PACKALL

PackAlliance:
European alliance for innovation training
& collaboration towards future packaging

Linking Academy to Industry.

Training program: modules

- **Eco-design & novel manufacturing processing**
  - New materials and biomaterials
  - Citizen and Consumer Engagement
  - Residue management and valorisation

Co-funded by the
Erasmus+ Programme
of the European Union

This project has been funded with support from the European Commission.
This publication [communication] 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.

1.5 Design for reuse, recycling and recovery

1.5.1. Adding sustainability to traditional design considerations
1.5.2. Design for dismantling (reduce packaging complexity)

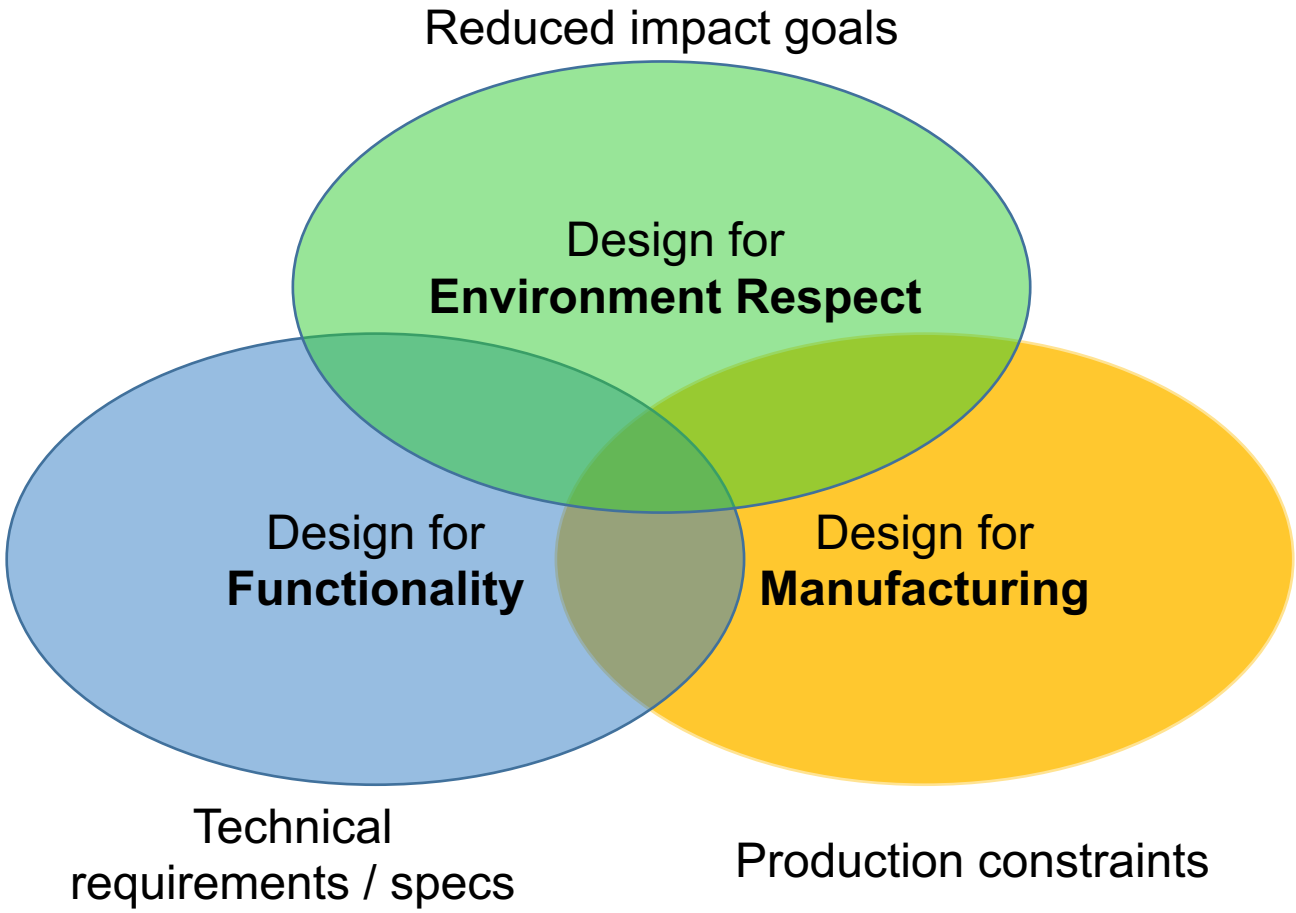
Packaging Ecodesign

a) Adding sustainability to traditional design considerations
b) Design for Purpose (Functionality, Manufacturing)
c) Plastic conventional design rules
d) Design for Environment Respect. An everyday challenge
e) Design to reduce packaging complexity (to Reuse, to Renew, to Resolve and Sort, to Save)

Co-funded by the Erasmus+ Programme of the European Union

A demanding balance

EcoDesign way of developing products must be carried out together with many other requirements.

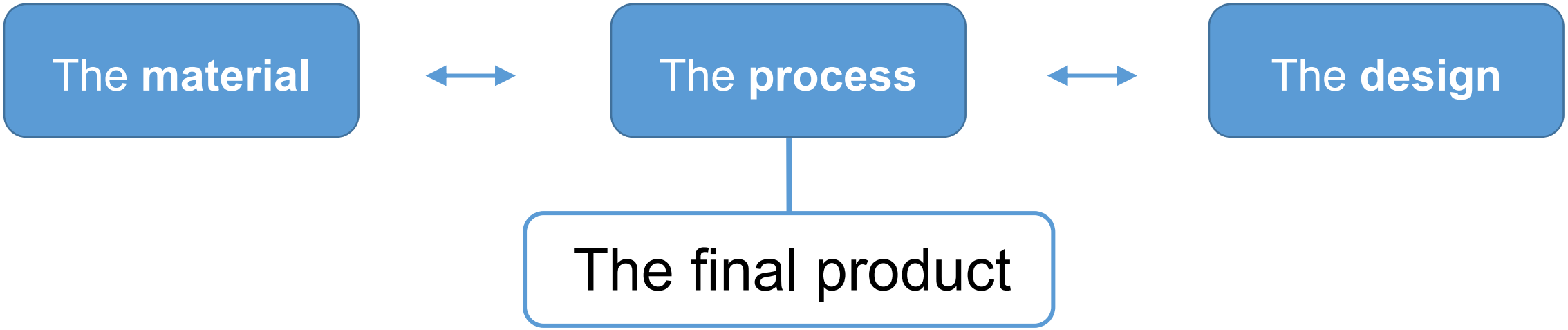


Co-funded by the
Erasmus+ Programme
of the European Union

Design for Functionality. A well-known task

Approaching plastic products three success-points have to be clear in mind for success.

From scratch.



Its quality

Customer's perception

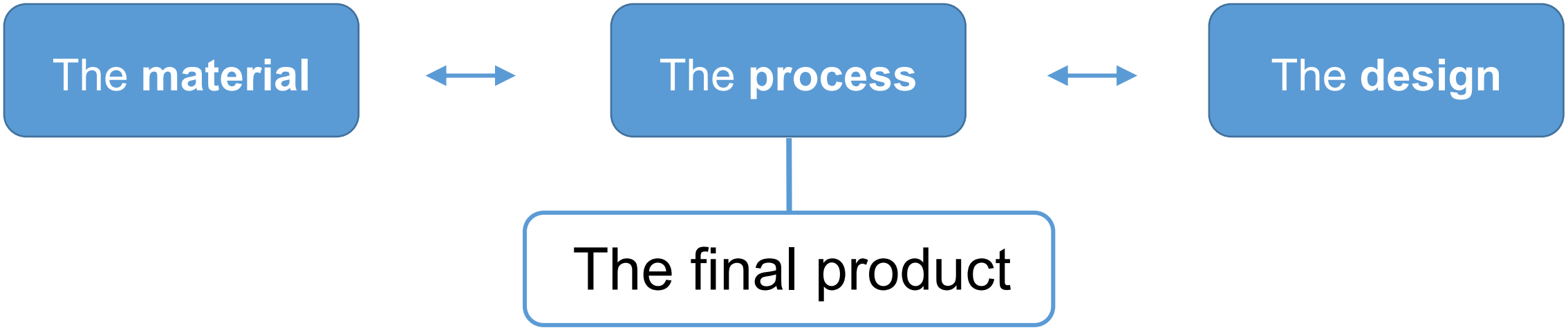
(performance, aesthetics, ergonomics, durability, utility, affection)

Co-funded by the Erasmus+ Programme of the European Union

Design for Manufacturing. A constrained opportunity

Approaching plastic products three success-points have to be clear in mind for success.

From scratch.



Productivity

Cost effectiveness

(cycle time, energy consumption, reduced scrap rate, production volumes and life)

Co-funded by the Erasmus+ Programme of the European Union

Design **guidelines** are available since plastics have had long development course.

In a short timespan.

Veniet tempus quo posteri nostri tam aperta nos nescisse mirentur.

(Lucius Anneus Seneca – Naturales questiones)

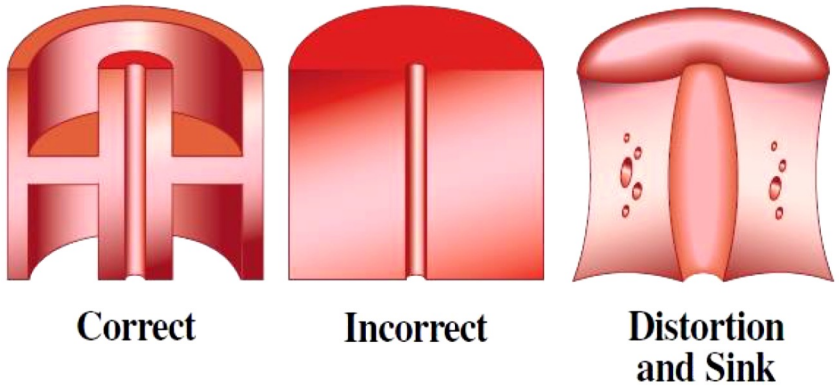
[A time will come when posterity will be wondering that

we didn’t know such clear things]

Co-funded by the
Erasmus+ Programme
of the European Union

Thickness control.

Plastics are processed by heating but they are **very poor thermal conductors**



Plastics strongly shrink when passing from melt to solid state.

Typical linear shrinkage coefficients range from 0.3-0.7% up to 2.5-3%, depending on the plastics family and processing conditions

Avoid high wall thickness and “bulky” design.

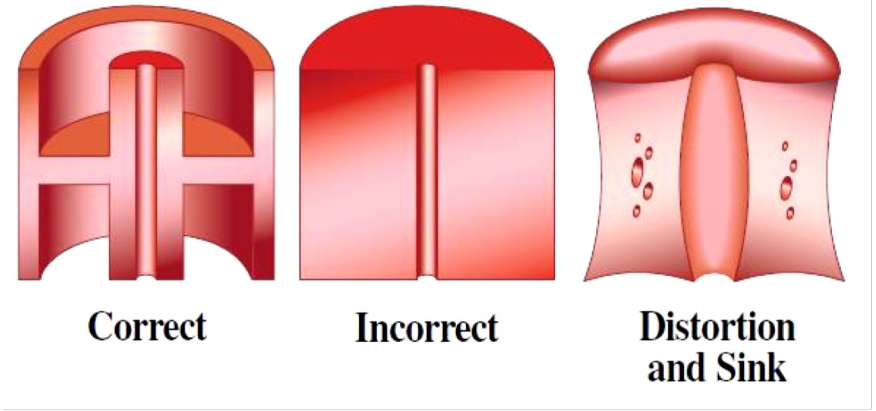
Core out whenever possible and uniform thicknesses.

Replace thick design with reinforcement structures (ribs, frames, double-wall, curvature)

Co-funded by the Erasmus+ Programme of the European Union

Thickness control.

Plastics are processed by heating but they are **very poor thermal conductors**



Typical technical plastic parts are usually designed as thick as 4-5 mm maximum.

Plastics packaging hardly exceed 1 mm of thickness. Quite much thinner, very often

Higher thickness means longer cooling time and higher energy consumption

Incorrect design will dramatically shrink, warp and yield defects

Co-funded by the Erasmus+ Programme of the European Union

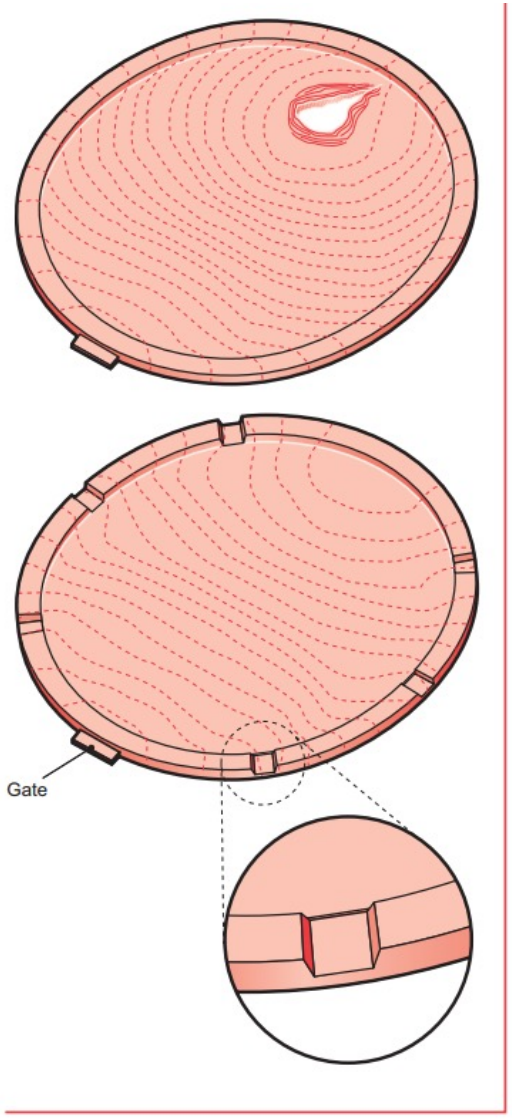
Plastics where we want. Try to predict the melt flowing

In injection moulding, plastics flow following low resistance paths (higher thickness, hotter areas)

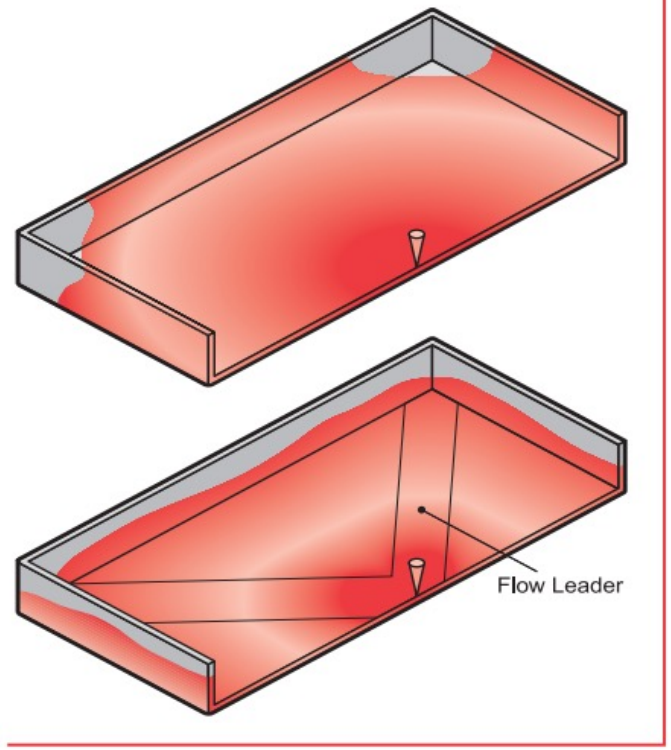
Use, in your design, flow leaders and restrictors to address the flow.

Balanced filling is the goal.

Check out for welding lines and undesired air traps.



Flow restrictors can change the filling pattern to correct problems such as gas traps.



Corners typically fill late in box-shaped parts. Adding flow leaders balances flow to the part perimeter.

Co-funded by the Erasmus+ Programme of the European Union

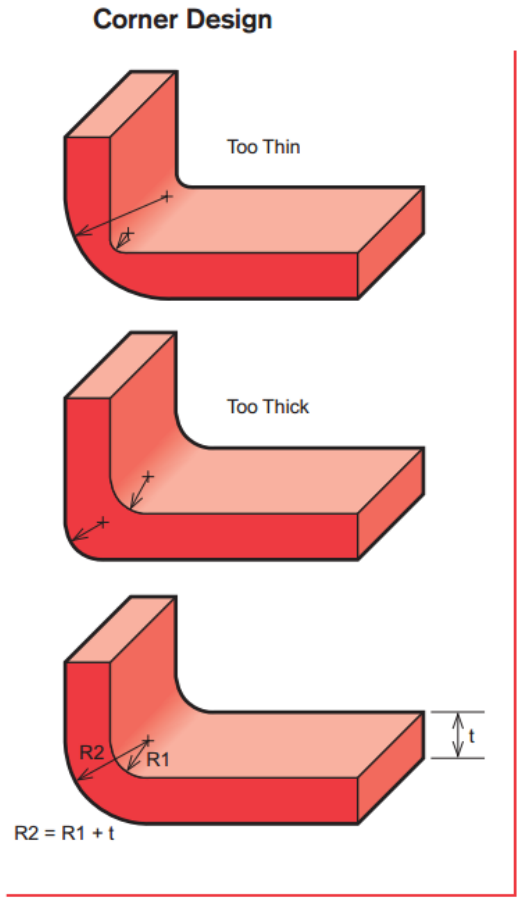
Wall thickness transitions. Mind the step

Plastics flow accelerates, overheats and may degrade when forced trough restrictions

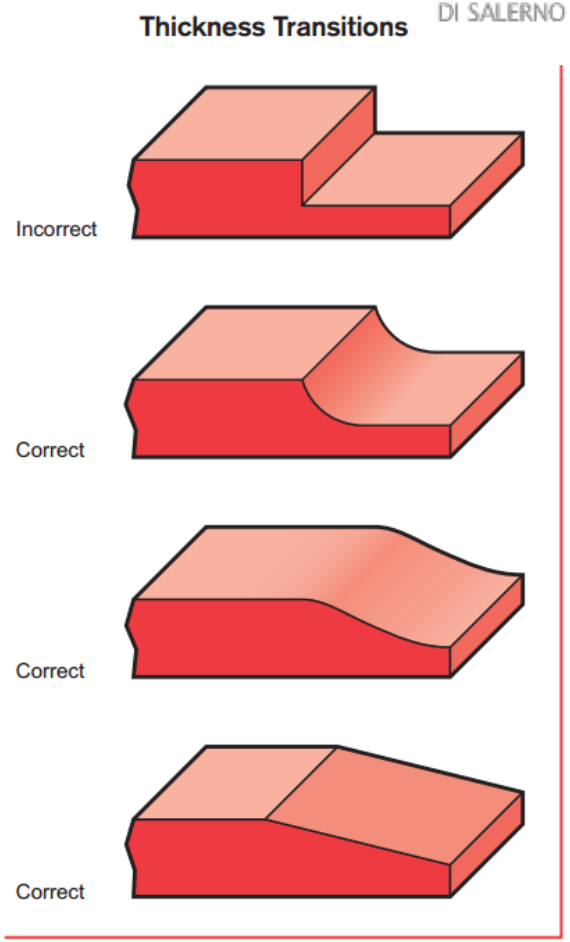
Take care of thickness transitions.

The smoother, the better.

Mind any restrictions or material accumulation. **Uniformity** is the choice.



Internal and external corner radii should originate from the same point.



Blend transitions to minimize read-through.

Co-funded by the Erasmus+ Programme of the European Union

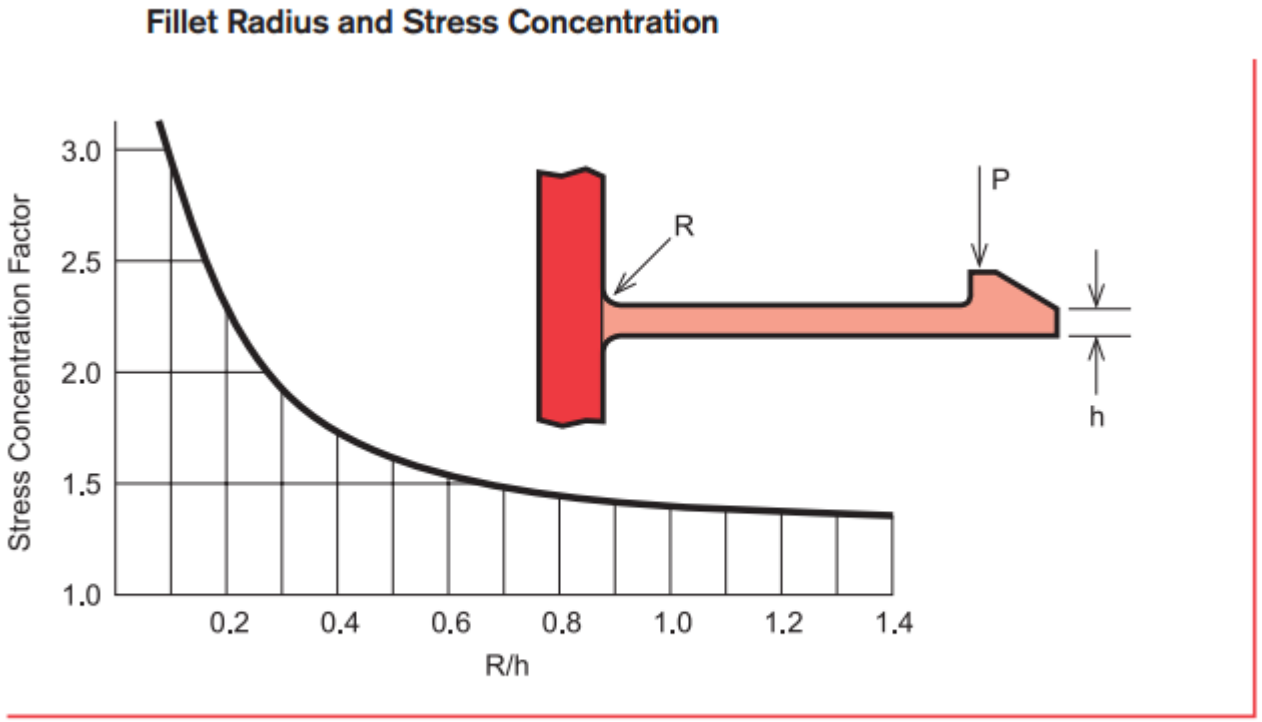
Fillet radii at corners. Distribute the stress

Plastics are very sensitive to notch and stress concentration.

All features, especially those which are functional should be filleted.

Fillets, even very small, will reduce the stress concentration at corners and prolong parts' life.

(especially under impact, fatigue, dynamic loads etc.)



Effects of a fillet radius on stress concentration.

Co-funded by the Erasmus+ Programme of the European Union

Taper any wall. Draft angles required

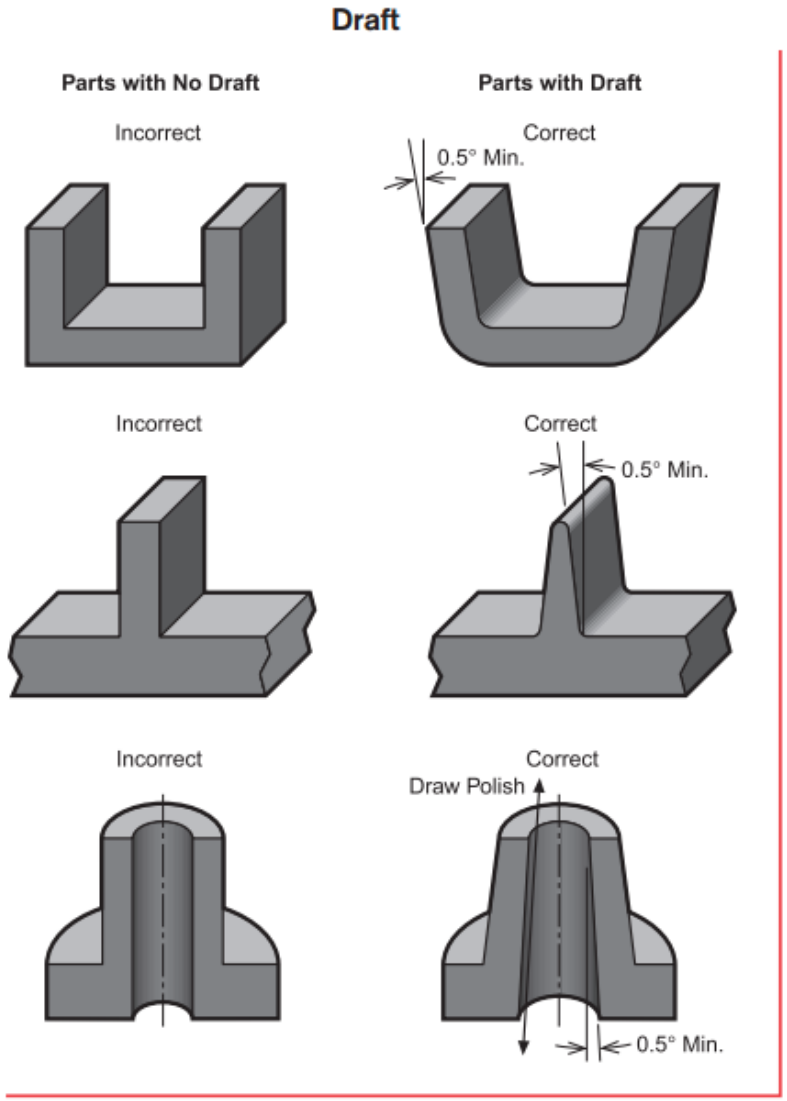
Part ejection requires drafted walls to help solidified plastic slip out of the mould.

Any wall or structure cut in the mould and

higher than few millimetres needs draft angles.

Drafts change the part's geometry.

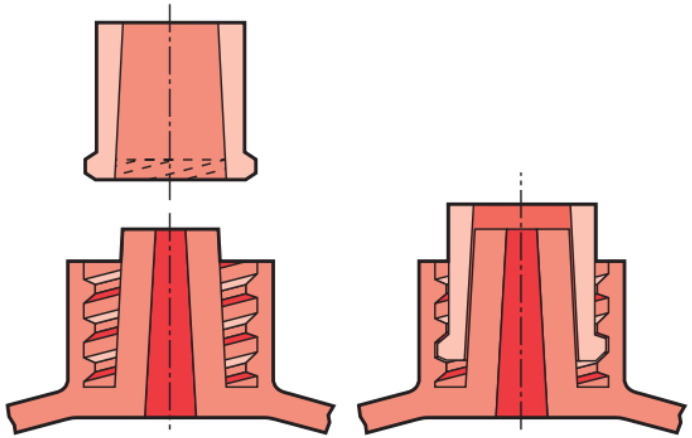
But will make your design **feasible**.

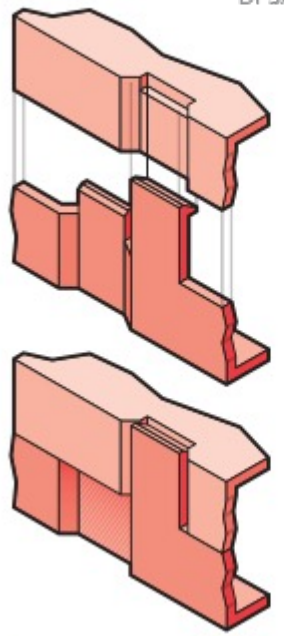


Co-funded by the Erasmus+ Programme of the European Union

General assembly. Joining our forces

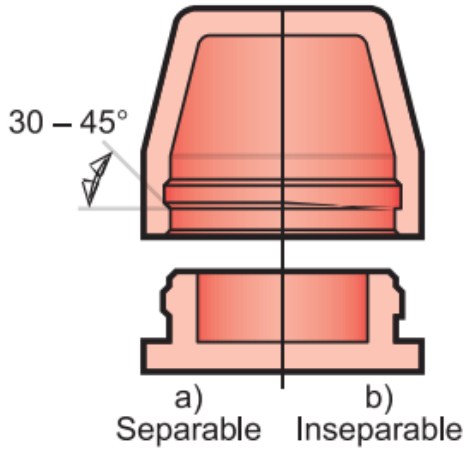
Specific plastics assembling solutions do-very-well to get more





Turn a single part to system.

Assembly technical features are longly proved on plastic parts design. And commonly used



Snapfits, hookes, bosses, threaded joints, fitting rings, welding etc.

Co-funded by the Erasmus+ Programme of the European Union

An effective design will do

Cheetah - max speed=110-120 km/h, $a_{0\text{-}100}$ in 3 s

EcoDesign means comparing different solution –all technically and economically valid- under the point of view of environmental impact.

Solution 1 ⟷ Solution 2 ⟷ Solution 3

What's the environmental cost (resource, energy, emission) for each variant?

The final product

Co-funded by the Erasmus+ Programme of the European Union

Design for Environment Respect. An everyday challenge

Solution 1 ⟷ Solution 2 ⟷ Solution *n*

LCA (Life Cycle Assessment)
will provide numerical evaluations

Raw material
Transformation
Transportation
Emissions - CO2 footprint
Air/water/land pollution
Use
Disposal

The final product

Co-funded by the Erasmus+ Programme of the European Union

Design for Environment Respect. An everyday challenge

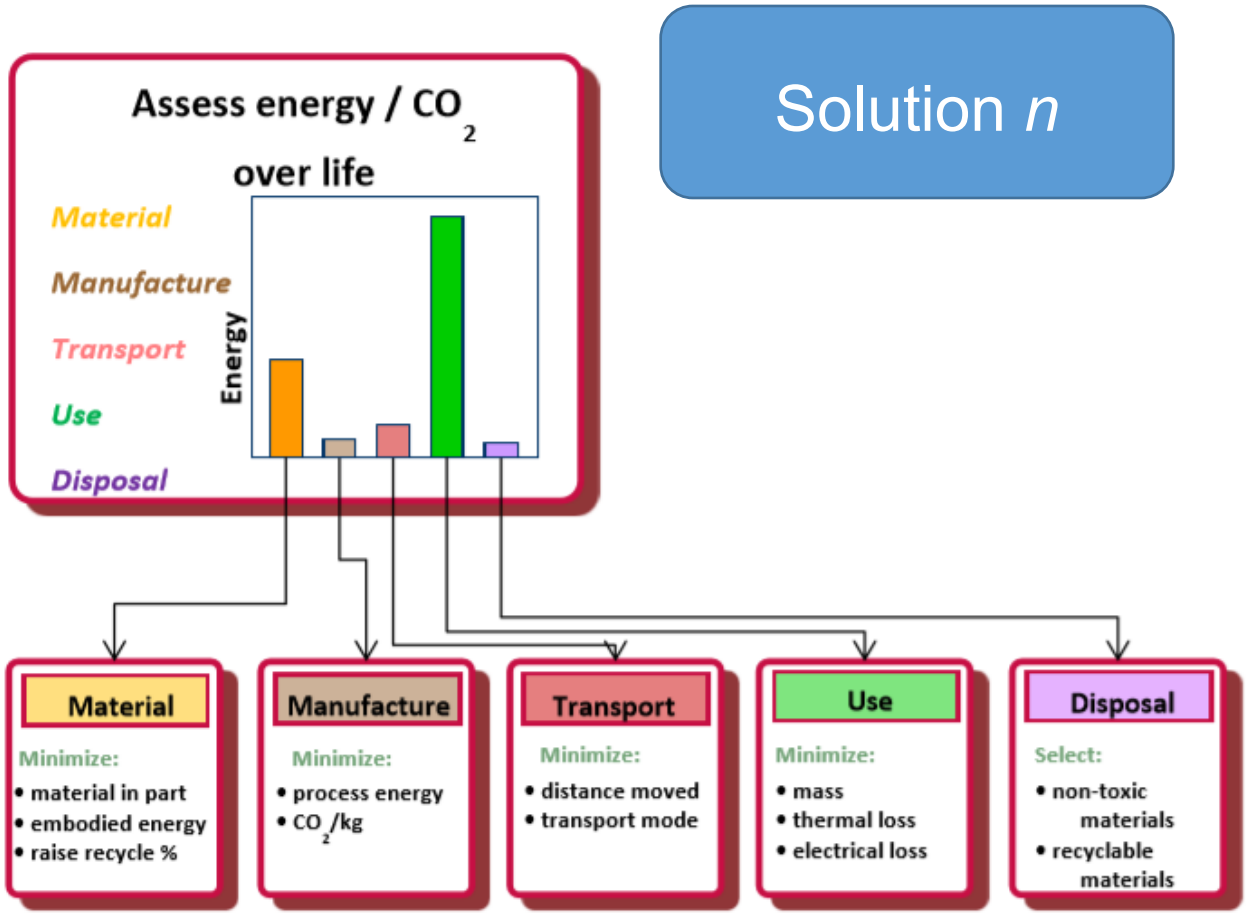


Figure 4: Environmental impact can be assessed for each life-stage of a product (Tip 3). Materials and process selection play an important role in determining environmental impacts and can be used in many eco design strategies (Tip 4.)

LCA (Life Cycle Assessment)
will provide numerical evaluations

Raw material energy content

Transformation energy consumption

Transportation effort (weight, volume)

Emissions - CO2 footprint

Air/water/land pollution

Use (thermal/electrical loss)

Disposal (recyclability, biodegradability, toxic substances)

Co-funded by the Erasmus+ Programme of the European Union

Comparison tip #1 – Consider Environmental impact early in design process

Evaluating the environmental performance during the early design stage allows to consider the environmental costs of different options and enables changes in design and solutions before significant costs and time have been consumed.

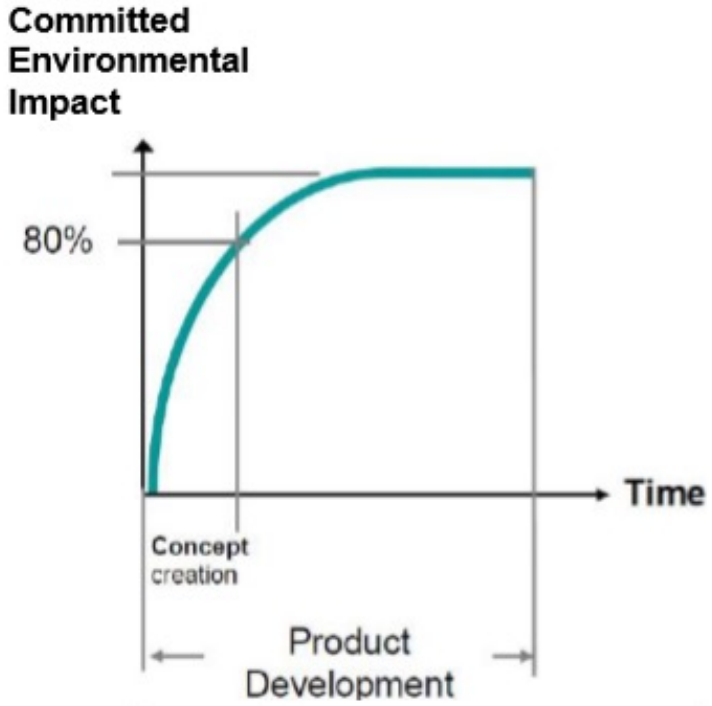


Figure 2: Illustration of design process against percentage of environmental impact fixed

Co-funded by the Erasmus+ Programme of the European Union

Comparison tip #2 – Trust also uncertain data to guide decisions

Eco-data are usually known within 10%.
Nevertheless, this does nott prevent good decision-making especially if a life-phase largely dominates.

Sometimes differences in environmental costs are very large from a material to another, much larger than deviation of data.

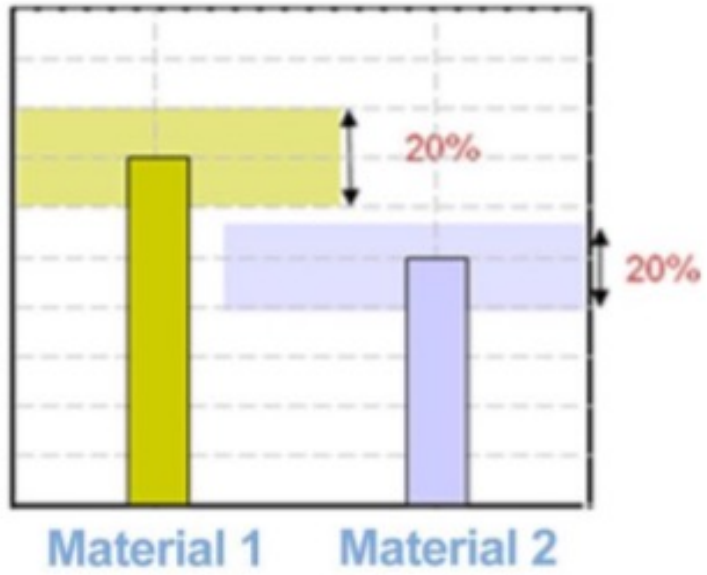


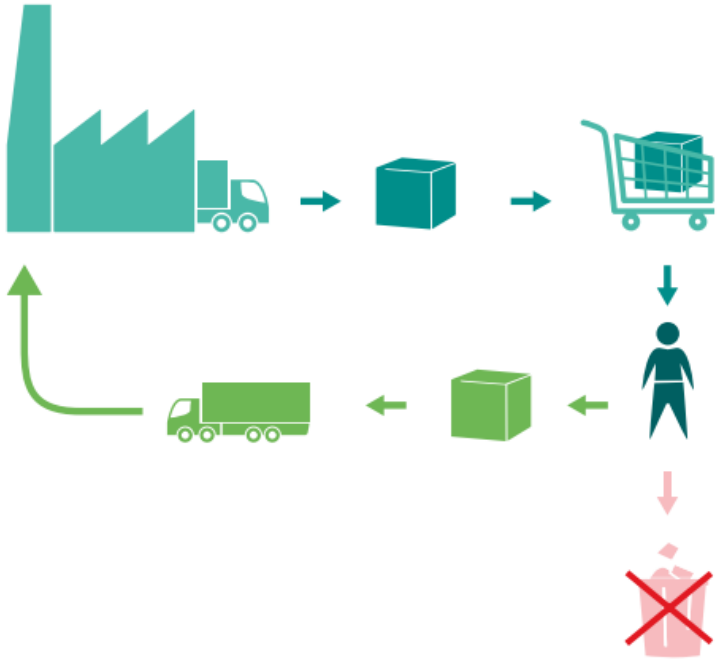
Figure 3: Firm conclusions can be drawn about the environmental impact of a material, even with imprecise data

Co-funded by the
Erasmus+ Programme
of the European Union

Comparison tip #3 – Consider the entire product system

User interaction with product, maintenance, operation and relevance to the user's needs greatly impacts on environmental performance.

Make decisions considering, at the design stage, the environmental impact of all the phases of a product's life (material, manufacture, transport, use, disposal).



Co-funded by the Erasmus+ Programme of the European Union

Comparison tip #4 – Material and process decisions are critical to environmental impact

Different materials carry on diverse level of embodied energy. The less it is, the lower the material impact on the environment.
Ashby diagrams are powerful tools to assess material technical and eco performances.

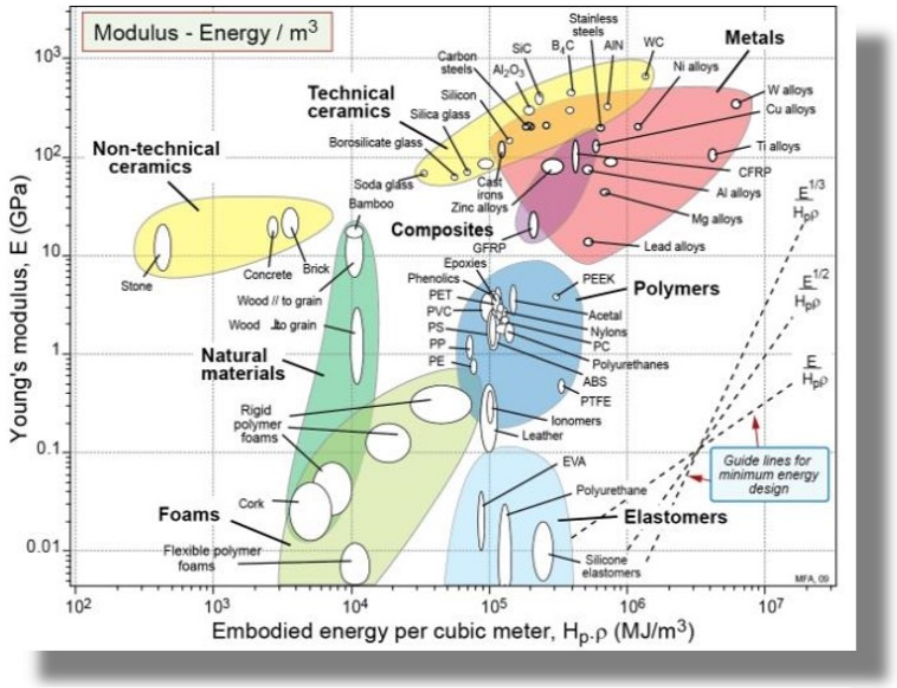


Figure 7: Ashby diagram showing embodied energy against Young's modulus

Co-funded by the Erasmus+ Programme of the European Union

Comparison tip #5 – Establish targets and information systems to promote EcoDesign

Setting targets has two effects:

- Demonstrates the company's **long-term commitment** to environmental performance
- Establishes a framework within all development activities and efforts will be concentrated at the project level

Delivering environmental targets requires the right information to circulate to raise all-level motivation among employees and players

Co-funded by the Erasmus+ Programme of the European Union

Design to
REUSE
AND LAST

Design to reuse and last. Empower our product

Packaging design should be strong, effective, long-lasting.

Try to design in order to:

- Realise products that last long and ay be reusable. Refilling/recharge can be an option
- Analyse, in early stage, all potential causes of failure or malfunctioning
- Make the product useful and reliable
- Make the product captivating and motivating. Try to cause *affection* by the customer

Co-funded by the Erasmus+ Programme of the European Union

Design to
RENEW

Design to renew. Refresh our choices

Packaging materials can be rated by their environmental impact.

Alternative materials are often available to replace traditional ones:

- Select materials with low environmental impact, whenever possible
- Prefer “green materials” such as recycled, bio-based or bio-degradable
- Reduce the number of polymeric materials
- Avoid coupled or layered materials

Co-funded by the Erasmus+ Programme of the European Union

Design to
RESOLVE AND SORT

Design to resolve and sort. Refresh our choices

Difficult separation of complex systems may prevent the chance of reusing or recycling.

Put you efforts in favour of the customer:

- Design your system preferring convenient assembling techniques (snap-fits, pin-holes, hooks)
- Try make the system easy to disassemble without the use of tools as much as possible
- Make it clear to the user how he can separate and sort components of different materials
- Avoid non-resolvable or hard-to-dismantle coupling systems (gluing, welding, screwing)

Co-funded by the Erasmus+ Programme of the European Union

Design to
SAVE

Design to save. Refresh our choices

Industrial production efforts of the final design may reveal to be overwhelming, if not considered early in the development loop. The EcoDesigner must take the production technology into account, at early stages:

- Optimise your design and the related production process
- Try your best to increase productivity
- Make all efforts to reduce energetic consumption related to manufacturing
- Consider innovative and non-conventional production technologies. Just to optimise

Co-funded by the Erasmus+ Programme of the European Union

Eco Design. An Attitude

EcoDesign requires a global vision. It's a choice.

Reduce
Our Impact

Reuse
Our Energy

Renew
Our World

Resolve
Our Lives

Save
Our Planet

Co-funded by the Erasmus+ Programme of the European Union

PACKALL

PackAlliance:
European alliance for innovation training & collaboration towards future packaging

Linking Academy to Industry.

campus iberus
CAMPUS OF INTERNATIONAL EXCELLENCE OF THE EBRO VALLEY

Tampere University of Applied Sciences

AGH

UNIVERSITÀ DEGLI STUDI DI SALERNO

ecoembes
El poder de la colaboración

pyroll

synthos
chemical innovations

proplast
PLASTICS INNOVATION POLE

Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission.
This publication [communication] 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.