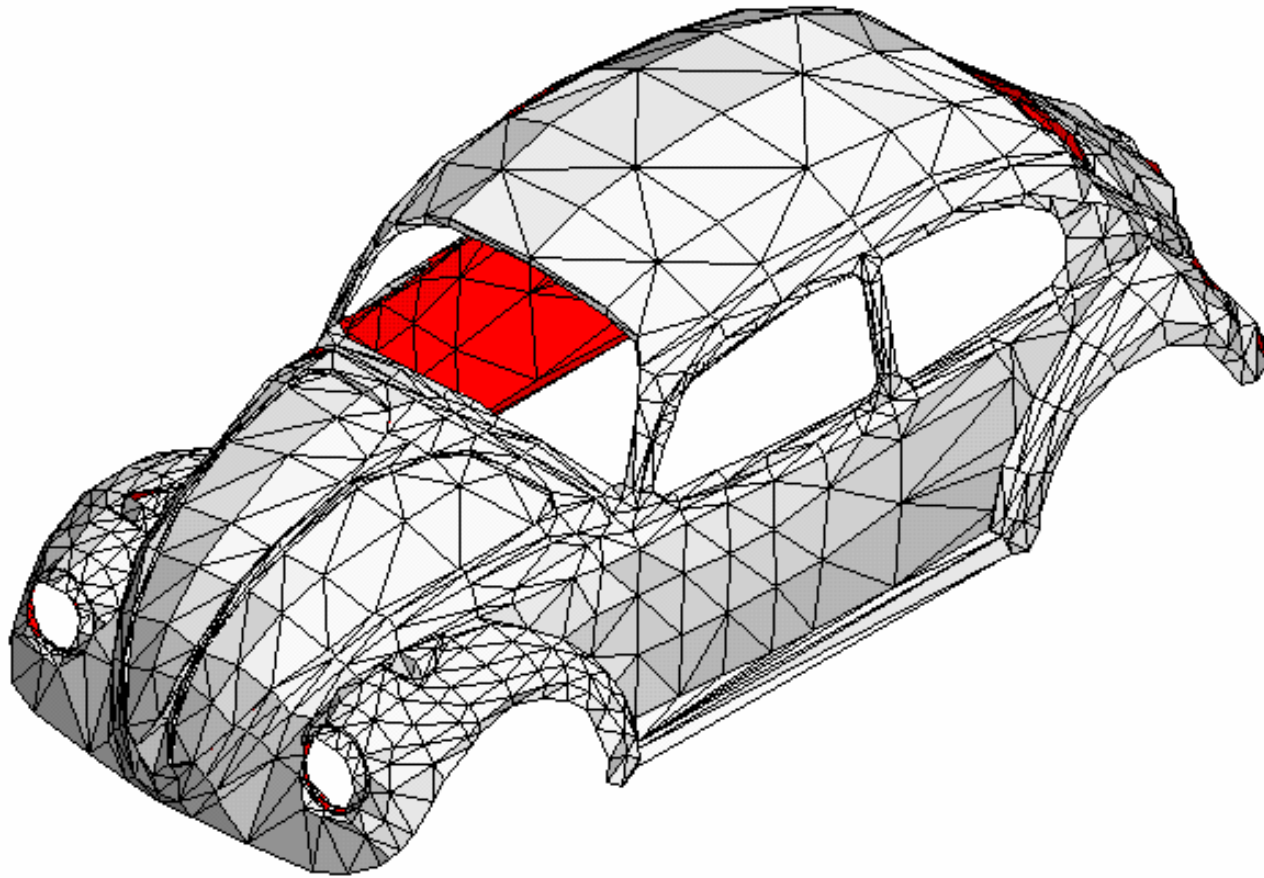


# Mechanical Reverse Engineering

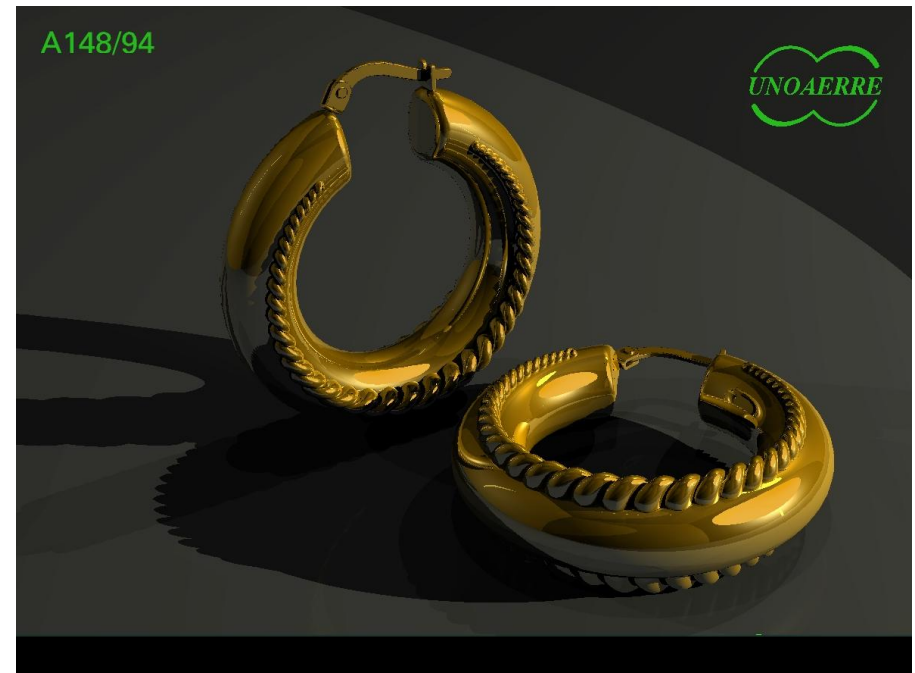


The Photorendering is the technique that concurs to obtain photographic images of a model CAD. The reason is that being able to introduce a product at the market before having it industrialized and therefore before having meaningful supported extra costs.

To obtain a good image the enterprise demands long experience and acquaintance of photographic techniques

Mathematical method to receive the photographic image more used, it is named a method

**Ray-Tracing**



Every algorithm of photorendering has the need of some information for being able to calculate a photographic image:

1) Characteristics of the material of the object in terms of:

- Color
- Diffusivity of a particular color
- Superficial finish
- Reflection
- Refraction
- Transparency
- Eventual pattern of covering of the object

2) Characteristics of the atmosphere in which the object is dipped in terms of:

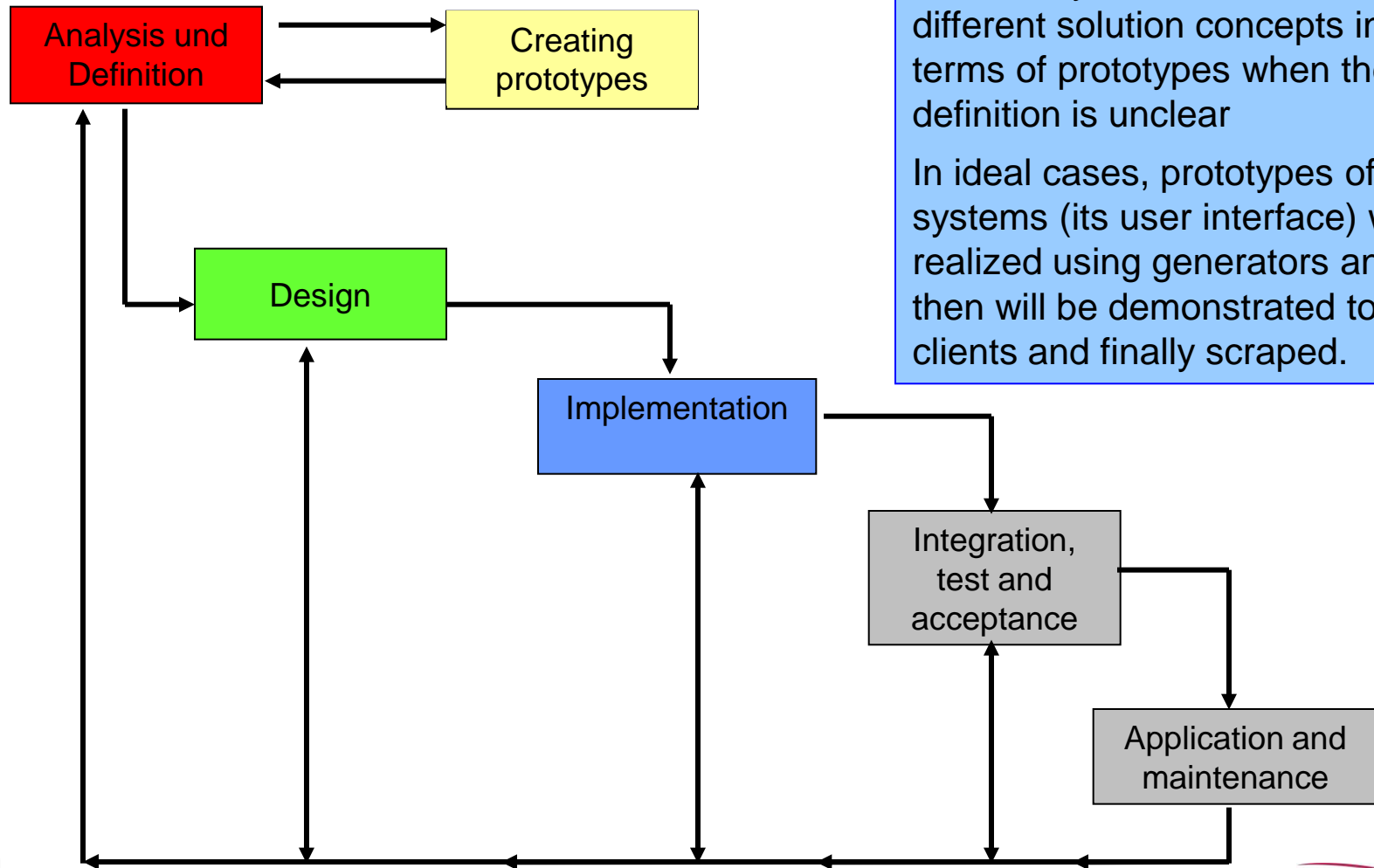
- Surrounding objects each one with characteristic detailed lists in terms of already seen object to be photographed
- Lights that illuminate the atmosphere in diffused way, concentrated, spot, defined in terms of geometry than of intensity and color

3) Characteristic position of the camera and of the objective

4) Activation of eventual filters actions to improve the image

5) Definition of the “depth of the reflections”



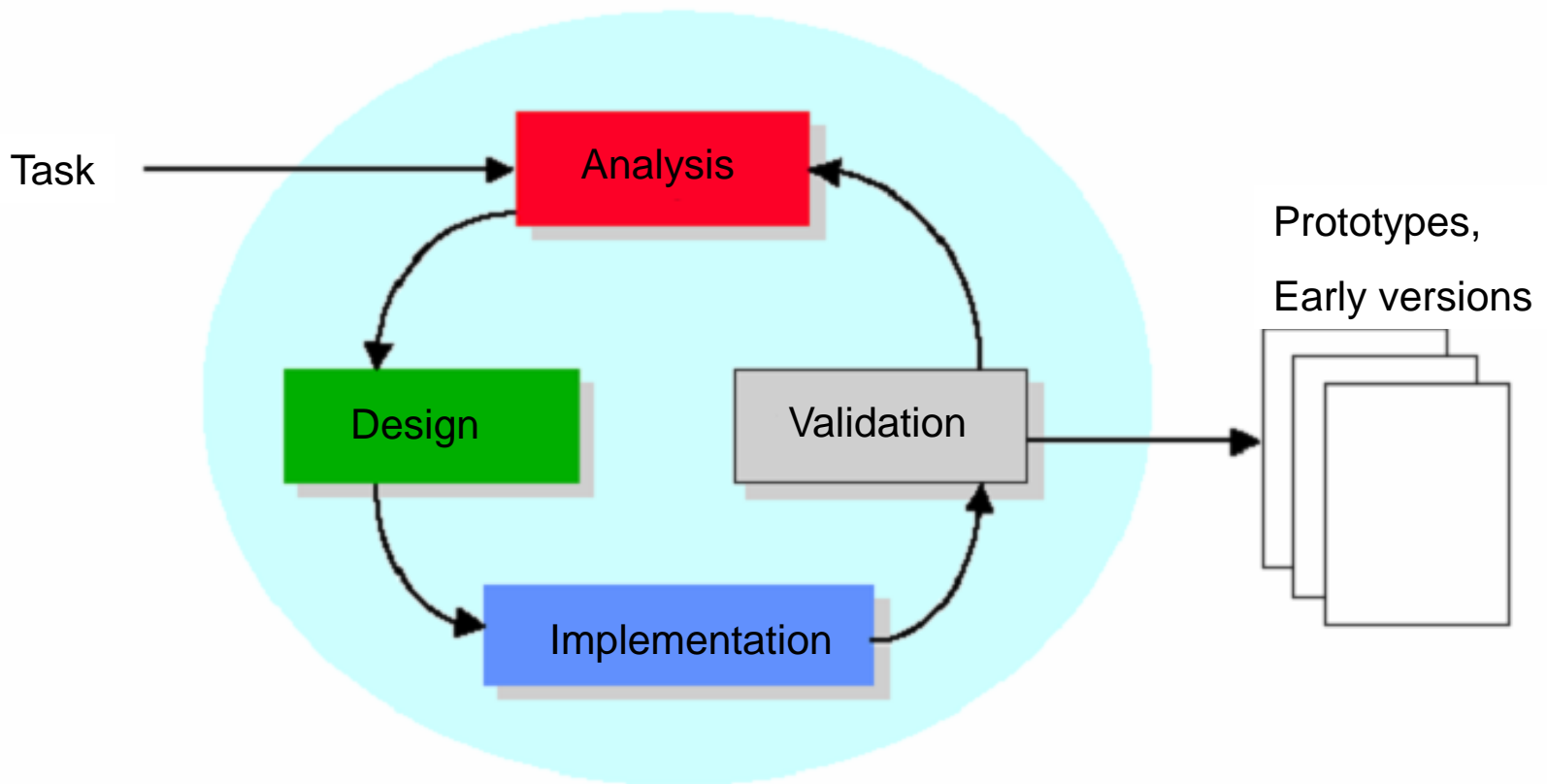


**Rapid Prototyping:**  
Essentially it is demonstration of different solution concepts in terms of prototypes when the job definition is unclear  
In ideal cases, prototypes of the systems (its user interface) will be realized using generators and then will be demonstrated to the clients and finally scraped.



- ✓ Permits fast clarification of the functionalities and risk minimization
- ✓ Avoid misunderstanding between the developer and the client
- ✓ User interface undergoes early tests
- ✗ The prototypes may be reused (unplanned evolutionary model)
- ✗ In certain cases the effort involved is quite huge

The prototype is assumed to be the mould of the targeted system and will be successively modified and extended



- ✓ At a very early stage a prototype (by the courtesy of clients) is available which can be evolved
- ✓ Costs and scope of activities of the complete software system should not have to be defined completely at the beginning of the project
- ✓ Project planning is made simpler by means of the more manageable sub-projects
- ✓ System architecture is set out to be extensible
  
- ✗ It is quite tough to establish a system architecture such that it can later be extended
- ✗ Evolutionary design and requirement specification inherently brings in the problem that the already realized functions might be depreciated later
- ✗ In some cases the end product might look like a software that has undergone 10 year's maintenance





Not always it is possible to take decisions on the base of a photographic image, often it is indispensable to have a model in scale, more or less, of the object even if a various material from the definitive one.

These cases the Photorendering yields the step to

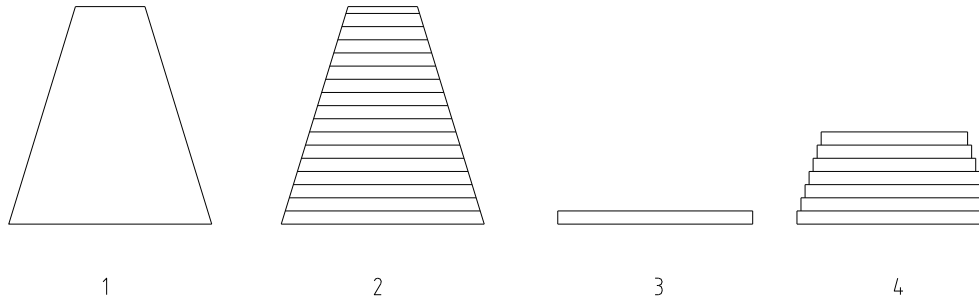
## RAPID PROTOTYPING

With the technique of RAPID PROTOTYPING physical copies can be obtained of the virtual model in a few hours and with an almost completely automatic progress.

Many techniques of Rapid Prototyping exist, but all are based on the SLICING concept:

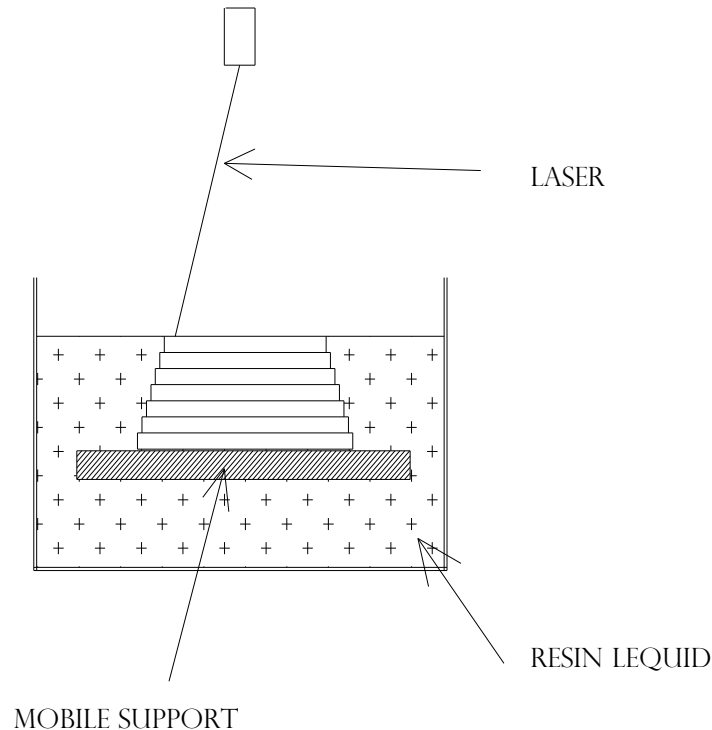
- 1) The model is "sliced" by parallel plans and the external outline of each section is noticed
- 2) The physical model is built through solidifying a liquid or sintering a powder section for section





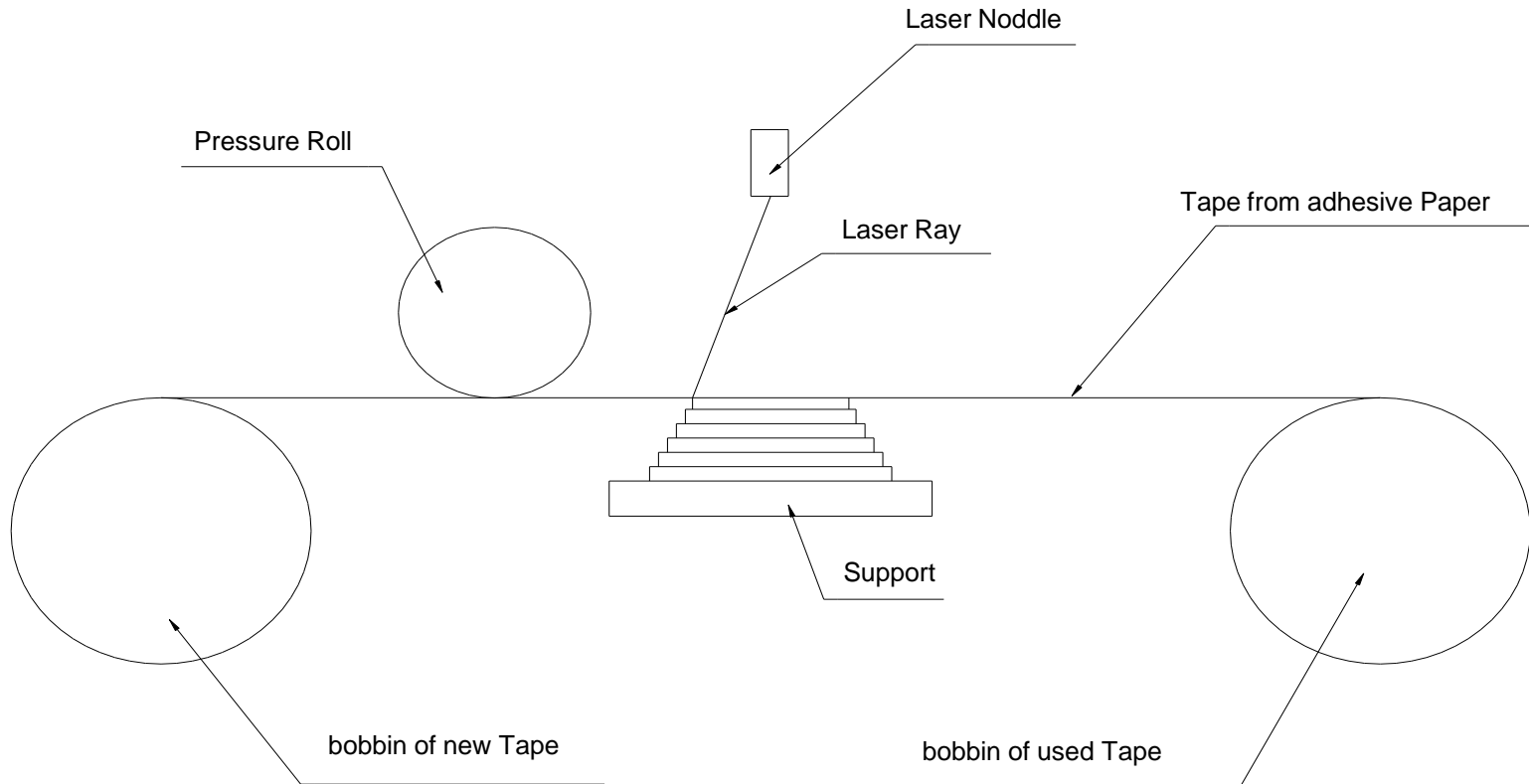
- 1) Model to be realized
- 2) Model “Sliced”
- 3) Construction of the first layer
- 4) Construction of the successive layers

The **Stereolithography** is the most consolidated method of Rapid Prototyping and it exploits a Laser ultraviolet ray in order to make a liquid resin solidifying layer for layer



The operation of solidification is not complete, at the end of the process the model is extracted by the liquid in whom it remains immersed and inserted into an ultraviolet furnace for the completion of the solidification

This technique consents of obtaining models in " wood " perfect for carrying out of pieces of fusion



The principal limitation of this method is in the difficulty of realizing pieces extracts

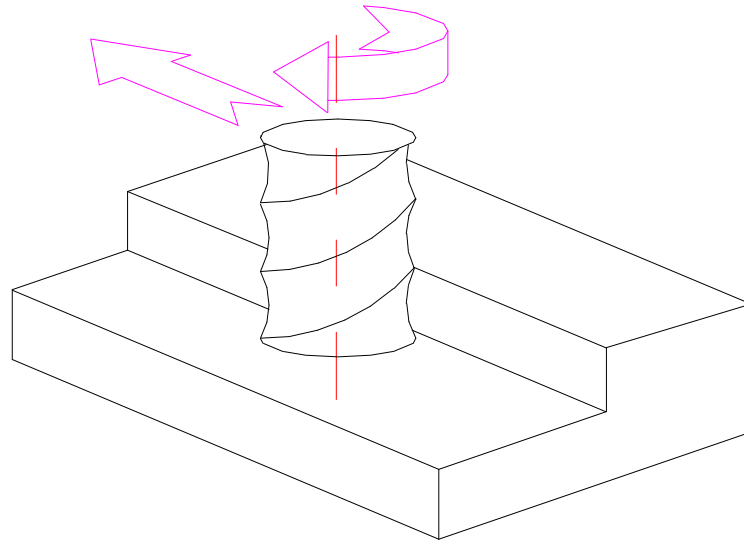
The method of selective synthesizing which is now very promising and it is based on analogous concept of the **Stereolithography** but are used for liquid resin of metal powders .

Thanks to the laser the powders are made to fuse and to tie with the below layer in localized way (selective). In this way prototypes in metal can be obtained directly. This issue is currently in course of continuous search on the usable types of metal with the objective to reliably utilization of powders from ferrous materials.

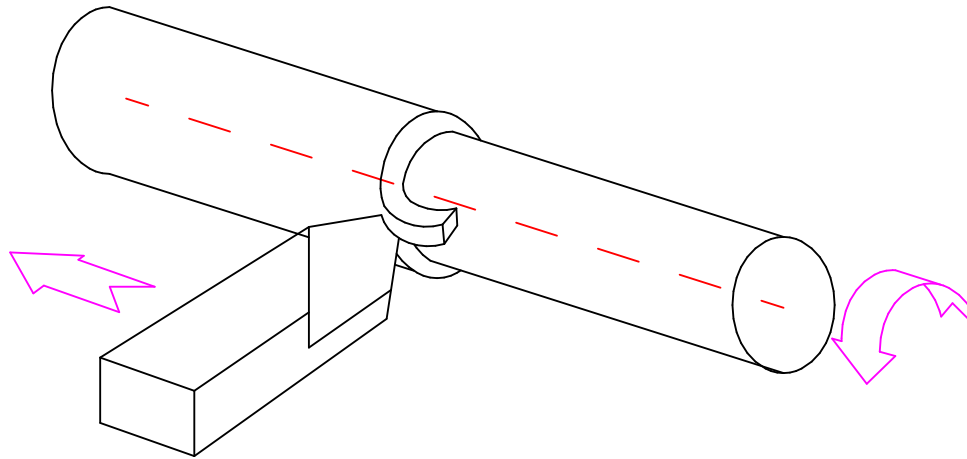
The great advantage of this method is to be able to obtain the metallic mould directly rather than a model in resin, mould that can rather be used for the production of pre series consisting in the event of the molding of metals and complete series in the event of plastic arts.

From a model in resin obtained by means of the rapid prototyping it is in some cases possible to pass to the production directly, when it is realizable with the ELECTRO-MOULDING or METAL CASTING techniques, while in the cases in which the technique of production of the molding or the plastic injection it is necessary to construct the moulds by means of the techniques of Computer Aided Manufacturing (CAM).

Computer-aided manufacturing (CAM) is the use of a wide range of computer-based software tools that assist engineers and Computerized Numerical Control CNC machinists in the manufacture or prototyping of product components.



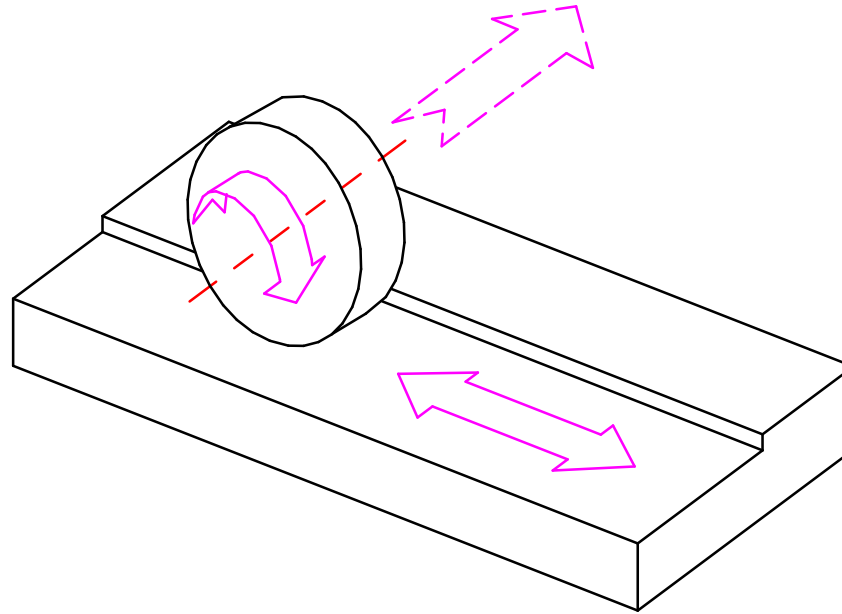
A **milling machine** is a machine tool used for the complex shaping of metal and other solid materials. Its basic form is that of a rotating cutter or endmill which rotates about the spindle axis (similar to a drill), and a movable table to which the workpiece is affixed.



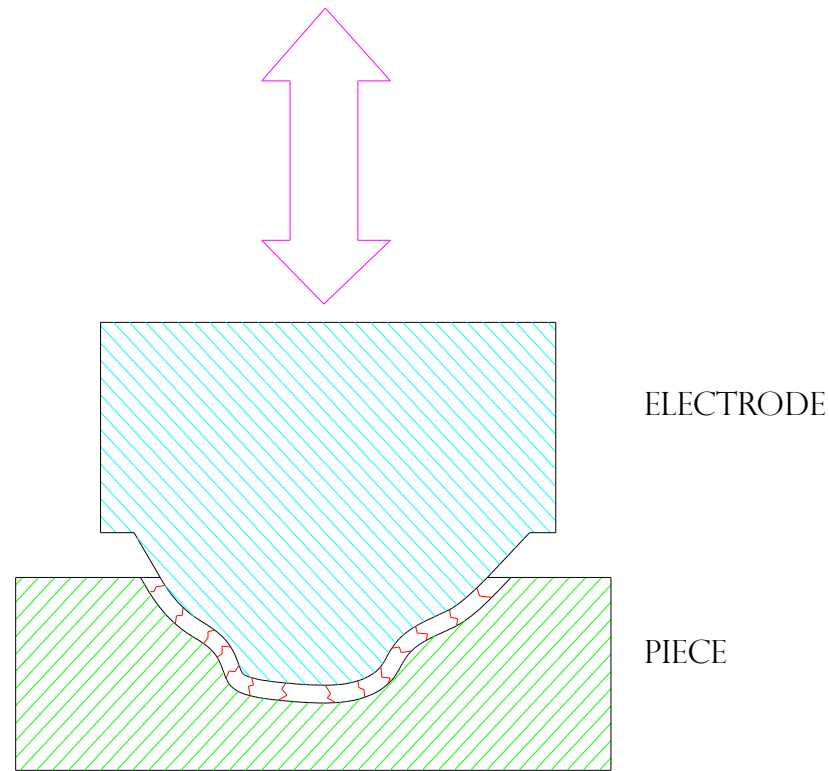
**Turning** is the process used to produce cylindrical components in a lathe. It can be done manually, or using a CNC machine.

When turning, a cylindrical piece of material (wood, metal, etc.) is rotated and a cutting tool is traversed along 2 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries.

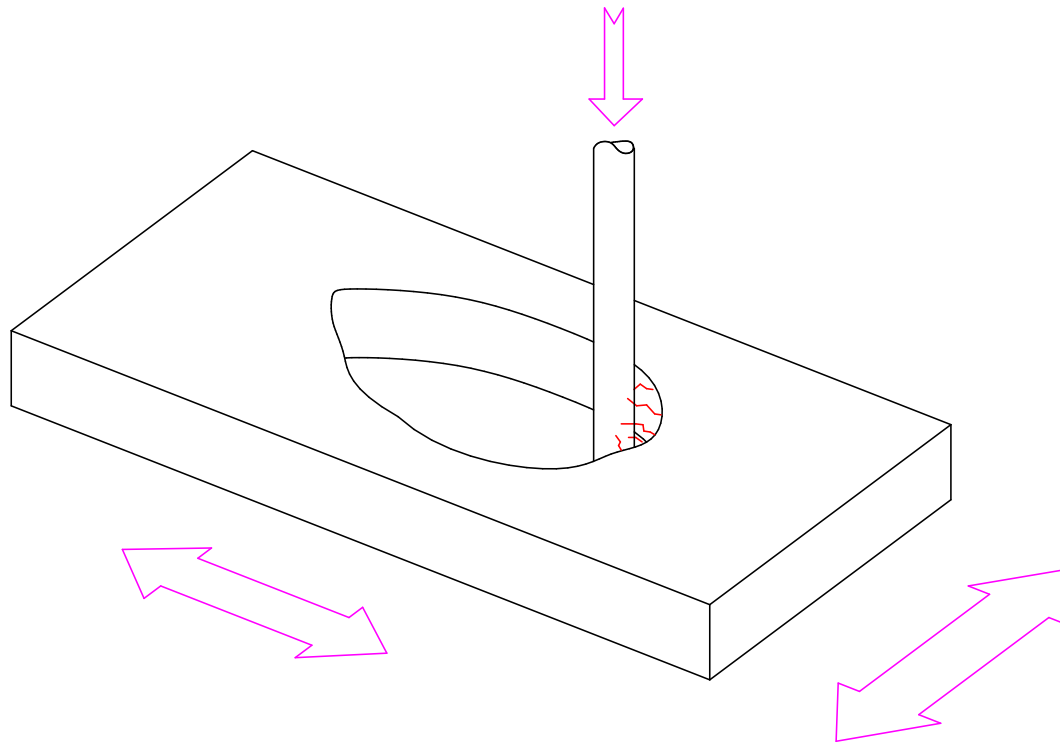




A **grinding mill** is a unit operation designed to break a solid material into smaller pieces. The removals are least but the quality of the worked surface is very superior compared to the preceding machines.

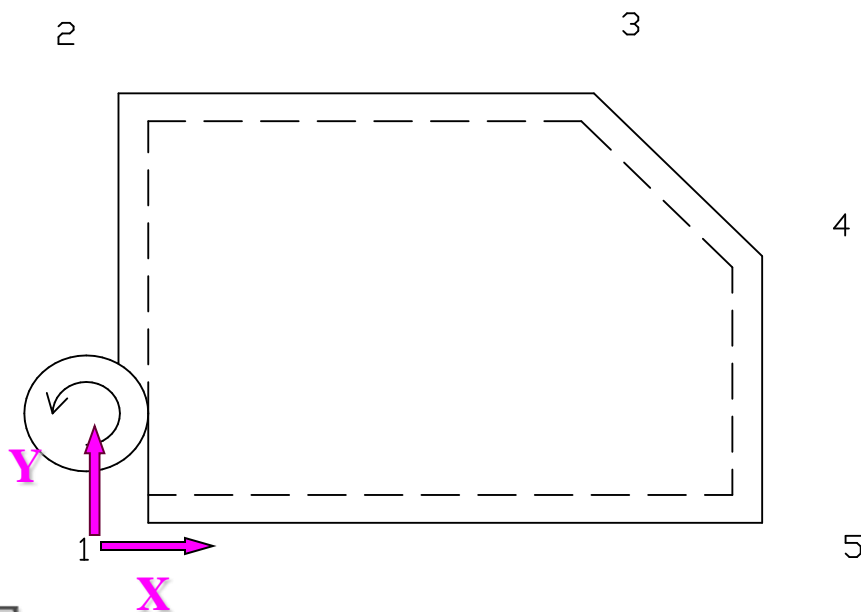


The removal from the material happens by means of static electric generated between the piece to work and a tool (electrode) molded in copper or graphite.



The removal from the material happens according to the same procedure of the diving electrical discharge, but in this case the tool is a thread of copper or alloy that crosses the piece of work.

In all machinery tools described the particular form of working is established by the relative movements between tool and piece. In the traditional machines such movements are given manually by the operator, while in the CNC machines the movements are completely automated and managed by a special applicatory program.



Coord. points

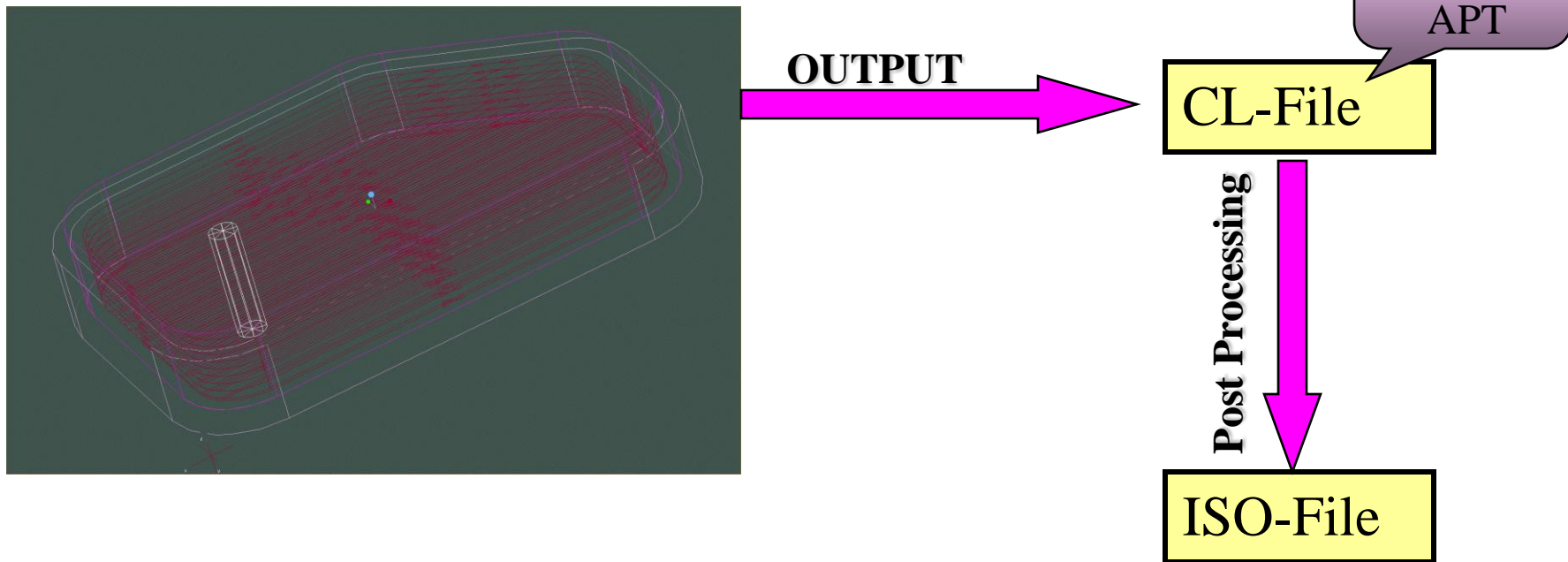
Point 1: X= 0 Y= 0  
 Point 2: X= 0 Y=100  
 Point 3: X=100 Y=100  
 Point 4: X=130 Y=70  
 Point 5: X=130 Y=0

Program

```
G00 X0 Y-6 Z0.5 M4 M8 S2000
G01 Z-5 F50
G01 X0 Y100 F100
G01 X100
G01 X130 Y70
G01 Y0
G01 X0
G00 Z100
M00
```

Often the ISO programs are very complex, constituted by many thousands of instructions, unthinkable to write manually. The systems CAM consent to carry out the automatic calculation of the running tool, the graphic simulation of the working and the automatic transformation into ISO language of the application

## Simulation CAM



## Example of CL-FILE in APT

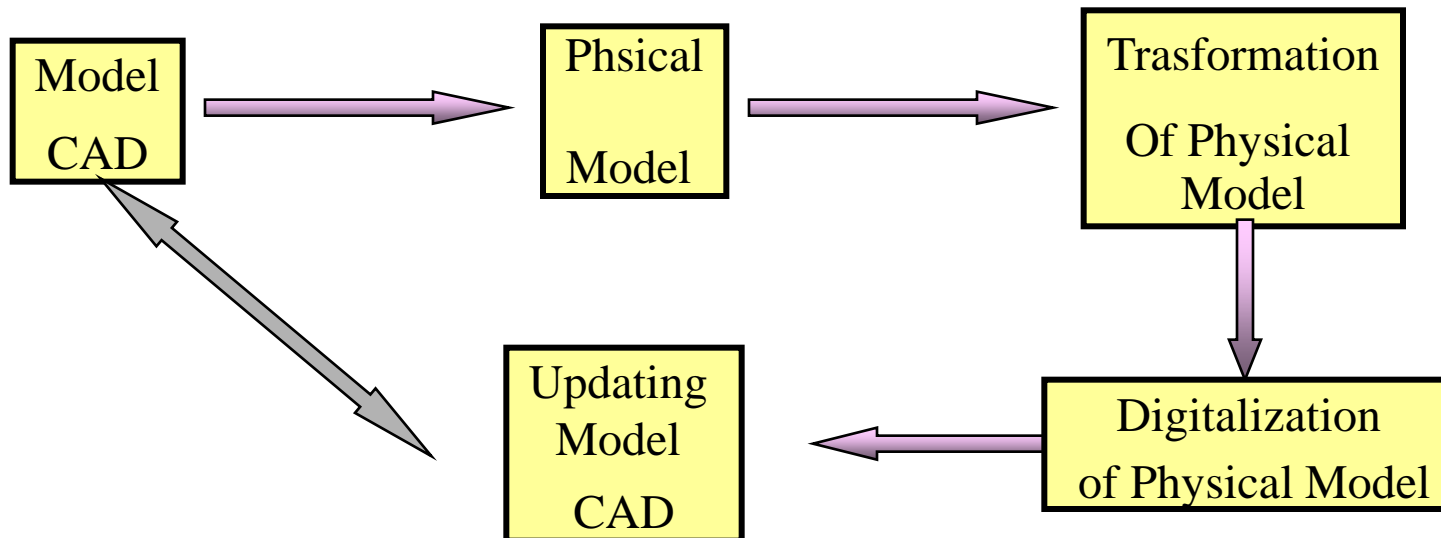
```
REMARK *      PRO/CLFILE VERSION WILDFIRE - 2003210
REMARK -> MFGNO / EXPERTM01
REMARK -> FEATNO / 585
REMARK MACHID=MACHIN / UNCX01, 1
REMARK -> CUTCOM_GEOMETRY_TYPE / OUTPUT_ON_CENTER
UNITS / MM
LOADTL / 1
REMARK -> CUTTER / 10.000000
  CAMERA/ 1.0000000000, 0.0000000000, 0.0000000000, 0.0000000000, $
    0.0000000000, 1.0000000000, 0.0000000000, 0.0000000000, $
    0.0000000000, 0.0000000000, 1.0000000000, 0.0000000000
SPINDL / RPM, 1000.000000, CLW
COOLNT / ON
RAPID
GOTO / -28.6816330640, -14.3758746218, 3.0000000000
FEDRAT / 10.000000, MMPM
GOTO / -28.8036721399, -14.3052753298, -1.3000000000
```

## Its correspondence in ISO

```
N5 G71
N10( / EXPERTM01)
N15 G0 G17 G99
N20 G90 G94
N25 G0 G49
N30 T1 M06
N35 S1000 M03
N40 G0 G43 Z3. M08 H1
N45 X-28.682 Y-14.376
N50 G1 X-28.804 Y-14.305 Z-1.3 F10.
```

The need for spare parts is increasing as technology continues to evolve. Companies that manufacture or produce constantly changing parts use reverse engineering as a primary inspection tool for recreation of spare parts. Reverse engineering refers to the process of obtaining a CAD model from an existing physical part.

Advances in laser scanning technologies have facilitated this process by sampling part surface data with speed and accuracy. With the help of this technology, it is possible to acquire the geometry of a part having complex and freeform surfaces. Laser scanning presents options, the previously used methods do not allow. Damaging parts surfaces due to contact is not a problem with laser scanning.



The digitalization of the physical model can be made by several methods the more or less exact.

The methods at present more diffuse are:

Mechanical Scanning



LASER Scanning



Fotographical Scanning

