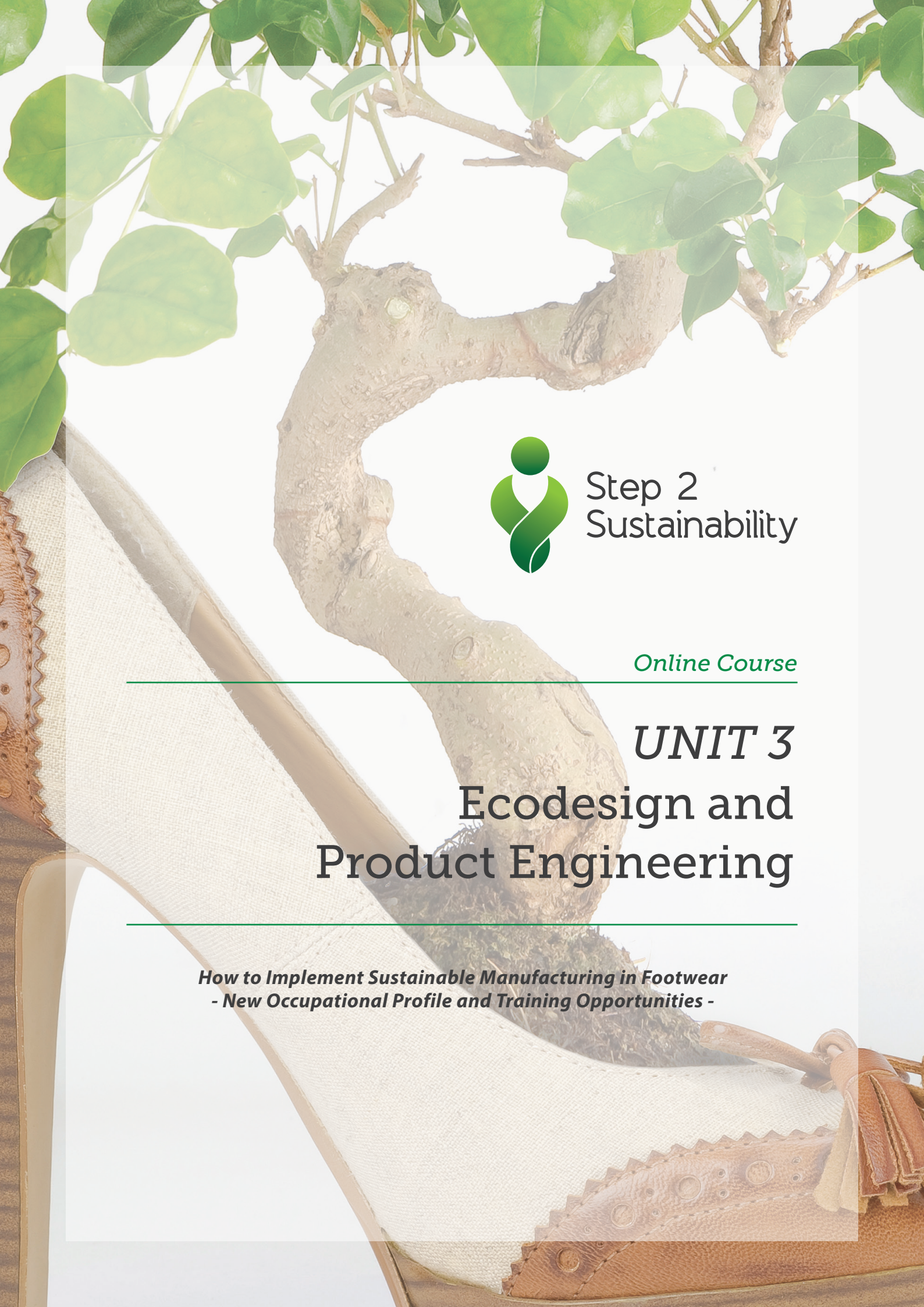


Step 2 Sustainability

*Online Course*

# *UNIT 3*
# Ecodesign and Product Engineering

***How to Implement Sustainable Manufacturing in Footwear***
***- New Occupational Profile and Training Opportunities -***

Lifelong Learning Programme

Project number:
539823-LLP-1-2013-1-PT-LEONARDO-LMP

# *How to Implement Sustainable Manufacturing in Footwear - New Occupational Profile and Training Opportunities*

**Credits**

***Title***
UNIT 3 - Ecodesign and Product Engineering

***Coordination***
Ars Sutoria School

***Layout and Editorial***
Salto Alto CTCP criativo

***Date***
January 2016

# CONTENTS

## 1. Introduction

Nowadays the whole world is talking about ecology and people, above all in the Western world, are becoming increasingly sensitive to the problems of a fair and sustainable development. An example of this is the success of an international event like Expo, focused on food and on the sustainability issues related to it.

The world population keeps on growing, the necessity and the request for wealth also in areas that until recently were underdeveloped are leading to unsustainable levels of raw material consumption, producing an increase in the product cost and in its unrestrained disposal, creating sometimes a gap between rich and poor countries.
The researches carried out in every field will lead to the solutions that the world demands from us and the new sensitivity is expecting.

**It is from this new universal sensitivity that the dream of a world able to respect the environment but also to guarantee the wealth everyone desires arises. Every dream generates a project that is the basis on which this future is built. And like any project it is its design, its model that connects the dream to reality. This is the mission of those who will design the new products with attention to the new era, designing not only products aimed at their use but also a new philosophy of product.**

Therefore the designers will be able to lay the basis and will be the creators of products that will be ecological but also competitive, in order to guarantee wealth to the greatest possible audience of consumers. A mission, thus, that is not easy but achievable. Ecological sustainability but also economic sustainability.

All products have an impact on the environment during their life-cycle, spanning all phases from cradle to grave, including the use of raw materials and natural resources, manufacturing, packaging, transport, disposal and recycling.

More than 80% of the environmental impact of a product is determined at the design stage.

Ecodesign implies taking into account all the environmental impacts of a product right from the earliest stage of design. In particular, this avoids uncoordinated product planning (for example, eliminating a toxic substance should not lead to higher energy consumption, which on balance could have a negative impact on the environment).

However, ecodesign requirements must not lower the functionality of a product, its safety, or have a negative impact on its affordability or on the consumers' health.

Although the applications of sustainable design are many, we can list the general principles that characterise this concept:

- Sustainable materials: non-toxic, recycled or recyclable materials made with production processes that use alternative energy.
- Design for recycling: a project that provides for a second use for the object produced both as a material and as a function.
- Energy saving: use of production processes or products that consume less energy.
- Quality and durability: a greater wear resistance and an optimal functioning guarantee a reduction of the impact of the waste produced.
- Design for Manufacturing: an improvement of the production processes efficiency, design of products that lead to a reduction of wastefulness.

## 2. Sustainable materials

In order to classify the materials used in footwear manufacturing it is possible to consider their origin or the process with which they were produced.

From the point of view of origin we can have «natural» materials, i.e. that come from animals (leather is traditionally the most famous but nowadays it is used only in a part of the market), vegetables or minerals. On the other hand we have the category made up of materials of «synthetic/chemical» origin, i.e. that come from a transformation process that chemically combines different components in order to obtain materials with different characteristics and performances (e.g. the family of plastics).

With reference to the origin of the **natural** materials, the level of sustainability is often linked to the availability/shortage of these resources and therefore to an issue of balance in the exploitation of these resources as regards the cycle of nature and the relationship between man and nature. Examples of this can be the use of leather coming from endangered animals, the discussion about the utilisation of animals bred only to exploit their leather/fur, the use of leather as a waste product in the food industry, the issue of deforestation, the exploitation of earth and water only to obtain materials that are used exclusively to manufacture consumer goods.

When we move from the origin of materials to the **production process**, we find an additional series of important issues concerning sustainability. In particular we move on to examine the quantity of natural resources (e.g. water) used in the production process, the degree of pollution generated by the process (e.g. the chemical component and, in general, the non-degradable component poured into nature during the process but also the emissions of the means of transport used to move the raw material from the production site to the usage site), the electric power used during the process etc... .

In regard to materials of **chemical** origin the discussion focuses both on the shortage of the components used in the transformation process (e.g. petroleum) and on the issues of pollution and absorption of the resources during the industrial production process.

### *2.1 Characteristics of eco-materials for shoes*

When we take into examination the offer of the materials suppliers we will notice that many companies qualify as «eco» or «sustainable» drawing the attention of the manufacturing company or the stylist to many issues. Here below we try to understand what are the most common arguments used in the materials marketing. To better understand which measurement systems already in use in the market can make the marketing communication objective, we refer you to the chapter on certifications and standards.

**1. Material:**

- The material comes from natural sources
- The supply of the material should be part of a "balance" (as a rule it should not be produced for only one specific purpose)
- Renewable sources: use of these materials as alternatives to petroleum for the synthetic materials chemistry (e.g. soles). The discussion about the impact of renewable sources cultivation on nature
- How much the transport (and the related pollution) impact the economy of the supply (0 Km philosophy)

**2. Transformation process:**

- How many resources (water, electric power, etc.) are absorbed by the process – how much the plants are efficient from the energetic point of view and what percentage of resources can be «put into circulation again» or re-used in other processes (e.g. heat)
- Impact of the pollution made by the material production process: usually the disposal/reinjection method in the chemical process. How much is dispersed into the environment without creating damage but also which technologies are used in order to reduce this impact
- How much chemicals remain inside the product and what kind of effect they can have on the product's life cycle (when it is used and at its end-of-life)
- How much product is moved during processing or for the sale (pollution caused by transport)

- Recycled materials: a separate discussion is dedicated to the topic of recycling the product at the end of its life. However there is also the issue of the reinjection of the industrial processing scraps in the process as a proof of the attention given to the environment by the production process.

**3. The company:** the communication often concerns not only the material and the way it is transformed but also the way the environment where the supply and transformation take place is organised in order for them to be «sustainable»

- working conditions of the people employed in the process
- special attention given by the company to the environment
- Interaction of the company with the surrounding community

### *2.2. Materials of interest to shoe designers*

A shoe is composed of a great quantity of components, both in the upper and in the structure. It is very hard if not impossible to design a shoe in which all the materials used for its parts are sustainable, from every point of view. It is certainly possible to talk about a **percentage** of sustainability, according to how many parts of the footwear comply with the desired standards.

We can divide footwear into two macro-categories:

| UPPER / LINING | STRUCTURE |
|---|---|
| Materials for the upper (leather-fabric-plastic) | Tip |
| Threads for stitching/ornamentals | Counter |
| Glues/tapes | Insole |
| Reinforcements | Sole |
| Laces/eyelets | Heel |
| Ornaments | Monobloc/Platform |

All the components listed above are footwear parts and therefore are relevant (some more than others, according to the quantity) from the point of view of design.

It is possible to discuss on which of these components **the Designer should focus his attention.**

We can think about what is visible and what is not. **The designer will have to take into examination what is visible, like the material of upper, sole and trinkets** then he will have to choose them together with the technician on the basis of their aesthetic and sustainability characteristics.

What is on the inside, which reinforcements, insoles, etc... will be the sole responsibility of the technical designers.

### *2.3. Leather and tanning process*

Leather is the natural material par excellence used in the footwear manufacturing.

Leather is traditionally the scrap of part of the food industry. The most commonly used leathers come from red meat animals (for example we do not use chicken leather). The most commonly used leathers are bovine and ovicaprines. Snake, bird and fish leathers are used to a lesser extent.

- The sustainability issue is sometimes improperly compared to the «vegan» issue, i.e. to the refusal to use anything of animal origin. The vegan inspiration will be briefly mentioned for some aspects that are not related to the sustainability issue.
- There are endangered animals whose leather is not possible to use in some countries. There is a regulations protocol (CITES, Convention on International Trade of Endangered Species, an agreement drawn up by many countries in Washington in 1973).

The leather can be used for the upper (or some parts of it), for the lining but also for other components, in particular for the sole or also for the assembly insole. Nowadays only a low percentage of footwear is entirely made in leather. It is estimate that 30% of the global footwear manufacturing has a leather upper.

There is a very precise definition of leather: "Hide or skin with its original fibrous structure more or less intact, tanned to be imputrescible. The hair or wool may, or may not, have been removed. It is also made from a hide or skin that has been split into layers or segmented either before or after tanning" (British Standard: 2780). The definition concerns also the proportion between leather and coating: "If the leather has a surface coating, the mean thickness of this surface layer, however applied, has to be 0.15mm or less, and does not exceed 30% of the overall thickness" (British Standard: 2780)

This definition clarifies that it is not possible to use the term «leather» for a series of products:

- The so-called reconstituted leather (or bonded leather)
- The so-called «eco-leather» that is actually a synthetic material

The rest of this document wants to highlight the sustainability aspects linked to leather manufacturing. The focus is notably on the leather manufacturing (tanning) process. At this stage we want to make an in-depth analysis not of the topic but of the guidelines that are useful from the ecodesign point of view.

*"Tanned to be imputrescible":* a big percentage of the leather's "sustainability" degree depends on the transformation process (that starts when the leather is separated from the animal and ends with the finishing operations that give the leather its final aspect and characteristics).

In the tanning field it has been proposed for some time to find solutions to reduce pollution in the tanning process but also to obtain products that contain the least possible quantity of chemicals and that do not create problems when used (e.g. irritations) and possess the best characteristics for the disposal stage, i.e. in particular regarding the biodegradability of the material itself and the absence of chemical components that can react during the disposal processes - e.g. when they are burned -without releasing volatile components into the atmosphere.

In this moment many companies/tanneries are carrying out a constant research for the realisation of innovative and sustainable materials that maintain the characteristics of the materials tanned with metals (in particular of the chrome tannage) among which the possibility to obtain a wide chromatic range, softness, ductility and resistance.

Clearly to different tanning technologies correspond different characteristics of the material. In the design stage it is important to know the characteristics that the material will have and be aware of how it will behave both during the footwear manufacturing process and in the use of the finished product.

Nowadays it is possible to divide the tanning world into two families:

- Chrome tannage: we will talk about it only as a method of comparison
- Organic tannages: this group includes the natural tannage (traditional vegetable), the synthetic tannage (use of synthetic tannins, aldehydes and phosphonium salts) and the mixed tannage, made with a mix of the previous two and the Wet White

Let's analyse the characteristics of the different tannings in order to understand the aesthetic and product differences.

**Chrome tannage:**

It is useless to point out that at the moment the chrome tannage is the most used, with a production equal to 80% of the leather market, that it is still the faster tanning method to this day, and that it guarantees leathers with the following characteristics:

**Advantages of the chrome tannage**

- The chrome-tanned leathers are easy and fast to make, usually they need one working day
- They are water-repellent if properly retanned and finished
- Soft and elastic to the touch
- It is possible to obtain leathers whose colour does not change with time
- It is economically more convenient in comparison with the vegetable tanned leather and, as a consequence, it is more common
- High thermal resistance

**Disadvantages of the chrome tannage**

- Little craftsmanship, the leathers are made with serial processes
- Typical smell of chemical substances
- Its aspect is not very natural
- It lacks charm and warmth

**Vegetable tannage:**

Among the different tanning methods, the vegetable tannage is the most classic, traditional, recognisable, natural and ecological. It is the only one that can give peculiar characteristics to the leather. The vegetable tannage unites comfort and look, fashion and tradition, uniqueness and versatility in a product that is almost vanishing from Europe, with the exception of Italy where the Tuscan tanning district is the best in this type of process. The raw materials used for the vegetable tannage are the tannins, natural substances available both as liquids and as powders, extracted from different parts of the plants among which wood, barks, pods, fruits and leaves.

**Advantages of the vegetable tannage**

- The vegetable tannage is ecological. All the items made with this technology can be recycled
- The vegetable tannage is an art with an ancient tradition. Most of the tanneries have able craftsmen involved in the leather tanning.

- Thanks to the use of natural tannins, the vegetable tanned items are unique and inimitable. They do not remain unchanged as time goes by, but they change, constantly, for the better, absorbing the traces of our experiences.
- The vegetable tanned leather presents natural colourings, with warm shades that tend to resurface with use.
- The vegetable tanned leather has a greater added value perceived by the consumer and therefore it is sold at a higher average price than the chrome tanned leathers.

**Disadvantages of the vegetable tannage**

- The average process time for the vegetable tannage is slightly superior to that of the chrome tanned leather, but it could take up to 60 days for the manufacturing of sole leather
- The leather can easily get stained during the processing stages
- The vegetable tanned items are more expensive. In fact, great crafting skills are required for their realisation This means that they have a higher quality
- The colours that can be obtained with the vegetable tannage are limited
- The direct heat can cause a reduction and cracks in the vegetable tanned items

**White tannage or Wet White**

The growing request for certificates for the production of leathers without the use of chrome and the necessity to obtain manufacturing cycles with shorter times than those of the vegetable tannage led to the emergence of the Wet White technology. The leather is obtained without the use of chrome and includes the combination of synthetic tannins and vegetable tannins, glutaraldehyde and minerals like aluminium and zirconium. The leathers tanned with wet white technology are made using the same machines of the chrome tannage.

The leathers thus obtained can be used for a wide range of items, from the car field (for example all Audi leather interiors are tanned without chrome) to furniture and from clothing to the shoe upper.

**Advantages of the wet white tannage**

- Wet white tanned leathers present a light colouring and pastel shades.
- They can reach shrinkage temperatures of at least 70°C
- High softness
- Good lightness
- Feeling of naturalness
- Pleasant to the touch
- The wet white leather has high performances, often better than those obtained with chrome tannage
- Absence of chrome and everything that comes with it during the material disposal stage

**Disadvantages of the wet white tannage**

- A slightly higher production cost than the chrome tannage The most recent technologies have considerably reduced this difference
- It requires more controls than the chrome tannage
- The direct heat can cause a reduction and cracks in the vegetable tanned items

**Recycled leather**

The leather is a material that can be recycled. The reconstituted leather is the main material derived from recyclable leather.

As it often happens with eco-leather there is a general confusion on the characteristics and realisation processes of this material that has been part of the footwear production cycles since ancient times and has always had a great use above all in the reinforcement part and for the sole making. It is better known as Salpa.

In the great majority of cases the natural leather working is made using the epithelial tissue of animals slaughtered for food purposes and therefore mainly ovines and swine and so only a limited part of the natural leather manufacturing has a real impact on the slaughter of animals for a specific goal. Actually this fact partly limits the "ecological" character of the reconstituted leather that, however, still is a very important aspect. Furthermore, the physical characteristics of the leather - i.e. of the tanned leather regardless of the tanning technique used - still cannot be totally imitated, therefore, despite the numerous attempts to that effect, the manufacturing of materials that are similar to the natural leather simply reproduces its "visual" and "tactile" characteristics, without being able to borrow its peculiarities, like breathability, great resistance and duration, thermal isolability or electrical conductivity.

The reconstituted leather manufacturing is incredibly similar, technically and mechanically, to paper manufacturing, from which it borrows also the "chemical" aggregation logics. The natural leather working scraps are finely chopped and mixed with rubber, latex and other synthetic aggregating agents until they are pressed and worked in sheets of different thickness according to the intended use, similarly to what happens with paper. Before being finally made available for the furniture, footwear or gift and fancy goods manufacturers, the reconstituted leather sheets can be subject to many "refinishing" processes, like calendering, sandpapering and varnishing, whose aim is to make them as similar as possible to the correspondent natural version, Notably the embossing process is very important, as the leather is "printed" using a particular drawing designated to imitate the "grain" that is found in the natural leather that often differs according to the animal from which the tissue comes.

From what has been said so far, the fundamental points to bear in mind while talking about reconstituted leather emerge clearly. It is a different product than the natural leather that imitates its visual characteristics but not its quality. It clearly has a lower price than the natural leather to the detriment of quality.

### *2.4. Case histories*

In this sub-unit we are going to present some cases of materials suppliers who claim to have an «eco» or «sustainability» characteristic.

The purpose is to help analysing the offer in order to try to understand:

- which characteristics are put in evidence (among the characteristics and origin of the material, characteristics of the transformation process and characteristics of the company)
- to which local or international standard they are referring to certify the characteristics underlined

**Upper materials / leathers**

***INCAS***
***http://www.hi-co.it/?lang=en***

**Product: Hi-Co**
(High-Contents) is the ICEC-certified process used by Incas to produce natural, metal-free leather, in full compliance with the strictest international norms for baby lines and environmental protection and in line with our ISO 14001 and EMAS certifications.

- the tanning stages are different than the standard plant-based processes
- the special treatment is carried out using natural tanning extracts, without damaging the environment and with the goal of obtaining an eco-sustainable product.

Leather produced using the Hi-Co process stands out for its natural fullness and smoothness, in addition to the characteristics indicated in the table on the right, that certify a metal-free leather completely respectful as required today by the most restrictive markets (South Korea, China for baby line).

***Specifiche tecniche del processo Hi-Co***
Applicate ai prodotti "Vitellino Concia Naturale INCAS" Linee: AQUA – TERRA – AER

| *Caratteristica* | *Metodo di prova* | *Requisito* |
|---|---|---|
| *Contenuto di metalli (Al, Ti, Zr, Cr, Fe)* | *EN ISO 17072 – 2* | *< 0,3% come somma dei metalli concianti su peso secco della pelle (pelle vegetale) < 0,1% per ciascuno dei metalli concianti su peso secco della pelle (metal free)* |
| *Azocoloranti (ammine aromatiche legislazione cinese)* | *GB/T 19942* | *n.r.* |
| *Pentaclorofenolo* | *UNI EN ISO 17070* | *≤ 1 mg/kg* |
| *Cr VI* | *UNI EN ISO 17075* | *≤ 3 mg/kg* |
| *Formaldeide* | *UNI EN ISO 17226-1* | *< 16 mg/kg* |
| *pH Delta pH* | *UNI EN ISO 4045* | *3,2 ≤ pH ≤ 7,5 Delta pH ≤ 0,7* |
| *Contenuto di metalli pesanti (Pb, Cd)* | *EN ISO 17072 – 2* | *Pb < 90 mg/kg, Cd < 40 mg/kg* |
| *Tributilstagno (TBT)* | *UNI EN ISO 17353* | *< 0,05 mg/kg* |
| *Dibutilstagno (DBT)* | *UNI EN ISO 17353* | *< 1 mg/kg* |
| *Metalli pesanti estraibili (Cr, Pb, Cd, Hg, Se, Ba, As, Sb)* | *UNI EN 71-03 sicurezza giocattoli, migrazione di alcuni elementi* | *Cr < 60 mg/kg - Pb < 90 mg/kg Cd < 40 mg/kg - Hg < 60 mg/kg Se < 500 mg/kg - Ba < 1000 mg/kg As < 25 mg/kg - Sb < 60 mg/kg* |
| *Metalli pesanti estraibili (sudore artificiale): Ni, Co, Pb, Cd* | *EN ISO 17072 – 1* | *Pb ≤ 3 mg/kg - Cd ≤ 1 mg/kg Ni ≤ 4 mg/kg - Co ≤ 4 mg/kg* |

***CARVALHO***
***http://www.couroazul.pt/***

**Product: Oak Leather**
They are a result of years of research and investigation, initially focused on the automotive industry. Currently, the OakLeather range includes articles for the automotive, shoe, leather goods and furniture (upholstery) industries.

To define the OakLeather range consider two ecological guidelines: the production process and the product itself.

The production process reduces to a minimum the environmental impact reducing water consumption and chemical charge in the effluents and its recycling, as well as the re-use of solid wastes as fertilizers, using natural drying of the leather at room temperatures and the reduction of volatile compounds emissions.

Starting with selected raw materials (fresh Iberian hides) the achievement of an ecological product implies the conservation of the hides by cold storage, without any other preserving agents, a chrome and metal free tannage (wet-white), along with the use of metal free dye stuffs and water based finishes.

All the OakLeather range is prepared to obtain the Chrome Free and Metal Free certification.

biocalce

**Upper materials / textiles**

***TESSITURA ATTILIO IMPERIALI***
***http://www.attilioimperiali.it/pagina.php?cod=1&lingua=eng***

The Company's fabrics reflect the tradition and culture of a family and a territory with a strong textile vocation. Today we believe that we can combine industrial production with environmental protection, and that respect for people and their future is the basis of a company's mission. To produce beautiful, high-quality fabrics but reduce the environmental impact of its industrial activities is a fundamental objective for the current textile and fashion industry, and Tessitura Attilio Imperiali aims to do its part.

Tessitura Attilio Imperiali makes fabrics using high-quality yarns that are employed in its warping and weaving departments. The dying, printing and finishing processes are carried out by carefully selected suppliers chosen for their reliability and geographical proximity. When selecting collaborators, the Company does not prioritise cost advantages but instead favours the sharing of common goals as well as trust and a desire to grow together. We believe that sustainability is a journey that has to be embraced by the entire production chain and can only be developed through communication and collaboration with our clients and suppliers.

To provide objective and reliable information about our activities and avoid 'greenwashing' is an integral part of our philosophy. Indeed, Tessitura Attilio Imperiali features in the Catalogue of fabrics and accessories for sustainable fashion created by sustainability-lab and presented at Milano Unica. In September 2014 we decided to sign the Detox pledge launched by Greenpeace to the fashion industry and to eliminate chemical substances recognised as being a threat to human health from our production process.

We believe that sustainability can also be achieved by small, everyday gestures such as opting to use recycled or eco-friendly office materials, and paying constant attention to energy savings. We have therefore joined the ReteClima , programme which foresees action to compensate CO2 emissions such as tree planting in areas lacking in environmental resources. We are also convinced that a sustainable enterprise must devote attention to the relationship with future generations. The Fashion Accademy project is devoted to the growth of the young generations, and was started by Tessitura Attilio Imperiali in order to develop training projects for future designers.

**Upper materials / synthetics**

***MIKO***
***http://www.dinamicamiko.com/it/dinamica***

**Product: DINAMICA (ECOLOGICAL MICROFIBER)**
Its production process is similar to that used for paper recycling, in which no harmful chemical substances are used. The recycled polyester contained in Dinamica® derives from polyester fibres (T-shirts, fibres, etc.) and PET (bottles, plastic, etc.). Recycling polyester means reducing energy consumption and CO2 emissions into the atmosphere by 80% compared to the traditional petrol-based polyester production process.

Eco-sustainability as well as the lowest levels of polluting emissions and energy consumption are guaranteed throughout the whole production cycle.

Dinamica® is designed for easy disposal, and is 100% recyclable at the end of its useful life.

As evidence of Miko's commitment to the environment, Miko won the Italian Environmental Business Award 2011 as Best Product of the Year, while in July 2013 the company was awarded as National Champion for Italy in the 2013/14 European Business Awards and selected by the jury to run for The Millicom Award for Environmental & Corporate Sustainability category in 2014.

***CORONET***

**Product: ECOLOGIKA**
***http://www.coronetspa.it/#!/page_EcologikaEn***

Coronet's green philosophy is history-long. We always strive to provide the safest materials and to achieve the cleanest possible production processes. This commitment to a greener environment and products is a never-ending challenge, and today we achieve a new milestone. After years of research, Coronet developed the first 100% solvent free composed exclusively of water born resins PU leather. Ecologika complies with – and actually far exceeds – the most stringent regulations about harmful substances. It offers the usual Coronet top-of-the-market look and feel – it's a highly breathable, absorbent, self-shaping, antibacterial lining material – with the certainty, un-achievable with standard production processes, of the complete absence of DMF residue.

***http://www.coronetspa.it/#!/page_Environmental_Policy***

To produce innovative, environmentally friendly materials has always been Coronet's vision. This concept prompted us to realize 3 photovoltaic generators on the roofs of our sites, and one ground based, for a total of 1.177 kWp. The environmental gain is quantifiable in 1.388.781 kWh of green energy produced each year, for a total Co2 saving of 1.023.990 Kg, an amount whose elimination would otherwise require 170 hectares of wood. Our vision is pursued in our laboratories as well: eco-compatibility is always the backdrop against which Coronet's top management evaluates which direction to take the business. The creation of a 100% solvent-free product, with zero environmental impact, is the near-future goal for our R&D.

***TORAY***

**Product: Ultrasuede**
***http://www.ultrasuede.com/about/responsibly_engineered.html***

The inventor of the world's first ultra-microfiber, Toray is a global leader of cutting-edge fiber technologies and their applications. We are also an innovator in environmentally conscientious technology and recycling, which has resulted in reduced energy consumption and a more ecologically sound manufacturing process.
Ultrasuede® HP is manufactured using ultra-microfiber made with recycled polyester. While being virtually reinvented as a recycled product, the new HP continues to deliver all the beauty and performance you've come to expect from Ultrasuede®. That's evident in the richness of its hand, the unsurpassed color palette, the superior durability, and its easy cleaning and maintenance. Toray products deliver the same level of excellence through our commitment to environmental.

Responsibility. Inherently beautiful. Responsibly engineered. This is the next generation of Ultrasuede®. Many recycling efforts in the market today consume large amounts of energy—Toray believes this to be a conflicting endeavor. Our strategy is to employ only those technologies that reduce energy consumption. Based on Toray's chemical recycling process that reduces both energy consumption and CO2 emission by as much as 80%, HP continues to deliver all the beauty and performance you've come to expect from Ultrasuede®.

***SISA Spa***
***http://www.sisaspa.it/english/index.php***

**Communication:** Sisa is leader in the production of eco-friendly synthetic leather

**Product: AEQUO**
Studies made in our R&D laboratory have led us to develop products with unprecedented eco friendly features for synthetic leathers.

Polymers deriving from natural renewable sources. Cereals and vegetable seeds coming from NO FOOD agriculture. CO2 emission at zero level.

**Upper materials / other materials**

***ANANAS ANAM***

**Product: Pinatex**
***http://www.ananas-anam.com/pinatex***

Piñatex™ is produced from the fibers of pineapple leaves which are a by-product of the pineapple harvest. Piñatex™ involves a patented technology that protects both the process and the finished material. While the initial development work leading to Piñatex™ originated in the Philippines, significant research & development is now being undertaken between the UK and Spain. This is specifically to enhance the finishing technology. Piñatex can be used as a leather alternative or textile in the fashion, accessory and upholstery markets. Piñatex™ is a by-product of the pineapple harvest, thus no extra water, fertilizers or pesticides are required to produce Piñatex' pineapple fibres.

The fibres that make Piñatex™ come from pineapple leaves. The fibres are extracted from the leaves in a process called decortication, which is done on the plantation by the farming community. The by-product of decortication is bio-mass, which can be further converted into organic fertilizer or bio-gas. This can bring additional income to the pineapple farming communities. The fibres then undergo an industrial process to become a nonwoven textile, which is the base of our product Piñatex™.

**Product: Cork «Leather»**
***http://www.corkor.com/pages/whycork***

Cork is 100% sustainable product, harvested from cork oak tree every 9 years without harming or killing trees.

Once harvested, the bark regenerates, making it a renewable and sustainable resource. Cork oak trees can live 170 to 250 years on average.

Linning of Corkor products are made with natural fabrics like cotton.

**Ocean Leather**

This is another leather substitute that can look and feel like leather. This material is known as ocean leather because it is made from kelp, a type of large seaweed. This is an abundant and sustainable resource, which makes this an ecologically sound choice too.

**Ornaments**

***ASTARTE***
***http://www.astarteaccessori.com/index_en.php***

The shells that we use in our work process are all found on the beach, we don't touch the sea ecosystem or the coral reef in any way.

Every product based on mother pearl comes from shells found on the beach, particularly from the commercial culture of pearls.

The water buffalo, from which this material comes, are slaughtered for human food.

We use for fibres and leaves which have fallen down naturally for our work process and they are integrated with textile and weave techniques.

***RAMPONI***

***http://www.ramponisas.net/en-US/values/ethical-code***

In summary, in 2014 our projects dealing with environmental protection and development in the surrounding area can be identified as follows: New investments and resources for the use of renewable energy, more effectively monitoring of all business processes that may impact upon the environment, new investments aimed at reducing and monitoring atmospheric emissions, collaboration with customers, suppliers, supervisory authorities and local institutions in selecting future environmental sustainability projects, commitment to our company's aim to increase environmental awareness among its employees, effectively and efficient management of our level of emissions into the atmosphere, increasing the capacity of our SPV system by doubling the amount of solar panels, improved management of water waste, improved waste management by the reuse of remaining raw materials used in production, reuse oil used in production, recycling of used toner cartridges, procedures and standards limiting.

**Soles**

***SACE***

***http://www.sacecomponents.com/en/footwear/footwear/index.html***

It is the business unit dedicated to manufacture and market cork semi-finished products for footwear industry. This unit manufactures and markets components and accessories for footwear in cork and other alternative materials (such as hide, leather, salpa, synthetic leather, etc.) meant for the Italian and foreign footwear markets.

***VIBRAM***

Vibram, a leading company in the manufacturing of rubber blends for soles, in 1994 presented Ecostep, an innovative eco-mix blend made with production scraps and able to reduce waste and the use of virgin materials up to 30%. This recycled rubber product, that maintains the high qualitative standards of the final product, is fully part of the intense work of Vibram, that has supported sustainable policies and great efforts for the protection of the environment for almost 20 years.

***DAVOS***

Each Davos product is 100% recyclable. If you take away all the rubber soles from all the shoes in the world that are manufactured with our products, the whole sole material is 100% technically recyclable.The attention for the environment in Davos implies first of all technology, a basic criterion for the establishment of the new headquarters. The headquarters in Cavaso del Tomba are in perfect harmony with the natural and environmental context. Davos is an active environmental and landscape conservation partner. An example of our highly innovative production systems is represented by the new Thunit sheets production process, with its minimal environmental impact: the new water painting system, characterized by computerized dosages and cooling waters recirculation.

One important example concerns the multiplicity of standards and laws regarding rubber, covered by Reach and the California convention or CADS. Davos has managed to standardize the production of eco-friendly rubber sheets for soles that can satisfy even requisites of the strictest laws, in particular the limits of PAHs (Polycyclic Aromatic Hydrocarbons) as regards the use of toxic and dangerous substances, without compromising the highest physical-mechanical characteristics of products.

***FINPROJECT***

***http://www-xlextralight.com***

XL Extralight sustainable soles are made from re-using expandable and cross-linking polyolefin material obtained from industrial production waste and moulded products We achieved this goal thanks to an exclusive process and special equipments which facilitate the blending of inhomogeneous components. This process keeps the performances and features of XL Extralight soles virtually unchanged. Waste recovery instead of landfill disposal. Once again living up to Finproject's commitment to environmental sustainability. Furthermore we improve our responsibility to preserve the environment using clean energy which comes from our photovoltain plants.

### *2.5. Sustainable packaging*

Beside fulfilling its primary function of containing, protecting and transporting a product, in the last few years packaging has acquired also the purpose of supplying information on the product itself, guaranteeing its quality and encouraging the consumer to buy it. For these reasons the designers are devising a packaging that is increasingly pleasant, captivating, and ready to appeal to the emotionality and psychology of the masses, so much so that it has become a real social and anthropological phenomenon.

However, the emerging of the environmental sustainability issue, that involves also the fashion sector, caused the companies to manufacture a packaging that is as eco-friendly as possible. It is a very hard task, above all for the most renowned brands, because they have to promote a sustainable policy without renouncing to the image of prestige conveyed by the packaging and without betraying the loyalty of the consumer who, even if he requires a packaging that is worthy of the products he is buying, is becoming increasingly sensitive to environmental issues. Gucci was the first firm to face this challenge by using sustainable packaging with 100% recyclable FSC (Forrest Stewardship Council) certified paper and to invent new forms of packaging like the foldable and recyclable case for glasses.

The great fashion chains, instead, prefer to invest in the new request for packaging created by e-commerce, in order to be able to grab this slice of market, developing new innovative forms of packaging that unite sustainability and aesthetic pleasantness. An example of this is given by Yoox, the chain that developed "Ecobox", a new ad hoc packaging for the delivering of the orders made on the group's e-commerce website all over the world : it is a box that can be opened without breaking it and therefore can be re-used in case of returned goods.

Since 2007 Timberland has been producing shoe boxes made with cardboard obtained from the recycle of used packaging and other 100% recycled materials and uses a soy and sesame based ink in small quantities. Among these the shoe box of the Eartkeepers line is the one that stands out; with its sober design it wants to sensitise the consumer to reuse, as stated in the sentence inside of it: "Reuse me". The box, in fact, is conceived as a simple foldable cardboard case, provided with a rope handle, and can be easily used for other purposes. Besides, in order to reduce waste, only the name of the line and the brand logo are printed on the outside, while a sustainable sticker carries the barcode. This kind of packaging is part of the massive information campaign with which Timberland wants to communicate to the consumer all the product's processing stages: the manufacturing site (most of the shoes are made in China and Vietnam) the use of renewable sources, the compliance with the international standards, the percentage of child labour, the number of volunteer hours of Timberland's employees.

Similarly Adidas use shoe boxes made with recycled cardboard and soy and sesame based oil and recently it wanted to sensitise the consumer by launching a campaign with the title “Grow the grass you play on”. The designer Tia Hughes created a packaging made withrecycled materials, among which a cardboard containing seeds, for the soccer shoes Adizero F50. A tag carries the instructions to follow in order to plant and water the packaging and thus make the grass grow.

In 2010, the designer Yves Béhar created for Puma the "Clever little Bag", a shoe box that received many important awards for design, innovation and environment protection and that was promoted by a wide and effective advertising campaign. This box was called clever because it slashes the production, storage and transportation costs because of its structure. In fact it is composed by a thin foldable and recyclable cardboard box, whose lid is the shop bag itself. The characteristics of the box are explained in a dedicated video. Seeing is believing!

## 3. Design for manufacturing

Design for Manufacturing means **to design a product paying attention to details that will have an impact in the subsequent production stage.**

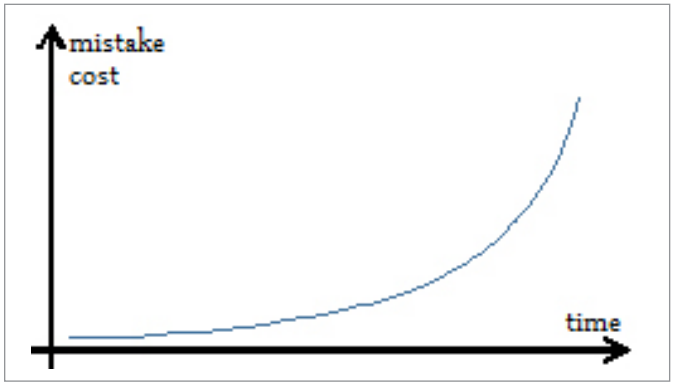
In simpler terms, it means to design products in such a way it is easier, faster and more convenient to produce them. This concept exist in almost every technical field, but the actual realisation varies a lot according to the production technology.

DFM describes the design or engineering stage of a product in order to facilitate the manufacturing process so as to reduce the production costs.

DFM will identify potential production products since the design stage, when it is less expensive to face them.

In fact it is well-known the principles according to which the later the mistake made in the initial stage (design) is discovered, the higher its cost will be. This can be true also if the mistake is made in the commercial evaluation (in this case it would be more correct to talk about Design for Sales, to which we will refer later in the chapter on virtual prototyping), but in this seat we want to refer in particular to considerations linked to the subsequent production of the product.

To be able to face and solve the critical aspect already in the initial stages of the design enables to save time and money. In particular it will be possible to avoid remakings and waste and so to create «sustainable» behaviours. In this case it is evident that a «sustainable» behaviour is also economically advantageous. This is all the more true the more the design process is long and demanding (let's think about footwears that require the development of moulds, for example for the soles) but above all this principle gets even more important the more pairs are planned to be produced.




### *3.1. Design optimisation in the collection structure*

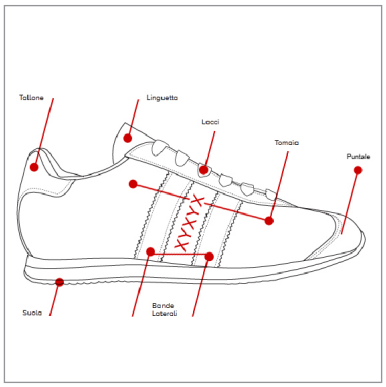
The designer needs to succeed in integrating aesthetic, marketing, production and cost necessities both in the design of a single footwear item and in the organisation of the entire collection.

The optimisation of the material and structures use reduces waste, improves the efficiency of the production process releasing resources and increasing competitiveness and profit margins. If we assume that the wastefulness reduction can be considered sustainable, every decision that improves the efficiency of the production process can make the product closer to the ecodesign goals. The design is the root of any product and the designer can surely influence the production process in advance.

There are many areas in which the designer can act to improve efficiency and optimise wastefulness in his footwear collection.

Three are the main elements on which a shoe designer works: **The design of the structures** (last, insole, sole and heel), **the upper's style lines and the choice of the materials.**

STRUCTURES




UPPER'S STYLE LINES

DESIGNER

MATERIALS

In this table we try to represent the **total cost** of a shoe. It is divided into three parts:

1. Design cost
2. Equipment cost (socket punches, moulds, lasts)
3. Production cost

Even if it is very simplified, this table helps us understand that the greatest share in the production cost is often given by the cost of the materials and of the upper and lining assembly.

But if we carefully examine the upstream costs we can notice that the greatest amount of the design and equipment cost is that of the development of new components of the structure.

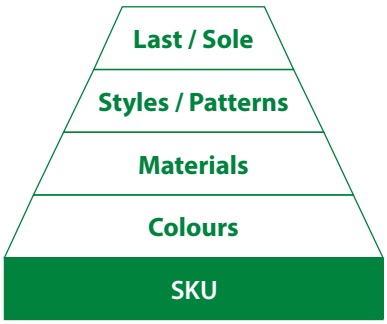
| | ENGINEERING COST | TOOLING COST | COST IN THE P&L OF THE SHOE |
|---|---|---|---|
| Upper / lining | ★★ | ★★★ | ★★★★ |
| Last / insole | ★★★ | ★★★★ | ★ |
| Die-cut sole | ★★★ | ★★ | ★★★ |
| Heel | ★★★★ | ★★★ | ★★ |
| Moulded sole | ★★★★★ | ★★★★★ | ★★ |

The structures entail an existing cost (the prototyping of a structure and the related size development has a cost) and a cost in terms of time used for the finalising and assembly of the components. The time used in the design of a new structure often derives from the fact that not all the components are produced by the same company; therefore the technicians of the shoe factories have to coordinate the finalising of the structures components. It is a long work that requires times, transfers to different laboratories, technical knowledges and economic investments like, for example, the opening of a heel or sole mould. In any case it is the designer who decides the profiles and the aesthetic details of the structures, taking into account many factors like the trends, style and brand target evolution, and the budget at disposal.

This is why in a collection it will be given attention first of all to the development of a limited number of profiles/ bottoms. Many are the models that will be designed starting from these structures (some of which will have a structure in common, so that it will be possible to amortise the fixed costs for the realisation of structures).

Once the styles are designed there is the choice of the materials for each part of the patterns and, finally, of the colours for each material.

Creating a collection that is efficient from the point of view of production and supply of the materials means being able to find synergies among the various products of the collection (SKU).




**The cost of the structures is decisive in the cost of a collection. As footwear structure we can mean everything that composes it, with the exception of the upper.**

**Let's see here below the components that can form a structure.**

Last

Insole

Heel

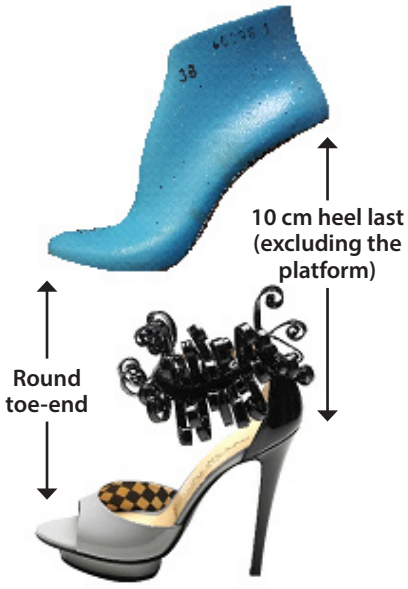
Platform

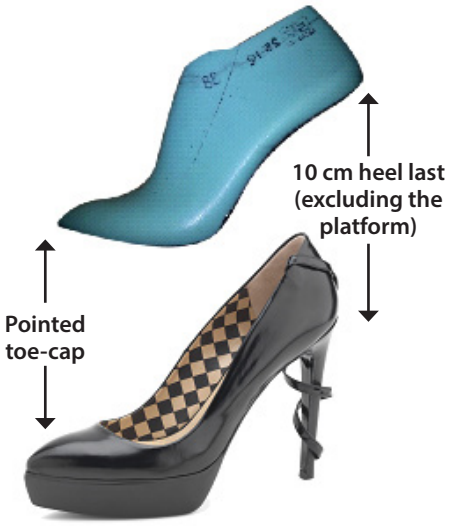
Reinforcements

Finished shoe

The **lasts** correspond to the exact shape that the shoe we are going to create will have.

- From the point of view of fitting (if it is created to host a thin or big foot, etc...)
- And of the last's heel height.
- And of style.
- For each shoe size we need to create it will be necessary to make a last of that size.
- In order make a production we are forced to buy many copies of the same lasts, to give fluidity to the production times.


The lasts also have to be differentiated according to their use and to the kind of footwear we need to create. Here below there is a little recap of the main differences.

The last of the sandal is shorter in front so to avoid the risk of having too much space in front of the fingers

**To make a sandal, you need a sandal last**

**To make a shoe, you need a shoe last**


**To make an ankle boot or a boot close fitting you need to have a close fitting boot last**


**To make an ankle boot or a boot pull up you need to have a pull up boot last**

Therefore the lasts are a necessary cost.

The designer then will feel he has to cyclically «rejuvenate» the profile of the lasts of his line and this will involve a further investment.

Having said that, it is important that the designer knows what the introduction of a new last implies, i.e.:

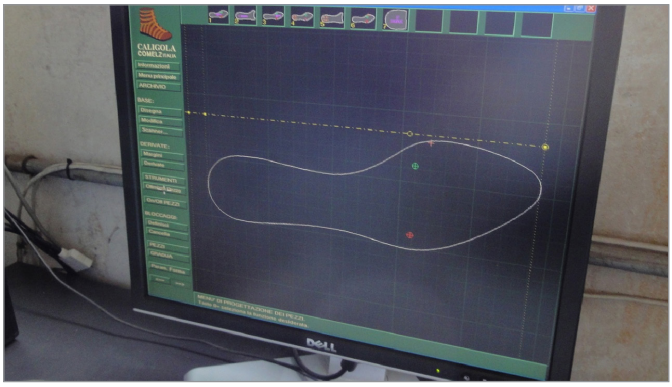
- Investment of time and energies to develop the prototype of the last
- Investment of money for the sizes development
- Investment of money for the specific bottom of the new last

In this way he will try to optimise the use of the lasts and the introduction of new ones inside the collection in order to avoid waste.

Here below we have an example of shoes inside the same collection developed on the same last.

In the classic shoe, the **insole** does not need particular set-up costs. However it will have to be created on the basis of the last.

The insole pattern maker will extract from the last the corresponding profile that, once digitalised, will be cut and crimped on the last.



**The insoles pattern maker will extract from the last the corresponding profile...**

**that, once digitalised, will be cut...**

**and crimped on the last.**

In any case, **EVERY LAST NEEDS ITS OWN INSOLE**

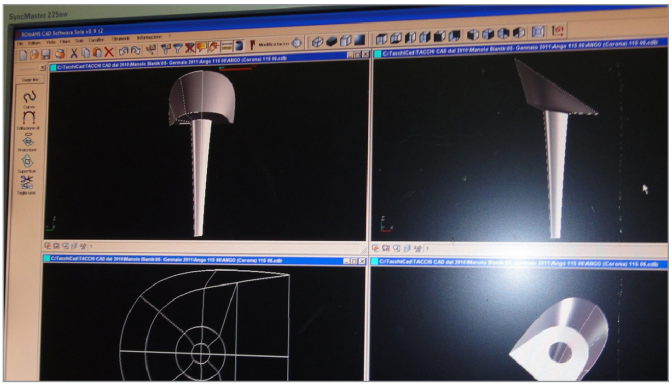
The **heel**, instead, can have different costs according to need. Let's consider first of all that the heel must be perfectly related to the last and the insole, otherwise it creates big problems.

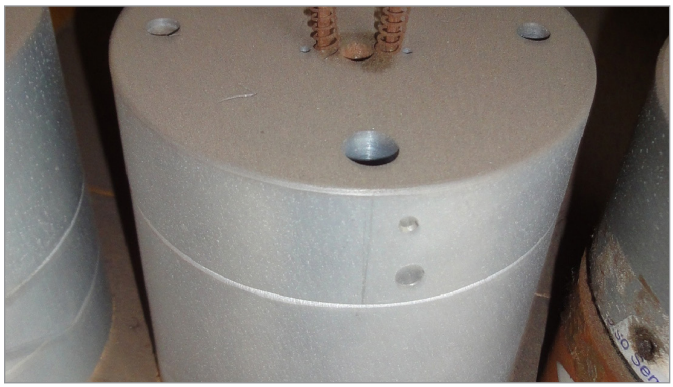
Many heel factories offer quite a wide range of heels, among which the designer can choose; then he can get the last made according to the chosen heel.

If, instead, the designer will want to create a new heel, he will have to face a high set-up and design cost.

- The cad design time
- The cost of the first resin and of the time for the first trials
- The mould and sizes development cost

Also the company's internal cost for the management of a new heel is not to be ignored.





The **platforms** can be either trimmed or printed. If they are trimmed there is no set-up cost: you start from a pre-existing plant and you «cut» according to need. However, the cost of each one is higher than a printed platform and usually it is less precise. The use of one typology or the other depends on the quantity of pairs with which it is possible to amortise the plateaux' moulding cost. Each size needs two moulds: right and left.

The wedges too, like the heels and platforms, need a mould that can have a price whose height depends on the complexity of the element.

Plateaux and wedges must be specifically made for a particular last, or a last must be specifically created for particular platforms or wedges.

The **soles**, instead, can be divided into two typologies:

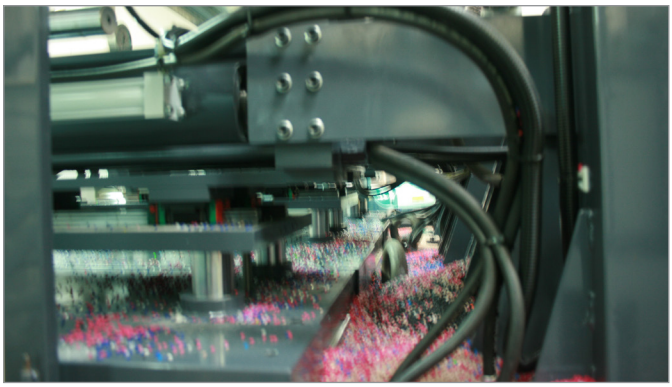
• **Cut soles:**

The cut soles do not need set-up costs: you give to the sole factory the last with the insole (in case the heel) and the lasted upper and they obtain the sole by making the pattern. After that the sole is slotted with a punch cutting and then sandpapered or (in case of bigger productions) punched down to size.

• **Printed soles**

To talk about printed soles is quite complicated as the type of moulding process changes a lot according to the different materials of which they can be composed.

In any case this kind of soles, made with different plastic materials, need a mould in which the material is injected. These moulds entail a cost that is generally quite high, considering also the size development.



After this smattering on the complexity of a footwear structure, we reach the conclusion that the optimisation of the structures within the collections is a way to save money and avoid waste. **It is possible to develop different upper patterns with the same structure,** changing its look countless times.

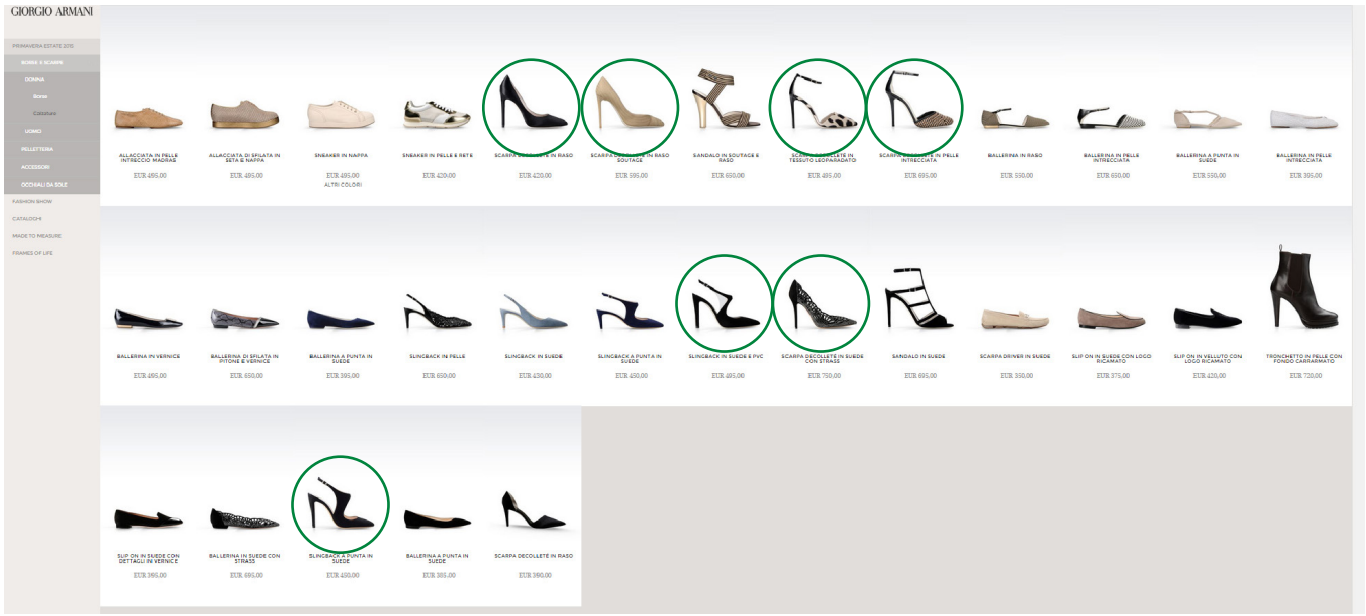
Here below, an example of a line of boots and ankle boots based on the same last, heel and sole. The pattern making is different between the two boots and compared to the ankle boots (that, in turn, can be distinguished only by the material used for the upper and the lining and for the heel and sole cover).

This line of sandals is based on one structure (last and sole). Also in this case the difference is given by the style lines of the upper and by the materials used.

Sometimes to think about using quite simple structures for a collection can help not only coupling different uppers to them but also being able to carry on the structures collection after collection.

Actually, it is the concept of fashion itself that implies the change and, as a consequence, the waste. In the case of footwear we can turn the aspect of a shoe upside-down through the creativity expressed on the upper, limiting, instead, the excessive change of structures. In this way we will be able to keep on evolving the style without an excessive waste

Another example:




Giorgio Armani women's collection sold in the on-line store: The pumps circled in green have the same last, heel, insole and sole.

Here below we grouped the shoes that can be found on Louboutin's website by structure:

We can notice that it is possible to create many different shoes starting from the same structures.

As we said at the beginning of the chapter, **another element on which the footwear designer can work is the optimisation of the materials.**

The materials within a collection are considered a key element of the style. The use of many different materials inside the same collection, once a prerogative of women's footwear, has been increasingly adopted also in men's footwear both in terms of colours and in terms of typologies of leathers. Nowadays the materials are one of the key elements on which the designers rely in order to determine the uniqueness of their product and create their style.

Unfortunately the use of many types of leathers and colours lead to some manufacturing problems:

- The tanneries reluctantly accept orders of few square meters that make their manufacturing ineffective. In order to discourage these practices they raise the prices for minor orders or they delete the orders.
- The greater the number of leathers the greater the amount of semi-cut leftover leathers that will remain in storage at the footwear factories and increase the administration costs for the samples orders management (telephone, storage management).

It is necessary to find a balance between the sales and the production necessities, improving the distribution of colours and materials within the collection, reducing the number of tanneries that supply us, using some colours as carry overs in different collections.

Another strategy for the optimisation of the materials and their cut is to use the same leather to obtain different pieces of various models that are part of a collection. Also in this case it is a strategy aimed at focusing the supplies on a smaller number of materials/colours, with the purpose of making the supplier obtain a greater efficiency but also of improving the performances in the cutting stage.

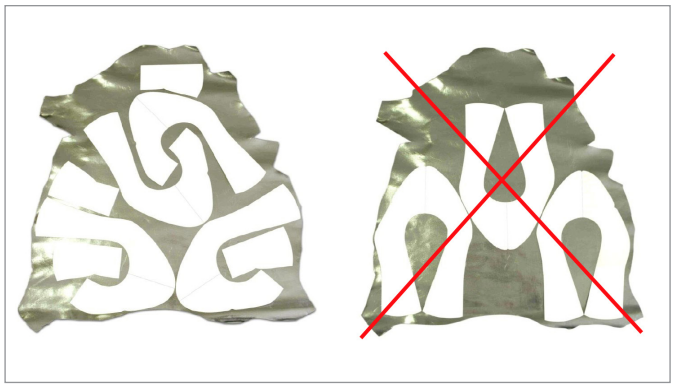
Here below we see the same shoes that we had previously grouped by structure divided into families of materials.

If we were to observe extensively the majority of the collections on the market, we could see that the same materials are proposed in many shoes within a collection. **This fact is certainly to be observed in an optimisation and saving perspective but it also has motives that are more linked to aesthetics, collection coherence and saleability.**

As anticipated, **another important component of the production cost on which the designer decision can have an influence is that related to material consumptions.**

Many are the factors that influence this cost:

- The cost of the material: clearly a valuable material costs more than a poor quality material used for the same surface.
- The pattern dimensions: there is no doubt that a boot consumes more material than a ballerina.
- **The way the pieces are designed and the dimension of the material to cut**
  - Big pieces are often harder to embed (place) in comparison with smaller pieces and therefore they will lead to a lower efficiency in the use of the materials to cut, which means that the waste will be greater.
  - Materials with smaller dimensions can cause an inefficient cut (above all if it necessary to cut big pieces)



This is an example of how the pattern of a pump can change in terms of consumption. If the designer decides that the pump can have an internal cut, this will enable to save leather allowing the cut to "embed" the pieces.

When the designer chooses the style lines of an upper he actually determines the dimension and profile of the pieces and when he chooses the material he determines those of the leather. He actually decides both the factors of the ratio relationship.

In these three oxfords we will have a different consumption despite the similarity of the patterns, as an oxford in one single piece consumes more than a disjointed one. This demonstrates that a careful choice in the style lines can determine a great saving.

Also the size of the leather is an important factor. The bigger a leather is the simpler will be to avoid waste during placement.

This example wants to show the ratio between the same last and different types of leather. Surely a bigger leather limits waste.

Even today the faster system for the cutting of upper and linings pieces is the punch cutting (the alternatives are to cut with the knife and the use of cutting tables).

The socket punch is the equipment that has to be made to produce the upper and lining pieces (ref. product's total cost page)

It is a steel twisted blade with the profile of the upper piece. It is used in combination with a punching machine that presses the socket punch blade on the material, causing the cutting. The main limits of the socket punch cutting are:

- The cost of the socket punch manufacturing (a simple model can have a dozen upper and lining pieces and for each piece it is necessary to create socket punches of all the sizes).
- the time necessary for its manufacturing
- the great space occupied and the management of its use

Strategies to improve the socket punch cutting efficiency can include:

- The creation of models that have some socket punches in common
- The use of the same socket punch for pieces of different sizes (the so-called lockings)

Example of socket punches and pressing machine.

These patterns of different boots made on identical lasts can use the same socket punches for the area in the circumscribed zone, optimising their use.

Example of space occupied by the socket punches

The explanation of the fields where the optimisation of the collection structure can entail a better allocation of the resources, lead us to some significant conclusions.
In order to optimise the use of the resources at his disposal, the waste reduction and the ability to put into action solutions that reduce the environmental impact, the designer should

- Increase his knowledge of the production process
- Improve the integration with the engineering system.
- Rationalise the use of the materials.
- Use the utilitarian incentives of these decisions

From these points it is possible to deduce that it is necessary to invest in technical knowledge. The technical education leads to an improvement of the design that becomes aware and active, instead of keep on depending from development centres that, instead of cooperating, often either blindly execute or create conflicts because their decisions are interpreted by designers as obstacles to their creation and not as an improvement of the efficiency.

Finally, when the economic interest (better margin, better profits) of the protagonists of the process (footwear factory, designer, brand) coincide with an improvement of the resource use with the environmental interests surely it is easier to implement them and made them effective.

### *3.2. Use of CAD (integration design – engineering - costing) to reduce consumption and waste in the design stage*

On the basis of the concept expressed in the previous chapter, according to which the designer is the one who defines characteristics and sustainability of the product, some of the companies that manufacture software are taking steps to link the moment when the product is invented to the creation of it.

**If the designer, in the very moment when he designs the shoe, is immediately aware of how many cuts the pattern of the upper and which costs the materials and the structure he decide to use will have, he will really be able to guide his creativity to the creation of a product of which he is the absolute maker.**

Nowadays the 2D and 3D CAD systems in use in the footwear factories enable to design the uppers and linings in a parametric way, that is:

- It is possible to modify the style lines of the standard in every stage of the design and, automatically, all the pieces built on these lines will change shape and assembly details.
- If the size development has already taken place, the geometries of the sizes obtained by the new standard will also be changed.
- If also the technical sheet have already been made, even the assembly instructions will adjust to the change

The most advanced CAD also enable to:

- make the counting of the consumptions related to all the pieces modified in real time.
- recalculate in real time also the costs of the material used for cutting, according to the new geometries

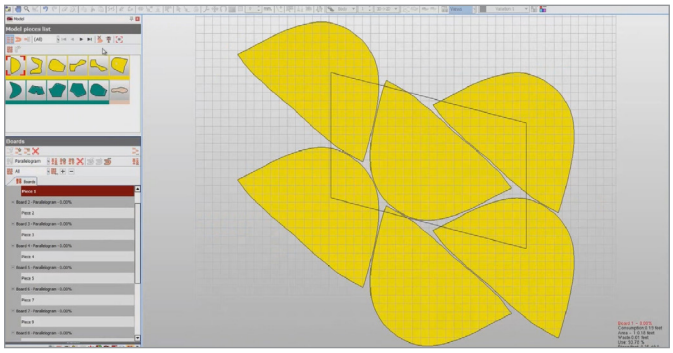
These advantages have radically improved the system used to obtain the patterns, the way the style is adjusted and improved, the method used for the placement on flat materials and the consumption calculation, made using many methods according to the needs and necessities.

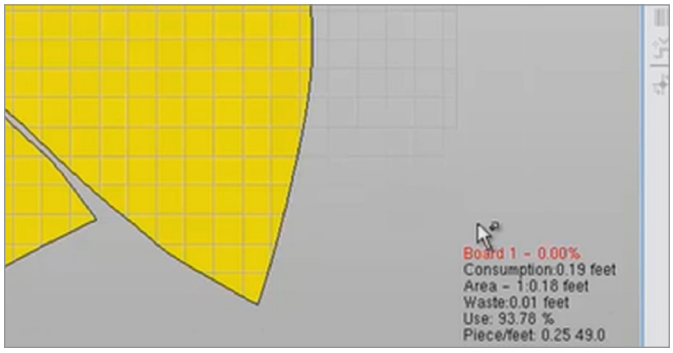
- The consumption calculations can be compared to each other
- The methods can be applied both on the leathers (single material pieces different from each other) and on the so-called homogeneous materials (synthetics and fabrics), also on the basis of the different types of pieces supplied.
- Therefore, many are the combinations and theories that the product technicians can evaluate in advance in order to calculate beforehand the engineering of the different products that will then be built.
-

All of this even before one single square metre of leather is purchased and in great advance in order to be able to optimise the supply of the warehouse.

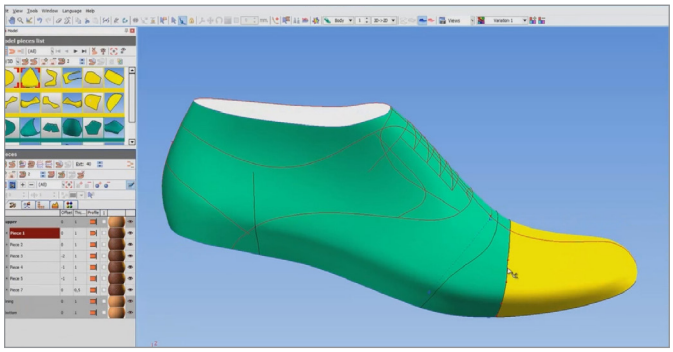
In summary:

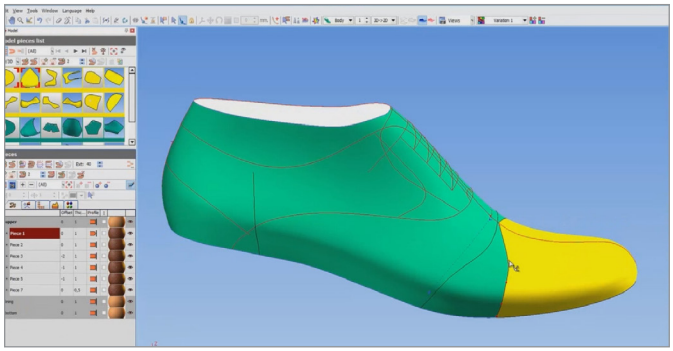
If I have a toe-cap whose placement and consumption can already be seen in the CAD system



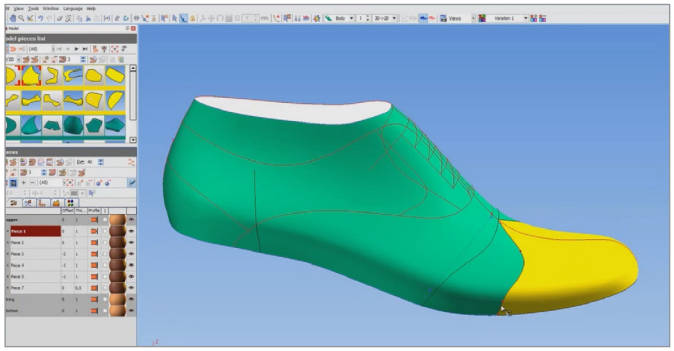


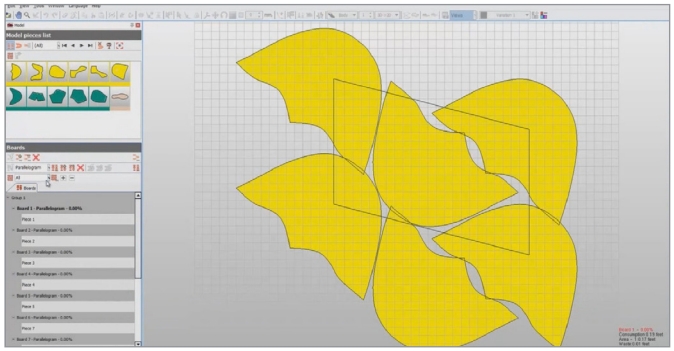

But I suddenly decide that I do not like the classic toe-cap anymore, I can change it designing directly on the 3D last



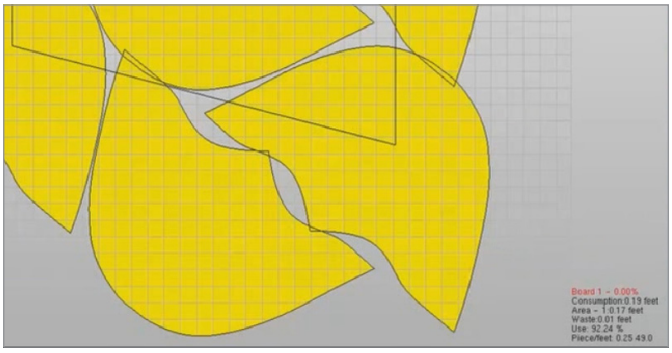


Until I decide that it is good and CAD automatically show me the modified pattern





And the related sq. ft. measurement



In this way the designer becomes immediately aware of how much the lines of the upper he is designing are efficient in the cutting stage, i.e. in the stage that determines the material consumption and therefore the main component of the production cost of the shoe.

### *3.3. Virtual prototyping (rendering) and 3D printing*

The modern CAD enables also to create very realistic renderings.

The footwear virtual prototypes are useful because:

- They enable to see in advance a 3D picture of the complete shoe that is very similar to the real result, like it has been made by the factory with the traditional systems
- The rendered virtual prototype enables us to analyse style, details and combinations of colours and materials. So it is easy to make continuous modifications without being forced to eliminate the previous prototypes: everything is similar to reality but nothing is physically made
- Some instruments at disposal make 3D prototypes and renderings of great quality and precision. It is really difficult to understand if it is a picture or a real footwear
- The CAD system and the rendering reduce the waiting times required by all the players for the physical realisation of the components.

There is no use and therefore there is no material waste to build the prototype. With the traditional systems, instead, the materials are cut and generate production wastages that, in turn, are subject to waste disposal and are not always recyclable.

- It is possible to create entire collections lines with infinite variations using only one plastic or a wooden last.

The footwear virtual prototypes have also some disadvantages:

- The 3D model and rendering realisation times can be very long, longer than the physical manufacturing of a real shoe
- In any case it is a static or dynamic rendering but it is not possible to touch and wear the product
- The equipment costs can be very high if you want to reach a high level of fidelity

- The traditional digital rendering enables to obtain only a 2D printing of the product, in other words a picture, even if very faithful to reality.

- In terms of wastes and creation of production wastes, the advantages given by the 3D printing are more than satisfying in comparison with those given by a static or dynamic virtual prototype.

The footwear prototypes printed in 3D are useful but still hide some disadvantages:

- The 3D printed footwear cannot always be worn because it does not have the parameters needed by the human foot in order to walk or run
- The additive printing has fewer materials than the traditional range. However it is still necessary to understand if the printable material, if the alternative materials, have the same or better characteristics than the traditional ones. They not always behave like those already in use. The 3D printers' manufacturers often tend to create and use their own.
- The great chemicals personalities and plastic materials suppliers are taking steps to adjust their materials to the 3D printing. We have reached a good result but the costs are still too high.

**From 3D footwear modelling it is possible to print components or entire shoes in 3D.**

The 3D printed footwear prototypes are useful because:

- They enable to materialise in a specific moment something that still does not physically exist
- We can print, depending on the case, complete footwear or components that can then be assembled on the upper made in the traditional way (hybrid system)
- In some cases it is possible to print, using additive systems, complete shoes that break the barriers of the physical limits imposed by the traditional systems. Design has no limits anymore.
- They enable to invent, design and build shoes with new concepts of functionality, comfort, style and fashion trend that are incredibly different from the usual.
- The analysis of the 3D printed pattern goes beyond what can be understood with a digital reproduction, even if it has high resolution and precision.

**Here below we have tried to identify some of the tangible advantages of the digital rendering and 3D printing used in footwear ecodesign´**

- We do not cut traditional materials like leather, synthetics and fabrics, because we do not make the shoe in the traditional way
- By doing so we do not produce wastages and scraps that have then to be disposed of like waste that sometimes is difficult to eliminate
- The prototypes built in a traditional way, after analysis and fitting trials, must be eliminated as garbage.

The footwear is notoriously a product composed of many materials and components and therefore should be disassembled and each element should be disposed of in a different way. For example: zippers, ornaments, metal lace hooks and eyelets, laces, soles, heels, etc...

- In general, in comparison with the traditional construction system, an inferior number of prototypes is needed in order to be able to validate and approve a product
- No adhesive are used to make the shoe
- We do not produce traditionally printed objects that, in turn, could require disposal or a difficult recycling
- It is also possible to act on the techniques employed to obtain the patterns by using all the instruments at disposal for the virtual analysis. Experiments and preventive trials of uppers divided into many parts enable to optimise the consumption of the materials cut. Thanks to the CAD systems we make simulations of the pieces' placement on the materials that in the future will have to be used physically. In this way it is possible to maximise the design and cutting geometries in order to reduce consumption and, therefore, the waste to dispose of.
- The 3D design and planning object does not need the production of a mould. There is an enormous advantage in the absence of metallic trimmings, noxious smokes produced by the working centres as well as of moulds prototypes that usually have to be then modified for improvements and design changes. In other words, discarded and disposed of when it is not possible to fuse the metal again.
- In terms of power consumption, the use of one machine is a clear advantage of the ecodesign if we compare it to the many types of equipment necessary for the construction of a traditional prototype.
- However it is also necessary to remember that, before deciding which printable material will better fit the costumer's needs, it is necessary to make more than one trial to reach the goal. Everything depends on what we want to obtain
- The 3D printing can have a sensational effect on footwear design and not only on it. This technology even gives the chance to create new materials with better functionalities than the traditional ones that come, for example, from natural fibres. We would contribute, so, to the environment safeguard and we would avoid the exploitation of the manual labour for the harvest (e.g.: cotton)

## 4. Design for Recycling

Design for recycling means to design a product having already in mind the end of its life.

The recycle of a shoe is complex, as a shoe is an assembly of materials that are:

- Inhomogeneous (e.g. leather for upper, rubber for the sole, cardboard and metal for the insole, etc.)
- Not easily separable (the upper and lining pieces are stitched, the insole is glued to the upper/lining and to the sole in the cemented construction)

According to the type of upper construction (lasted, strobel or mocassin-like) and according to the type of sole construction (lasted, stitched down, vulcanised, injected) can be more or less complicated to separate the the pieces of a shoe.

There are some key elements to keep in mind if we intend to develop a recyclable shoe:

- The collection of the products at the end of their cycle of life
- The separability of the components
- The recyclability/ biodegradability of the single components

Here below we will see some examples of companies that have launched recycled footwear projects.

Some years ago Nike started a project that aims at recycling the sports shoes.

The slogan of this project is NIKE REUSE-A-SHOE. SHOES DIE. SOLES LIVE ON.

The company started the sports shoes collection project in the 90es, succeeding in collecting a million and a half pairs. Thanks to the project the shoe is cut into 3 parts, upper, sole and intersole, each of which is grinded and recycled in order to create fields and sport surfaces. You can see it in detail in the dedicated website

***http://nikegrind.com/how-its-made***

Timberland created the boat shoe Earthkeepers 2.0, designed to be recycled. It has a "green" recyclable rubber sole and a stitching that enables to easily remove the sole after it is thrown away. Timberland has collection points in each of its shops.

The Esosport project has arisen in Italy in order to compensate for the lack of collection points for sports shoe. Unfortunately this reality still has not a network presence, but it supplies many collection points throughout Italy in order to recycle the used training shoes.

It is fundamental for a designer to know the different constructions, taking into account the fact that the separability of the components is one of the key points for recycling a shoe.

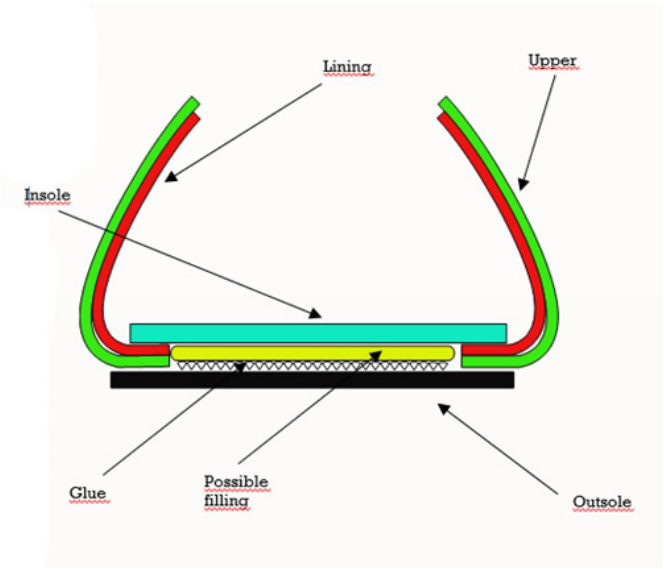
We can think to the constructions as divided into two macrocategories:

- Upper constructions (lasted, strobel or mocassin-like)
- Sole construction (cemented, stitched, vulcanised, injected)

For what concerns the separability of the components, the crucial point is the separability of the sole from the upper; therefore we will examine directly the types of sole construction.

**• Cemented construction:**

The cemented construction is the most common. As the name says in this construction the outsole is glued to the shoe. It is a construction where it is quite hard to be able to remove the upper from the sole.

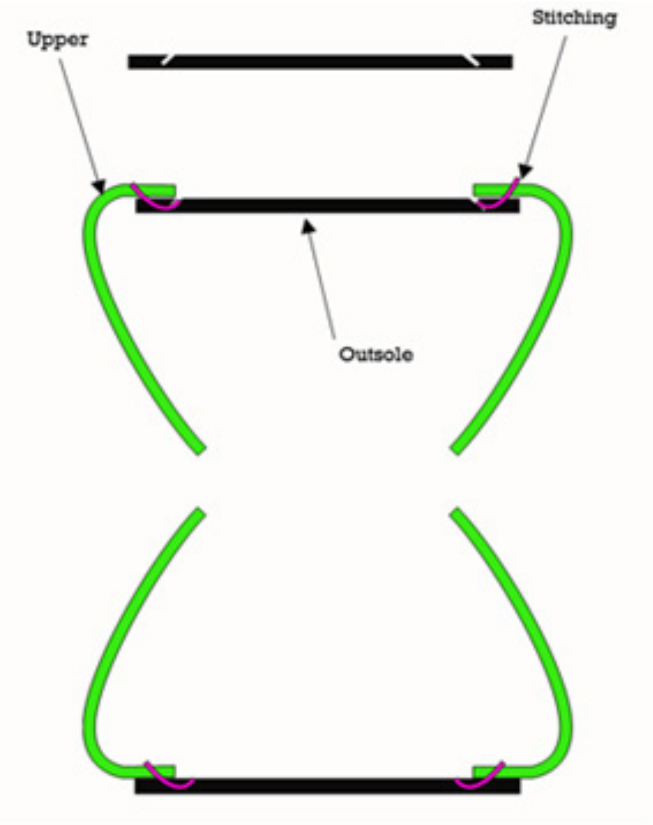



**• Stitched constructions:**

In the stitched constructions the use of glue is more limited than in a cemented one, so in many cases it is simpler to remove the upper from the sole.

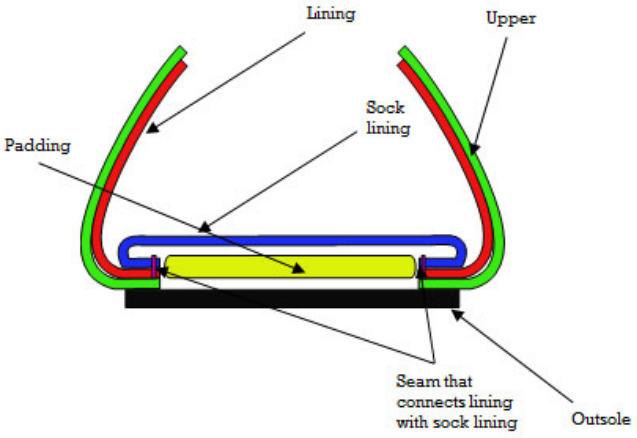
**Inside-out:**
The inside-out construction is a construction of the ballerina that makes it more flexible than a shoe built in the traditional way.

It involves sewing the upper to the sole upside-down, and then flipping it over. In this way the presence of the insole is not even necessary, and that increases flexibility and lightness.

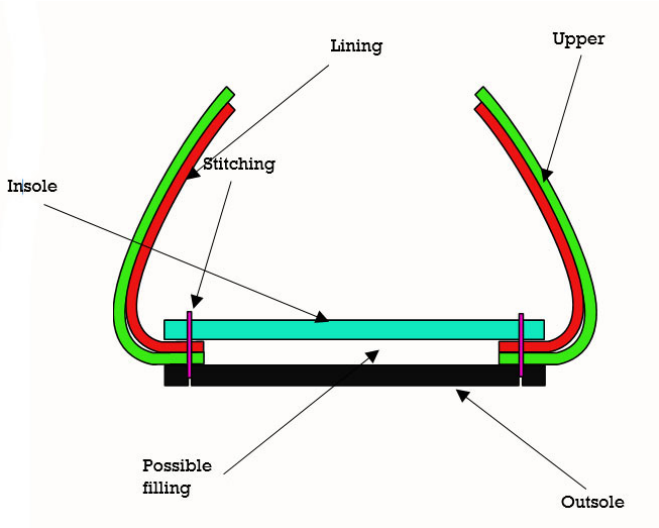


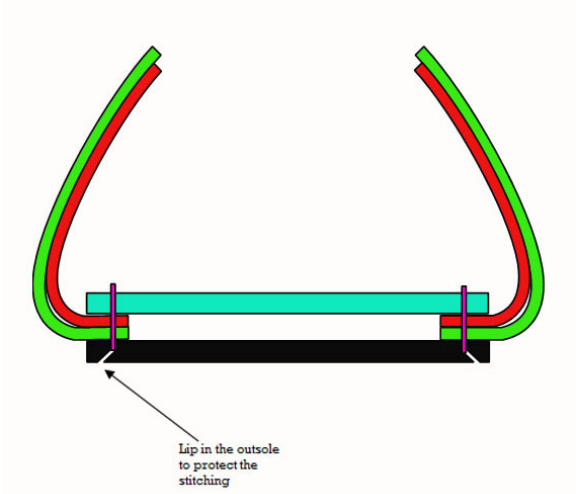
**Sol-California:**
Another type of processing that allows a greater flexibility and lightness is the sol-California construction (sewn-in-sock):

- Full California: the lining is sewn with the sock lining, then slips into the last and paste the outsole. You can insert a small insole or place the sole directly. In this way you avoid the rigidity due to the shank. In order to make this working the pattern must be very accurate, since the lining must coincide perfectly with the outline of the shape. Furthermore, as the upper is slipped into a bag shape, the ballerina will not have the same tension on the last as a shoe in which both uppers and lining are lasted. Often you can see an elastic band along the neckline, arching its footwear, emphasising its flexibility and avoiding the risk of losing it because of the absence or lightness of reinforcements. The ballerina will have a great softness and extreme contact with the ground.
- Half California (toe sock): In this process the lining is sewn to a half sock lining in the front part. The back and the sides will be lasted to a half insole. This enables to obtain a heel height, even if modest, and to insert a half insole with the shank.
- Half California (back sock): Sometimes the lining is sewn to an "incomplete" sock lining in the tip, as it can be very difficult to sew a sharpened tip directly to the sock lining without obtaining folds.




**Blake:**
The Blake construction is very common in classic men shoes. The process of this construction is very similar to the classic cemented, so the machines to make it are very similar, except for the fact that in the last stage the outsole is not just cemented but is stitched to the insole. The stitching on the bottom makes the shoe look classical and more precious.

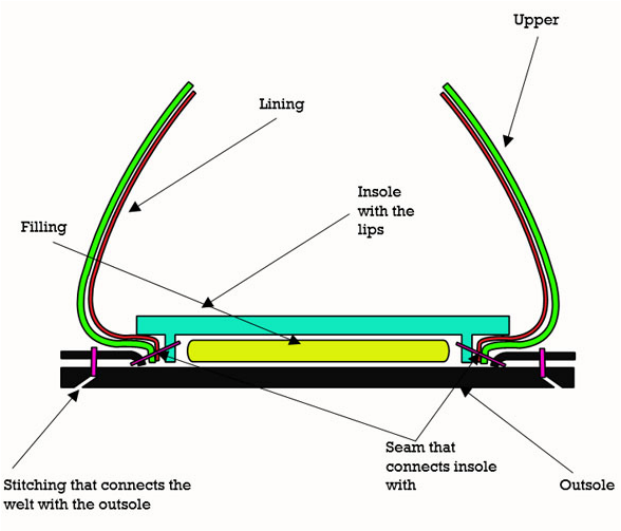


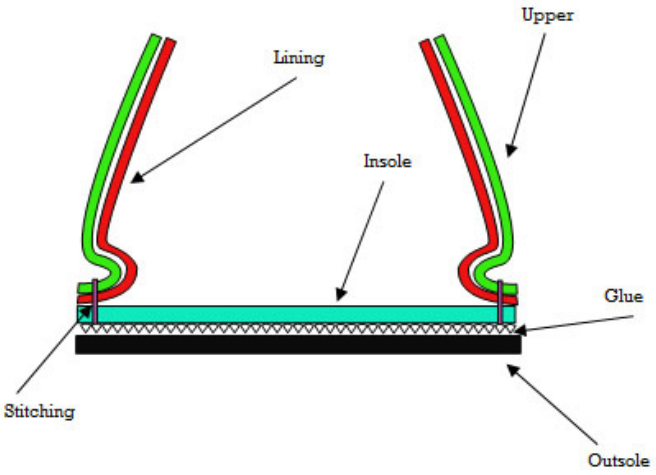
**Goodyear:**
The Goodyear is a very luxury construction for men. It is made differently than the cemented construction. At first the upper is lasted with a lasting machine that differs from the classical one that leaves the upper lasted in "horizontal". Then the welt is stitched to the insole (that is a special insole, with a lip) and the upper.

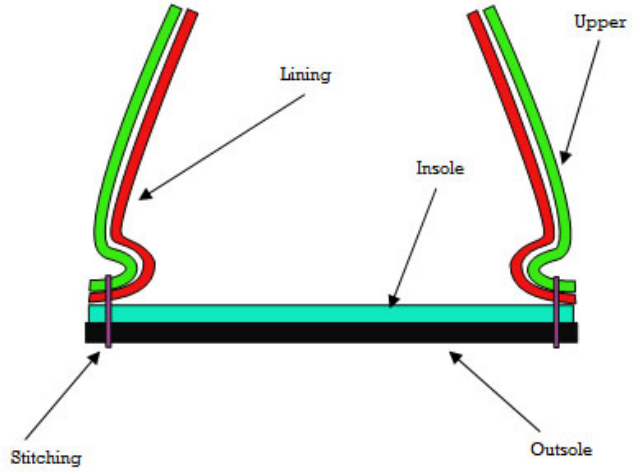
After that the filling, usually made with a paste of cork, is inserted.

Then we have a second stitching that connects the welt to the proper outsole.

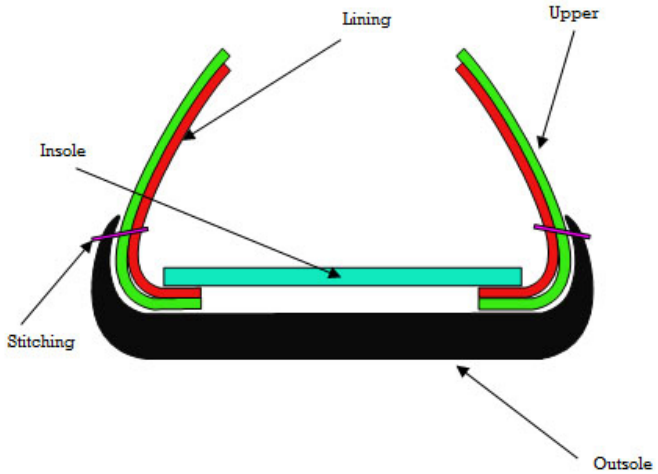



**Stitch out:**
The stitch out construction is very casual. The upper is lasted on an insole larger than the last. After that the outsole is attached to the insole and the upper with an external stitching. Sometimes, as we can see in the example, the outsole is glued separately.



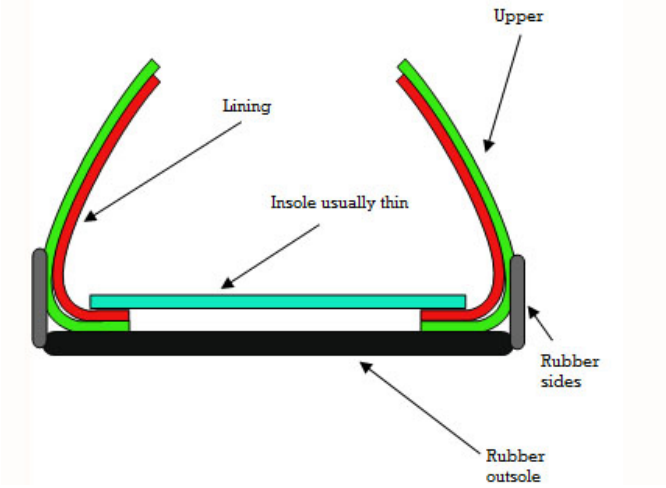
**Opanka:**
The Opanka construction is a lasted upper on a normal insole or a strobel where the outsole goes over the last like a box. The sides of the outsole are stitched to the upper with a special vertical machine.




**• Vulcanisation:**

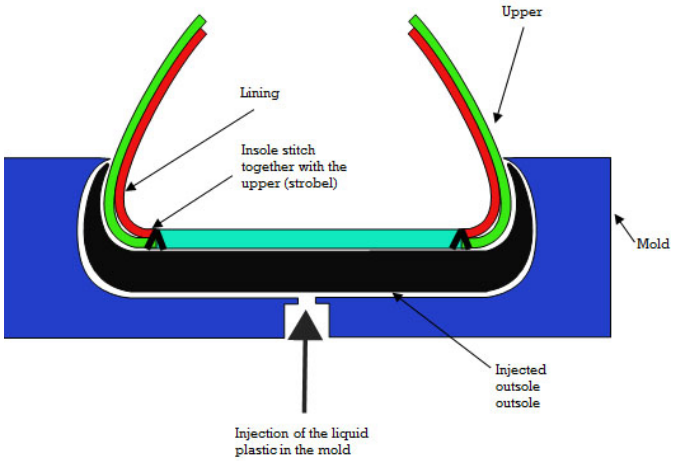
This is how the vulcanisation process takes place: the shoe can be normally lasted on a soft insole or a stitched strobel. Then, when the outsole has to be placed, we spread the latex glue and apply the semi-rubber that is still soft. After that the outsole looks like a finished outsole, but is still too soft to be used. The finished shoe is inserted in a furnace where the temperature and pressure cause the vulcanization process. The parts of the rubber blend and acquire the final characteristics of elasticity and strength.

In this kind of process it is very difficult to detach the upper from the outsole.




**• Injected:**

The direct injection on the upper entails the use of a mould that closes around an upper (usually slip-lasted) put on a metallic last. The plastic material, that is still not solid, is injected through a hole into the mould and takes its form, sticking well to the upper. The detachment of the upper from the sole in this case is extremely difficult.



## 5. Sources of inspiration for ecodesign

Like all the green fashion sectors, footwear too is constantly evolving.

Every day companies from all over the world look for materials, techniques and production systems able to supply shoes that, besides satisfying the aesthetic canons and the functionality of the contemporary society, guarantee the respect for the environment and health.

Some of the little brands base their concept entirely on sustainability, but many of the world's most important footwear brands are including a percentage of sustainable products in their product offer.

Footwear manufacturer have many ways to go through the path of sustainability: choice of sustainable materials, practices to safeguard the environment and the animals, fair trade and recycling. Often they end up choosing more than one of these behaviours, so much that it is often hard and belittling to associate a brand to a category and not to another. In any case, we chose to create some categories in order to emphasise the characteristics of the brands examined, even if they often merge.

1. **Analysis of eco sustainable brands**
2. **Analysis of vegan-brands**
3. **Analysis of slow design brands (ONG fair-trade)**
4. **Analysis of brands that use recycled materials**

In this wide and complex overview we have identified known and lesser known brands that distinguish themselves for the ability to unite the concept of sustainability to the originality of design and to innovative solutions, in order to give some ideas for anyone to embark on his own path.

### *5.1. Analysis of sustainable brands*

Some sustainable brands often communicate their being eco through design. Their style often makes strong references to the world of nature both in the colour and in the shapes and textures and usually it does not neglect comfort.

Among them, **El Naturalista** is the one that gives a winning example. Its production immediately catches our attention because of its soft lines and the predominance of the colour, but its mission is first of all to create comfortable and breathable shoes, able to adjust to the foot and make the walk easy.

This is obtained thanks to a careful study of the soles, an accuracy in the processing and to the use of high-quality materials, above all natural materials like leather, bamboo and cotton for the upper, but there also of recycled and biodegradable ones, confirming the interest that the Spanish brand has always had in the environment.

**Please notice the cut of the vamp that resembles the leaves draw**

**Please notice the sole design that resembles the texture of a bark**

**Please notice the natural colour used in the whole collection and the cut of the lace that resembles the shape of a leaf**

Similarly **Ligneah**, a brand from Rome founded by the designer Marta Antonelli and her father Marcello, a former textile manager, distinguishes itself for the use of ligheah, a material born from the processing of walnut, birch and ash wood coupled with cotton that gives the products of the company a softness similar to that of the leather and a delicate texture with wooden veining.

On their website it is possible to read their «manifesto»: cruelty free and eco-sustainable.

***http://www.ood-italy.it/it/#manifesto***

**Defa's**, a footwear factory in Monte Urano (FM), in the Marche region, gave life to the projects Risorse Future and Green Peletto, in order to manufacture ecological shoes that are entirely designed and made in Italy. Using materials like hemp, suberis, and vegetable tanned leather for the upper, apinat bioplastic for the sole, texon cotton for the insole, jute for the laces and water-based glues, these shoes have, in fact, a design that we could define as completely natural, besides being breathable, comfortable and resistant.

Designed in Italy and fairly handmade in small, family-owned factories across Europe, **Kailia's** vegan boots, pumps, and flats abide by strict environmental standards, including the eschewal of toxic polyvinyl chloride and a preference for vegetable-dyed organic linen and cotton linings, pre-consumer recycled footboards, and water-based glues. In the styles of this brand there are many references to the world of nature, like the flower linings and the natural shades in the uppers.

A very original contribution has been made by **Oat Shoes,** the Dutch company of Christian Maats and Dirk-Jan Oudshoord that created the eco-friendly shoe. In fact, besides being made of hemp, corn, cotton, chlorine-free bleach and biodegradable plastic, the tongue contains a seed that, at the end of the shoe's life, will be able to give birth to a plant if watered.

Other brands, that usually are already famous, for whom the creation of a sustainable «division» certainly has a different kind of communication than a brand that, instead, completely rely on sustainability, do not need or, in any case, chose not to make a design with references to nature, relying completely on labelling and communication, in order to be coherent with the brand.

**Timberland** is one of the first fashion houses to support a low environmental impact production; every year it proposes the collection Earthkeepers, characterised by the use of natural materials (but also of eco-compatible, recycled and recyclable materials) where the faint colours are interchanged with more resolute models. Finally, by purchasing a pair of shoes of this line it is possible to participate to the **Planet One on Us** campaign, with which Timberland will plant a tree.

**Carrera, instead, thought to develop** the project Scarpe a Km zero (0 Km shoes), **with the purpose of relaunching** the high quality product made in Italy, in contrast with the costs and pollution caused by delocalisation. These shoes, in fact, are made using leathers, accessories and soles certified as "with low environmental impact" and all the different processing stages, from the material treatment to the disposal, are made complying entirely with Italian regulations concerning the environment safeguard.

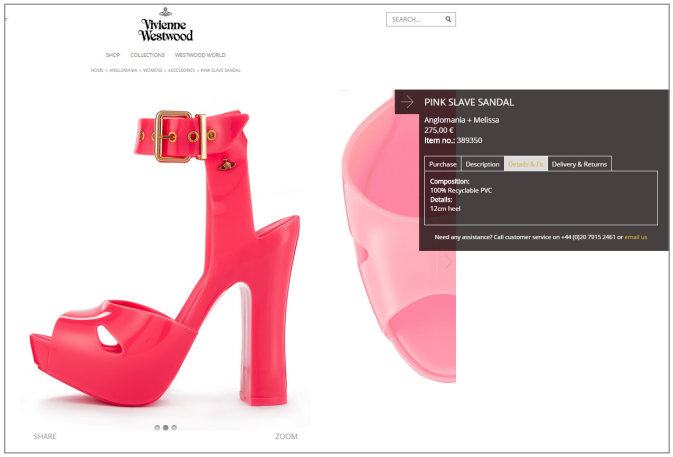

The **Nike** brand also pays close attention to sustainability, in different areas and aspects.

In the sustainability area of their website they clearly explain their vision:
***http://about.nike.com/pages/sustainability***

This mission does not emerge in the hyper modern and contemporary style of their shoes.

**Vivienne Westwood** has a blog dedicated to ecology issues called Climate Revolution and her products pay special attention to recyclability, as it can be seen in the descriptions on her website.

She introduced also natural processing for her clothes and created a cruelty free make-up line.



### *5.2. Analysis of vegan brands*

Another important category, towards which many brands are moving, is that of the vegan shoes.

The vegan shoes, also called animal free, are shoes made without materials of animal origins.

**Stella McCartney** is certainly a pioneer in this sense as she, a committed vegetarian, does not use leather for her creations. However the designer is able to create high fashion shoes through the scrupulous research and selection of biological and synthetic fibres that create a splendid eco-leather able to endure the working process. The latter, in fact, is completely made by hand, as the machines currently on the market are designed only for leather working. Besides, the brand does not use glues of animal origin and for the soles and heels it chooses cork and bioplastics.

**Bhava shoes**, by Francisca Pineda, are also made with sustainable and cruelty free materials and with an artisan care so great that it sometimes makes limited productions, able nonetheless to guarantee a great variety of style, from classic to contemporary.

**Beyond Skin**, a brand guided by Natalie Dean, is also quite popular, so much that its shoes are worn by Natalie Portman, Anne Hathaway, Leona Lewis and Sadie Frostil. Classic, feminine and elegant in a very British way, they are manufactured in Spain with an eco-leather obtained from the processing of synthetic fibres.

Founded by Gina Ferraraccio and Julie Dicterow, **Cri de Coeur** clads its kicks in premium, cruelty-free materials such as low-VOC polyurethane, 100 per cent recycled Ultrasuede (derived from post-industrial polyester), and reclaimed wooden soles.

### *5.3. Analysis of slow design brands (ONG fair-trade)*

The fair trade footwear area has many aspects: use of materials and craftsmen from the developing countries, charity towards poor people, recovering policies for more disadvantaged people.

**Inkkas** belongs to the first group: it is a brand that produces sneakers with an unmistakable style, given by the contrast between the white sole and the colourful upper. The latter is woven by hand by craftsmen in Peru, Colombia, Bolivia, Guatemala and Mexico, reproducing geometrical motives of the pre-Columbian tradition. In this way Inkkas distributes a modern product all over the world, spreading, at the same time, the culture of these populations and guaranteeing them a source of income.

Similarly **Veja** make very cool sneakers, using natural material that comes from the fair trade, i.e. vegetable tanned leather from Uruguay, ecological cotton from Brazil and India rubber from Amazonia extracted respecting the forest and using local manpower. Furthermore the shoes storage and delivery are made in France by "Ateliers Sans Frontières", an association dedicated to labour market integration.

**LaidbackLondon**, a London brand founded in 2002, manufactures mainly sandals that are entirely handmade by master craftsmen from Mombasa. These sandals are decorated with beads that are manually stitched on a leather manufactured locally, reproducing the colourful iconographic motives of the local tribes. Made slowly and carefully, they are a high quality product destined to last, a product that, also in this case, generates employment for the local populations respecting their tradition and talent.

**Toms**, instead, is a brand that works to help poor children; it was created in 2006 by Blake Micoskie following a holiday in Argentina, during which he met some volunteer workers who collected donations to buy shoes to children. Today Toms donates a new pair of shoes to a child in need for every pair of footwear sold. Toms shoes are mainly loafers with a colourful fabric upper, that is inspired by the bright colours dresses of Micoskie's grandmother.

In order to guarantee shoes to poor children all over the world in the long term, Kenton Lee invented **"The shoe that grows".** It is a shoe with automatic buttons on the upper that enable to adjust it according to the foot growth, hence the name "the shoe that grows". A simple but absolutely innovative idea!

### *5.4. Analysis of brands that use recycled materials*

Another field is that of the footwear made using recycled materials.

**Nike** wanted to be an example in this sense by manufacturing, even if in limited edition, the ecological soccer shoe Nike GS. It is obtained from recycled plastic bottles and the Pebax Renu biodegradable material, derived from castor oil plant seeds working and is ultralight in order to favour the best performance. Besides, it is equipped with special studs devoid of noxious chemical substances and made with vegetable tanned leather and recycled rubber and felt.

The shoes made by **Cartina**, a start-up where innovation and tradition unite to create a product that fully respects the environment, are born from recycled paper. Located in the heart of the historical Tuscan footwear district, the company produces sneakers with urban design that become waterproof and very much lighter than any other training shoe through a working process that is specifically studied.

**Carta Vetrata**, instead, is the name of another young Italian brand that manufactures footwear without using chemicals additives and employing only vegetable tanned leather and recycled rubber and felt. Of high quality and very particular and innovative, in the shoe collection signed "Carta Vetrata" we find sneakers made with cent per cent organic cotton and shoes with soles in cork or corn-cob, a material recovered from agricultural and food waste, breathable, resistant and environment friendly.

Cork is a protagonist also in the Cork Flips, toe posts with anatomical arch support obtained from the recycling of natural cork caps, made by the Canadian brand **Sole**, within the Recork project.

While in 2013 **Ska shoes**, a brand from Monza, launched the Bailarinas Sandali, obtained from leather and fabric waste, in many shapes and colours, **Unu's Footwear** has devised a shoe that, sure, is made strictly with recycled leather, but is also completely self-made, in other words a loafer that the costumer can receive at home and then assemble by himself through apposite cuts studied to make it easy to insert the parts, without the use of glues.

In order to better safeguard the environment, three young people from London, Chalres Duffy, Willuam Gubbins and Billy Turvey, gave life to the project **"Everything is Rubbish"** that entails the production of shoes made from urban solid waste, that is first collected, washed and disinfected and then is heated and remodelled. The material thus obtain is fit for making shoes, multicolour shoes with an alternative style.

The eco-sustainable action of **Hetty Rose,** a London brand of the designer Henrietta Rose Samuels, is very different: it uses vintage Japanes kimonos fabrics and vegetable tanned leather to create colourful and very feminine women's shoes.

## 6. Test of knowledge

**Choose the correct option:**

**Q1. Which of the following can NOT be the origin of materials used in the shoe?**

- ○ Mineral
- ○ Natural
- ○ Synthetic/chemical

**Q2. Which of the following is not relevant in the process of transformation?**

- ○ How many resources are absorbed by the process
- ○ Working conditions of the people employed in the process
- ○ How much product is moved during processing for the sale

**Q3. Which of the following is a material of interest for the shoe designers?**

- ○ Reinforcements
- ○ Glues/tapes
- ○ Materials for the upper (leather/fabric/plastic)

**Q4. Which of the following can NOT be called leather?**

- ○ Eco-leather
- ○ Pig leather
- ○ Calf leather

**Q5. Which of the following is an advantage of the chrome tannage?**

- ○ The chrome-tanned leathers are easy and fast to make, usually they need one working day
- ○ The chrome tannage is ecological. All the items made with this technology can be recycled
- ○ The chrome tannage is an art with an ancient tradition

**Q6. Which of the following statements about recycled leather is true?**

- ○ It is also called salpa
- ○ It is of high quality
- ○ It is not possible to make it from ovine leather

**Q7. Wet white tannage leather can NOT :**

- ○ Show a light colouring and pastel shades
- ○ Be the most economical
- ○ Be pleasant to the touch

**Q8. What is NOT important for the design optimization in a structure of a collection?**

- ○ Structures
- ○ Upper style lines
- ○ Trends

**Q9. What tooling is more expensive?**

- ○ Last
- ○ Molded sole
- ○ Upper

**Q10. The same last can be used for different heel heights?**

- ○ Yes, if we add a platform
- ○ No
- ○ Always

**Q11. The same last can be used for all kind of upper styles?**

- ○ Yes
- ○ No
- ○ Depends on the material used for the upper

**Q12. What does the introduction of a new last imply?**

- ○ Investment on time and energies to develop the prototype of the last
- ○ Investment on money for the sizes development
- ○ Investment on molds

**Q13. The creation of a new heel assume a set up cost?**

- ○ Yes, because we need to create a mold
- ○ Yes, only for the first pair
- ○ No

**Q14. Is it possible to develop different upper patterns with the same structure?**

- ○ Yes, if we add a platform
- ○ No
- ○ Yes, in many variations

**Q15. Is the optimization of the material important in a collection?**

- ○ Yes, because in this way we save material and avoid waste
- ○ No
- ○ No, we can have a different material for every style of our collection

**Q16. The material optimization in a collection has also aesthetic reasons?**

- ○ Yes, because if we repeat the same materials along the collection; the collection will look more consistent.
- ○ No
- ○ No, because every style should have its own original material

**Q17. What are the factors that influence the cost of the material consumption?**

- ○ The cost of the material
- ○ The pattern dimensions
- ○ The kind of cutting machine

**Q18. Does a different cut of pattern influence the material consumption?**

- ○ No, because the dimension of the shoe is always the same
- ○ No
- ○ Yes

**Q19. Does it makes sense making strategic cuts in the inside part of the upper?**

- ○ Yes, so we can save leather
- ○ No, the inside part is always the same of the outside
- ○ No

**Q20. Does an entire oxford consume more than a divided one?**

- ○ No, it consumes less
- ○ Yes, because you cannot compose the pieces
- ○ It consumes the same

**Q21. Does the size of the leather influence the material consumption?**

- ○ No
- ○ Yes, because in a bigger leather you can better place the pieces
- ○ Yes, because in a bigger leather is more difficult to place the pieces

**Q22. Is the leather a homogeneous material?**

- ○ No, every leather is different
- ○ Yes, if the animals are the same age
- ○ Yes

**Q23. The main limits of the socket punch cutting are:**

- ○ The cost of the socket punch manufacturing
- ○ The great space occupied and the management of its use
- ○ The loss of time during the cutting process

**Q24. How can the designer optimize the use of the resources at his/her disposal?**

- ○ By increasing his/her knowledge of the production process
- ○ By following trends
- ○ By making a limited number of samples

**Q25. CAD systems can help the designer to understand:**

- ○ At the drawing phase, the use of leather he is using
- ○ How to better follow the trends
- ○ How to solve technical problems

**Q26. The footwear virtual prototypes are useful because:**

- ○ They enable to see in advance a 3D picture of the complete shoe that is very similar to the real result, like it has been made by the factory with the traditional systems
- ○ The CAD system and the rendering reduce the waiting times required by all the players for the physical realization of the components
- ○ Better understanding of the fitting

**Q27. The 3D printed footwear prototypes are useful because:**

- ○ They enable to materialize in a specific moment something that still does not physically exist
- ○ The analysis of the 3D printed pattern goes beyond what can be understood with a digital reproduction, even if it has high resolution and precision
- ○ The 3D printed footwear are more comfortable than the traditional ones

**Q28. Is the recycling of a shoe a complex procedure?**

- ○ No
- ○ Yes, because the materials in a shoe are not easily separable
- ○ No, each shoe can be easily recycled if brought to separate recyclable bins

**Q29. Some of the main upper constructions are:**

- ○ Strobel, moccasin, lasted
- ○ Strobel, blake, lasted
- ○ Strobel, moccasin, goodyear

**Q30. What is the lasted construction of the upper?**

- ○ In this construction, the upper and the lining are made to be cemented under the insole
- ○ In this construction, the upper and the lining are made to be cemented under the outsole
- ○ In this construction, the upper and the lining are made to be stitched under the insole

**Q31. What is the strobel construction of the upper?**

- ○ In this construction, the upper and the lining are cemented together with the soft insole
- ○ In this construction, the upper and the lining are stitched together with the soft insole
- ○ In this construction, the upper and the lining are stitched together with the outsole

**Q32. Which of the following is not a sole construction category?**

- ○ Stitched
- ○ Connected
- ○ Cemented

**Q33. Are the sewn constructions easier to separate for recycling?**

- ○ No
- ○ Yes
- ○ They are the same

**Q34. Is the blake a stitched sole construction?**

- ○ Yes, because the welt is stitched with the insole
- ○ Yes, because the insole is stitched with the ousole
- ○ No

**Q35. Is the injected sole construction easy to separate for recycling?**

- ○ No, because the outsole is melted together with the upper
- ○ Yes, because it is easy to separate
- ○ Always

**Q36. How many stitching does the goodyear construction require?**

- ○ 1
- ○ 3
- ○ 2

**Q37. How can it be a sustainable brand?**

- ○ A brand that uses recycled materials
- ○ A brand that makes a design inspired to nature
- ○ A brand that makes green advertising

**Q38. Timberland supports**

- ○ Low environment impact production
- ○ Vegan design
- ○ Slow design

**Q39. The "shoe that grows" is sustainable because:**

- ○ It can be adapted to different stages of growth of the person who wears it
- ○ It is totally recyclable
- ○ It is produced with sustainable materials

**Q40. El naturalista is a brand that conveys its being environmentally sustainable by design because:**

- ○ The design of its shoes is inspired by nature
- ○ It is totally recyclable
- ○ It is produced with sustainable materials

**Answer Key:**

| | |
|---|---|
| **Q1.** | Mineral |
| **Q2.** | How much product is moved during processing for the sale |
| **Q3.** | Materials for the upper (leather/fabric/plastic) |
| **Q4.** | Eco-leather |
| **Q5.** | The chrome-tanned leathers are easy and fast to make, usually they need one working day |
| **Q6.** | It is also called salpa |
| **Q7.** | Be the most economical |
| **Q8.** | Trends |
| **Q9.** | Molded sole |
| **Q10.** | Yes, if we add a platform |
| **Q11.** | No |
| **Q12.** | Investment on money for the sizes development |
| **Q13.** | Yes, because we need to create a mold |
| **Q14.** | Yes, in many variations |
| **Q15.** | Yes, because in this way we save material and avoid waste |
| **Q16.** | Yes, because if we repeat the same materials along the collection; the collection will look more consistent. |
| **Q17.** | The pattern dimensions |
| **Q18.** | Yes |
| **Q19.** | Yes, so we can save leather |
| **Q20.** | Yes, because you cannot compose the pieces |
| **Q21.** | Yes, because in a bigger leather you can better place the pieces |
| **Q22.** | No, every leather is different |
| **Q23.** | The cost of the socket punch manufacturing |
| **Q24.** | By increasing his/her knowledge of the production process |
| **Q25.** | At the drawing phase, the use of leather he is using |
| **Q26.** | They enable to see in advance a 3D picture of the complete shoe that is very similar to the real result, like it has been made by the factory with the traditional systems |
| **Q27.** | The analysis of the 3D printed pattern goes beyond what can be understood with a digital reproduction, even if it has high resolution and precision |
| **Q28.** | Yes, because the materials in a shoe are not easily separable |
| **Q29.** | Strobel, moccasin, lasted |
| **Q30.** | In this construction, the upper and the lining are made to be cemented under the insole |
| **Q31.** | In this construction, the upper and the lining are stitched together with the soft insole |
| **Q32.** | Connected |
| **Q33.** | Yes |
| **Q34.** | Yes, because the insole is stitched with the ousole |

**Answer Key:**

| | |
|---|---|
| **Q35.** | No, because the outsole is melted together with the upper |
| **Q36.** | 2 |
| **Q37.** | Low environment impact production |
| **Q38.** | Low environment impact production |
| **Q39.** | It can be adapted to different stages of growth of the person who wears it |
| **Q40.** | It is produced with sustainable materials |

## 7. Glossary

**Leather**
A material consisting of the hides of different animal species after being treated to a tanning process wich prevents deterioration. Some hides, such as those of reptiles, fishes, birds, etc. are currently called "skins". In Italy and in some other countries the tendency is to use the word "pelle" (skin)or other equivalent term for all thin leather

**Fur**
A clothing article entirely or partially made with unshaven animal skins with the fur on the outside.

**Footwear**
Foot covering of leather or other material, fabric, plastic, etc

**Upper**
The part of the shoe which covers the upper side of the foot. It includes the lining and all the components, but not the sole and the heel

**Lining**
The inside covering of the upper or part thereof, made of laether or fabric.

**Fabric**
A generic world meaning any kind of cloth, made of natural or synthetic fibres, woven or knitted into a compact surface

**Tip**
An appliquèd shape generally of the same material as the upper, covering the toe section of the forepart of the vamp

**Insole**
The upper part of the bottom where the foot directly lies

**Sole**
Front part of that section of the shoe which is in contact of the ground. Totally or partly covering underside of the shoe, it is made of leather, rubber or syntetics and can be of any thickness.

**Heel**
A support placed under the back part of a shoe to give it the required uprightness

**Wedge**
A wedge-shaped piece, often of wood, inserted between sole and midsole from the heel seat to about 1/3 from the toe-end ( sometimes applied to a platform of agglomerated material extending for the full lenght of the shoe) raising the heel seat with respect to the tread. A low heel may sometimes further raise the heel-seat.

**Tanning**
A process through which the hides are made non putrescible.

**Chrome Tannage**
A mineral tannage which, like the alum tannage, results in a particularly soft leather.

**Vegetable tannage**
A tannage carried out by means of vegetable tannin, with the addition of other ingredients which facilitate the process without influencing the characteristics of the product.

**Last**
Each of two pieces of wood, metal or plastic symmetrical to each other, with the shape and the dimensions respectively of the right and the left foot. On this the shoes is assembled and made

**Socket punch**
A knife pre-cut to the shape of the pattern, which puches out the pieces of upper or sole

**Mould**
A hollow shape into which melted synthetic (currently polyurethane or polystirene) or natural (rubber) plastic materials are poured or, more frequently, injected. When cool and solid, the result is a piece of the same shape as the cavity. The process is used in most methods or production involving the direct assembly of soles on the uppers.

**Salpa**
A reclaimed leather obtained by using veal scraps delivered from the tanneries. Thoroughly washed, pulverized and drained, thay are turned into a thick paste by addition of variuos acids and alkaline product. Finally they are laminates and set to dry. Considering the possibility to obtain products of different flexibility and thickness, sapla can be used for soles, insoles, welts and even uppers.

**Reinforcement**
A piece of leather or another material applied between the lining and the upper at the points where the latter is subject to wearing out

**Fitting**
The correct closeness of the shoe to the foot

**Instep**
The width of the footwear or last at the widest point of the sole. It reveals whether a foot is narrow, normal or wide

**Sandal**
Light summer footwear consisting of a flexible sole, straps or laces fastening the upper part of the foot

**Pattern**
The basic model cut in tin plate or other material bearing all the grading marks necessary for cutting out the different size with a shoemaker's knife

**Derby**
Calzatura da uomo, i cui gambini sono cuciti sulla mascherina soltanto lateralmente, da cui risulta una maggiore facilità di infilarvi il piede

**Oxford**
Footwear for men or women, of a basic shape, with the vamp overlaid and stitched upon the quarter

**Vulcanization**
An irreversable alteration of the molecular structure of natural or synthetic rubbers, obtained through the action of catalizers and vulcanisers under heating conditions, and assuring a higher elasticity and a higher resistance to the stretching.

**Vulcanized working**
A type of manifacture, similar to the Sol (California) method. The sewing of the insoleon to the upper is carried out 5 mm inside the margine of the insole to avoid the cutting edge of the punch which, when filled with high temperature melted rubber, may damage it, if too close to the stich line.

**Mocassin**
A shoe whose vamp completely encloses the foot, wrapping it round from underneath, and is drawn up under an apron.

## 9. Bibliography

*http://www.isri.org/about-isri/awards/design-for-recycling#.V6yMZPmLRaR*

*https://it.wikipedia.org/wiki/Design_sostenibile*

*https://en.wikipedia.org/wiki/Design_for_manufacturability*

*https://en.wikipedia.org/wiki/Design_for_the_Environment*

*http://www.greenme.it/consumare/mode-e-abbigliamento?limitstart=0*

*http://www.tuttogreen.it/eco-fashion-scarpe-dai-turaccioli-riciclati/*
*http://www.alternativasostenibile.it/articolo/ska-bailarinas-sandali-il-sandalo-eco-chic-che-fa-moda-con-gli-avanzi-.html*

*https://modavanti.com/search/women?ita=Shoes*

*http://www.arssutoria.com/elearning-online-footwear-courses/*

Lifelong Learning Programme

Project Number:
539823-LLP-1-PT-LEONARDO-LMP

Project Duration:
30 months
October 2013 - March 2016

***How to implement Sustainable Manufacturing in Footwear - New Occupational Profile and Training Opportunities -***

**The project *STEP to SUSTAINABILITY* aims at:**

Developing a new qualification profile and correspondent training in the field of sustainable manufacturing.

Training technicians with knowledge and skills to implement manufacturing strategies envisaging the sustainability in Footwear and Leather goods.

*www.step2sustainability.eu*

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.