameters selection.
The strength of this product is the possibility to have infinite set combinations implementing the colors range and the texture type during the years. In addition it is possible to add printed version that can be used to creates special edition if the design is famous.
The starting point will be based on black, blue, red, white, orange, green and pink plus a printed version.

Fig.69_ Clockwise: Same color all embosses, same color different finishing, two colors, three colors

Fig.70_ Shells with printed patterns

4. REFERENCES

BOOKS

- Filippo Cangialosi, Proprietà e lavorazioni delle materie plastiche, Youcaprint 2011.
- Mike Ashby, Kara Johnson, Materiali e Design_l'arte e la scienza della selezione dei materiali per il progetto, casa editrice Ambrosiana 2005.
- G. Bertolotti e V.Capitelli, Dizionario delle materie plastiche, Tecniche nuove 2007.
- Francesca Tosi, Ergonomia e progetto, Collana FrancoAngeli – Poli.Design, 2006.
- Laura Anselmi, Quale qualità_ Cosa si intende per qualità d'uso e come è possibile verificarla, Polidesign 2013.
- Stan Davis, Future perfect: tenth anniversary edition, Basic Books 1997.
- B. Joseph Pine II, Don Peppers, Martha Rogers, Do You Want to Keep Your Customers Forever?, Harvard Business Review Classics 2010.
- B. Joseph Pine, Mass Customization: The New Frontier in Business Competition, Harvard Business School Press 1999.
Silvia D. Ferraris, Vedere per progettare, Basic Design e percezione visiva per il disegno industriale, Franco Angeli Editore, Milano 2014.

ARTICLES & OTHERS

- Mass customization: literature review and directions, Giovanni da Silveira, Denis Borenstein, Flavio S. Fogliatto
- Design Tips for RIM_ Volume I, Protomold (manuale pdf sullo stampaggio a iniezione e argomenti correlati)
- Design Guide, GE Plastic
- General Design Principles – Module I, DuPontTM Engineering Polymers (vademecum per il corretto approccio alla scelta dei materiali all'interno di un progetto di design)
- "Snap Fit Design", vademecum sulla corretta progettazione degli snap fits
-Luggage manifacturing, U.S department of commerce
-Mass customization and Modularity: a theoretical position in the past decade
- B. Joseph Pine, Beyond mass customization, Harvard business review (May 02, 2011)
- The History of the Humble Suitcase, Smithsonian (May 09,2014)

WEBSITES

- http://www.focus.it/cultura/storia/bauli-cappelliere-e-beauty-case
- http://www.entrepreneurial-insights.com/mass-customization-what-why-how/
- http://www.slideshare.net/valuelab/mass-customization-1459548
- http://visual.ly/evolution-luggage
- http://businessdictionary.com
- http://edition.cnn.com/2010/TRAVEL/10/04/wheeled.luggage.anniversary/
- http://betafactory.com/what-came-first-wheeled-luggage-or-men-on-the-moon
- http://www.foxnews.com/travel/2014/05/30/history-luggage/
- http://samsonite.com
- http://brics.it
- http://rimowa.com
- http://tumi.com

5. ACKNOWLEDGEMENTS

Foremost, I would like to express my sincere gratitude to my advisor Prof. Silvia Ferraris for the continuous support of my product developing, for her availability, patience, motivation and valuable advices. Her guidance alongside the corelator Marco Febbo helped me in all the time of research, developement and writing of this thesis.

I want also to show my appreciation to all the people that assisted me during this two years of L.M. In particular i want to thank my family that gave me the possibility of going on with my studies after my bachelr degree and supported my Chinese internship, my girlfriend Claudia that encouraged me in concluding in time this experience in order to start some new ones soon and my course fellow for the mutual support in facing the problems, for sleepless night we worked together before the deadlines and for all the fun we have had in the last two years.