



EUROPEAN ADHESIVE ENGINEER

HEALTH AND SAFETY

7.2 CHECKLIST WITH COMMENTS

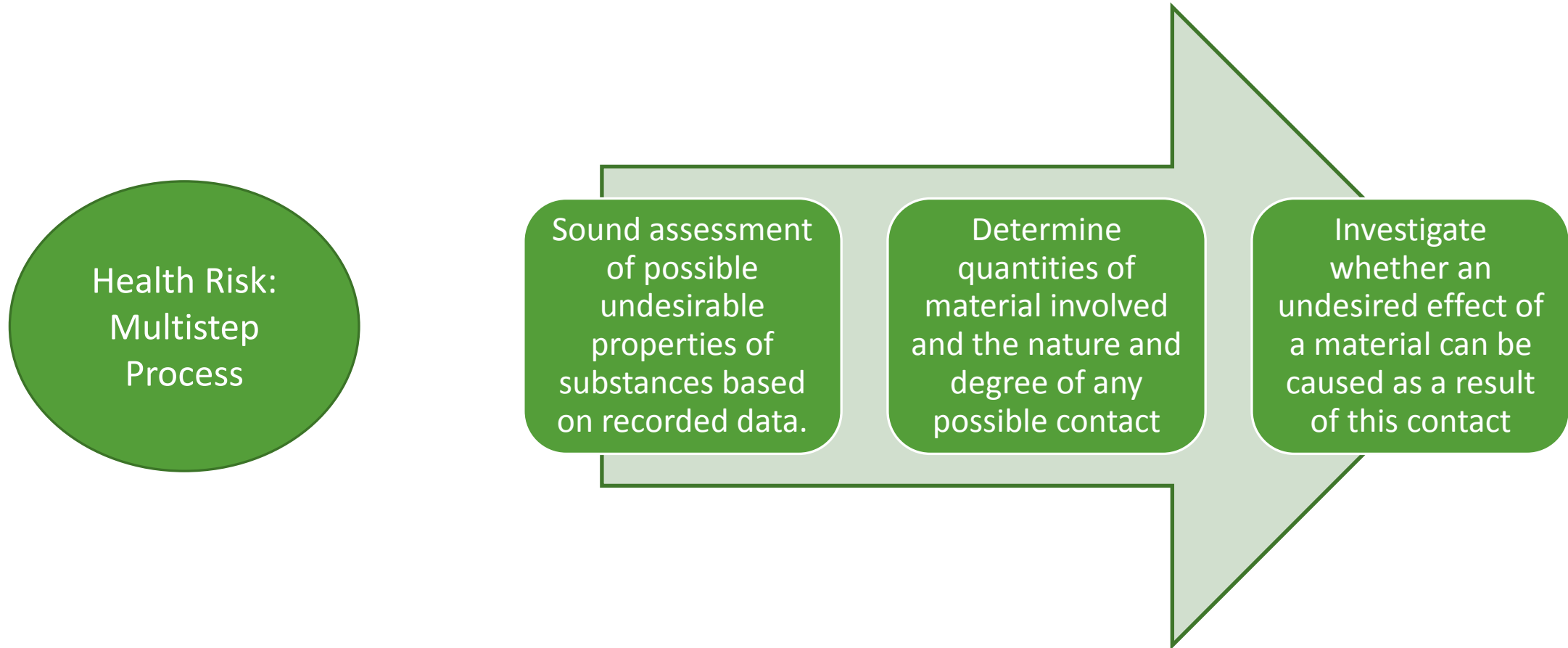


7.2 Checklist With Comments

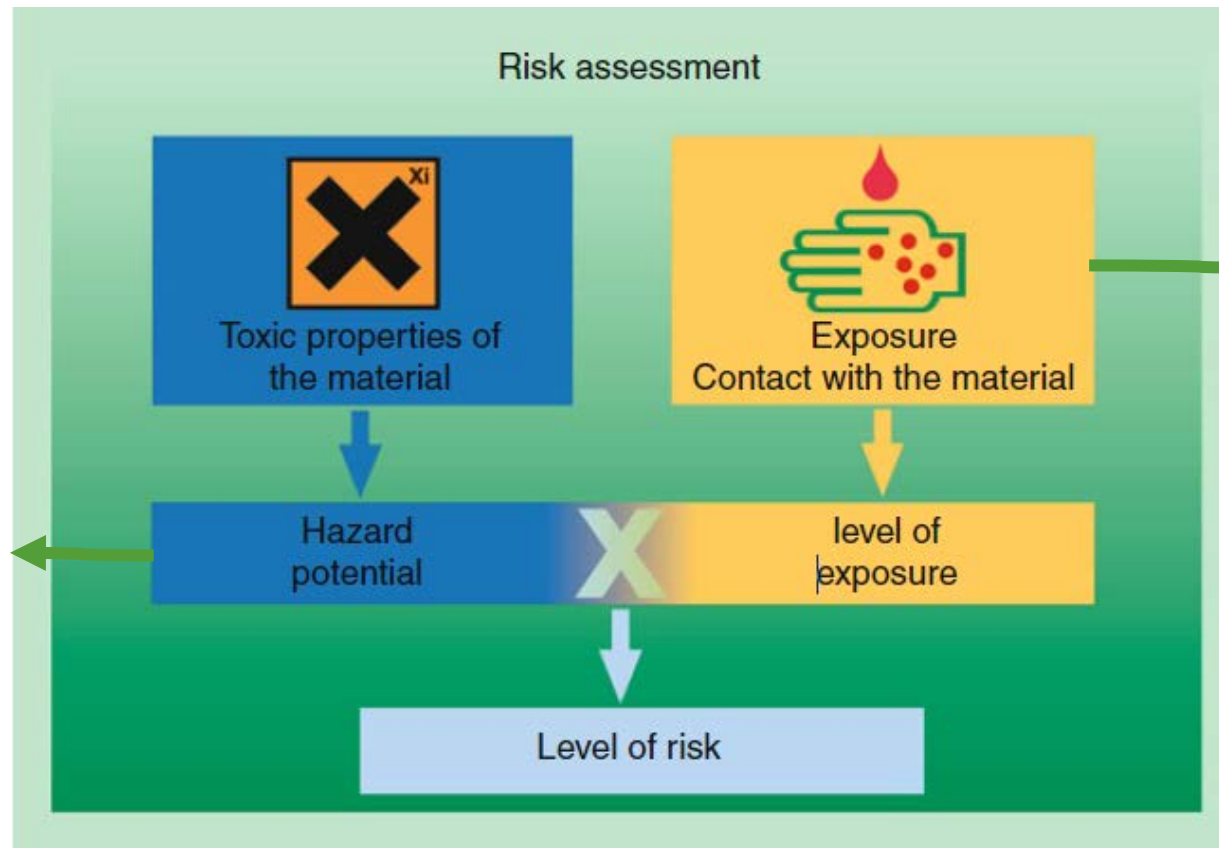
Learning Outcomes:

- ✓ Explain the main topics about adhesives' risk assessment
- ✓ Relate: step of a specific adhesive process ↔ Health effects

Risk Assessment ^[1]



Risk Assessment ^[1]



- Can be reduced by:
- automated processing
 - suitable protective measures

- Fundamental property of a substance/formulation
- Generally decreases when the fraction of hazardous material present is lower

A. Ö. R. D. A. Lucas F M da Silva, Ed., Handbook of Adhesion Technology, Springer, 2011, p. 1000

Risk Assessment ^[1]

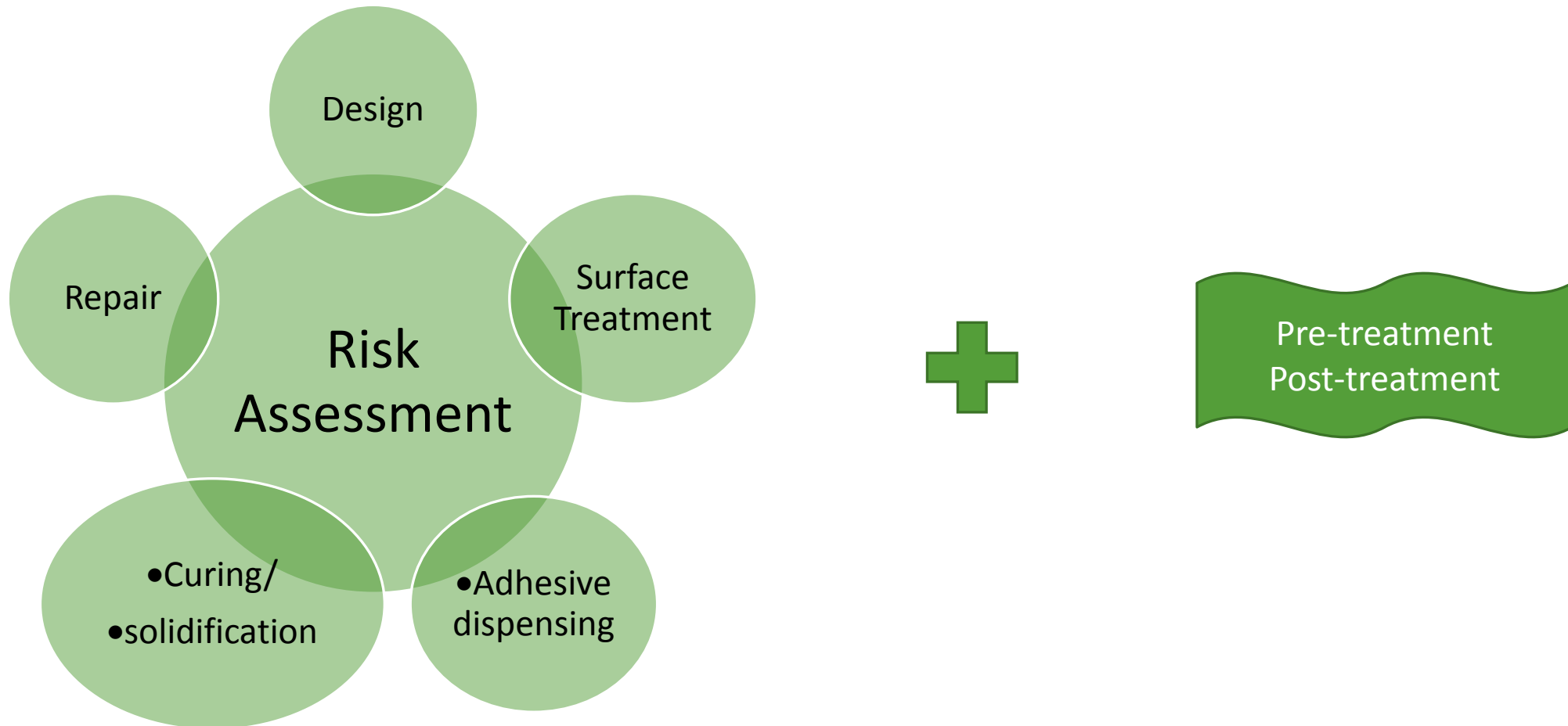
- Small amounts of a hazardous substance can often be present without the product having to be accordingly labeled

- Physicochemical properties of the substance
- Nature
- Degree of exposure
- Ability of the substance to get into the body

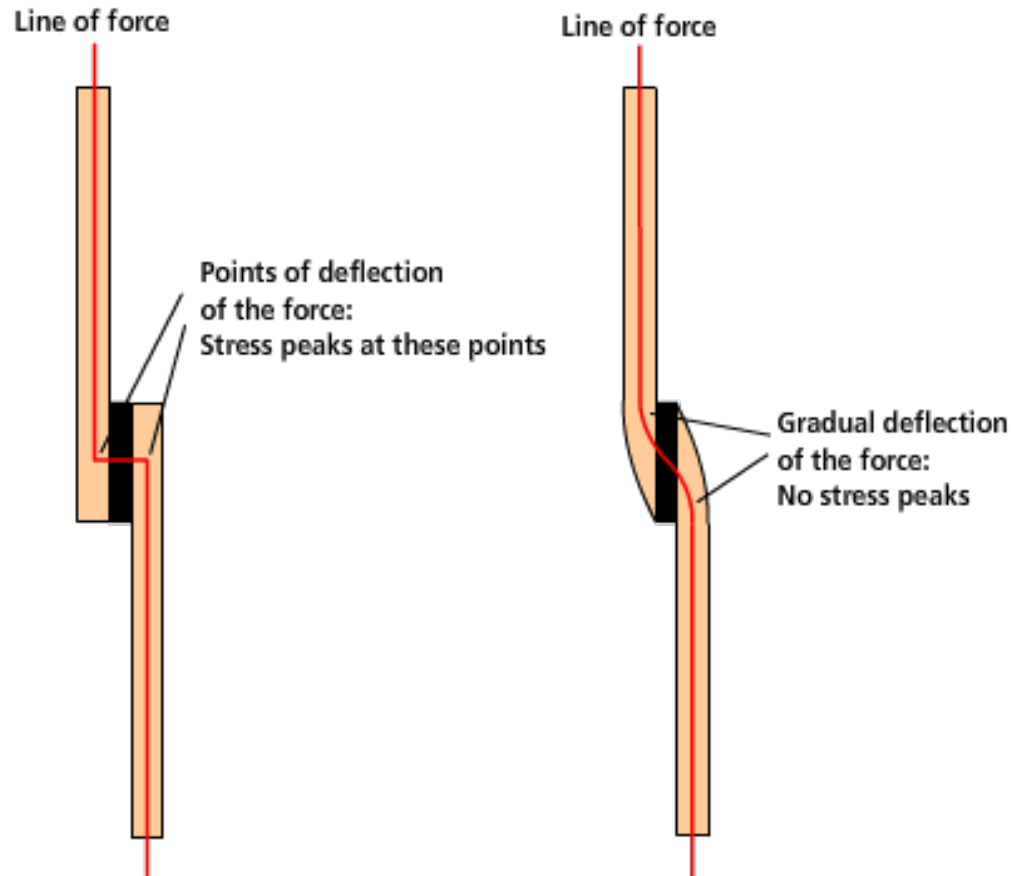
} determine the relevant amount
and the resulting dose that
can be taken up by the body

- In general, there is no undesired effect below a certain dose
- The dose level determines whether and to what degree a substance can harm a person's health.

Risk Assessment



Risk Assessment – Design [5]



Design guidelines taking into account:

- Expansion
- Creep and relaxation
- Corrosion
- Production
- **Risks**

Focus of this chapter

http://onlineguide.klebstoffe.com/english/index.php?section=3_24

Risk Assessment – Design ^[6]

➤ As with all joining methods, designing bonded joints involves balancing:

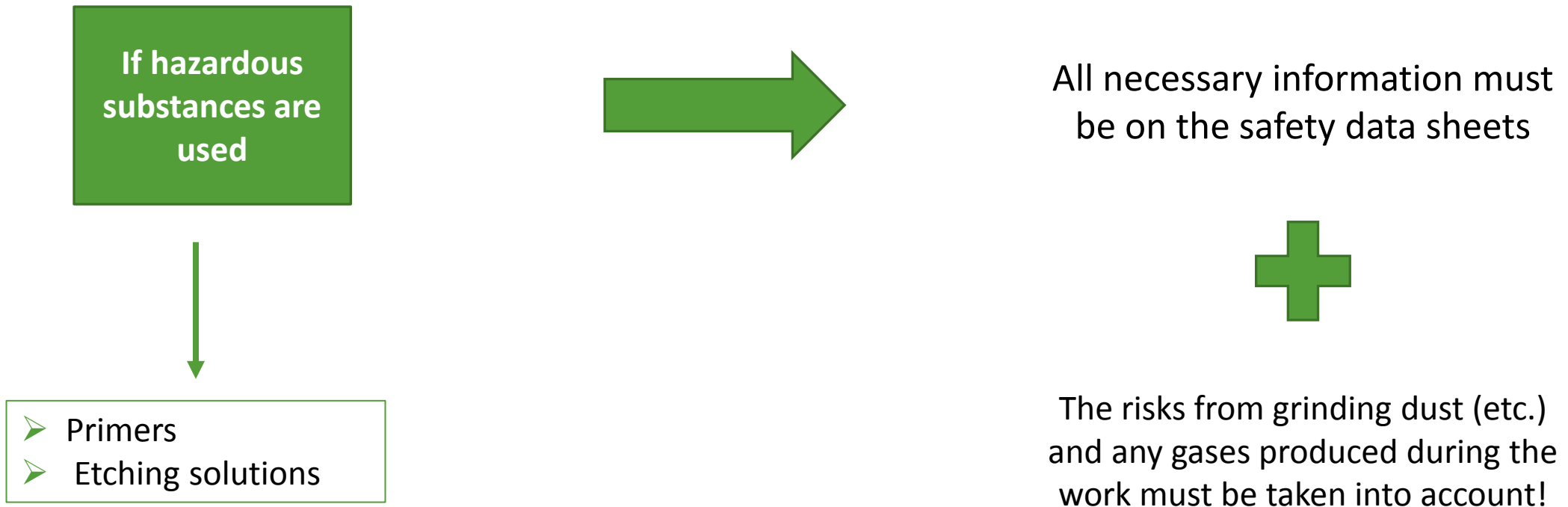
- Technical
 - Commercial
- } Risks

➤ If, to achieve 100% technical safety, namely to design a bonded component such that the loads acting on the component during its service life remain far from the load limit, results in:

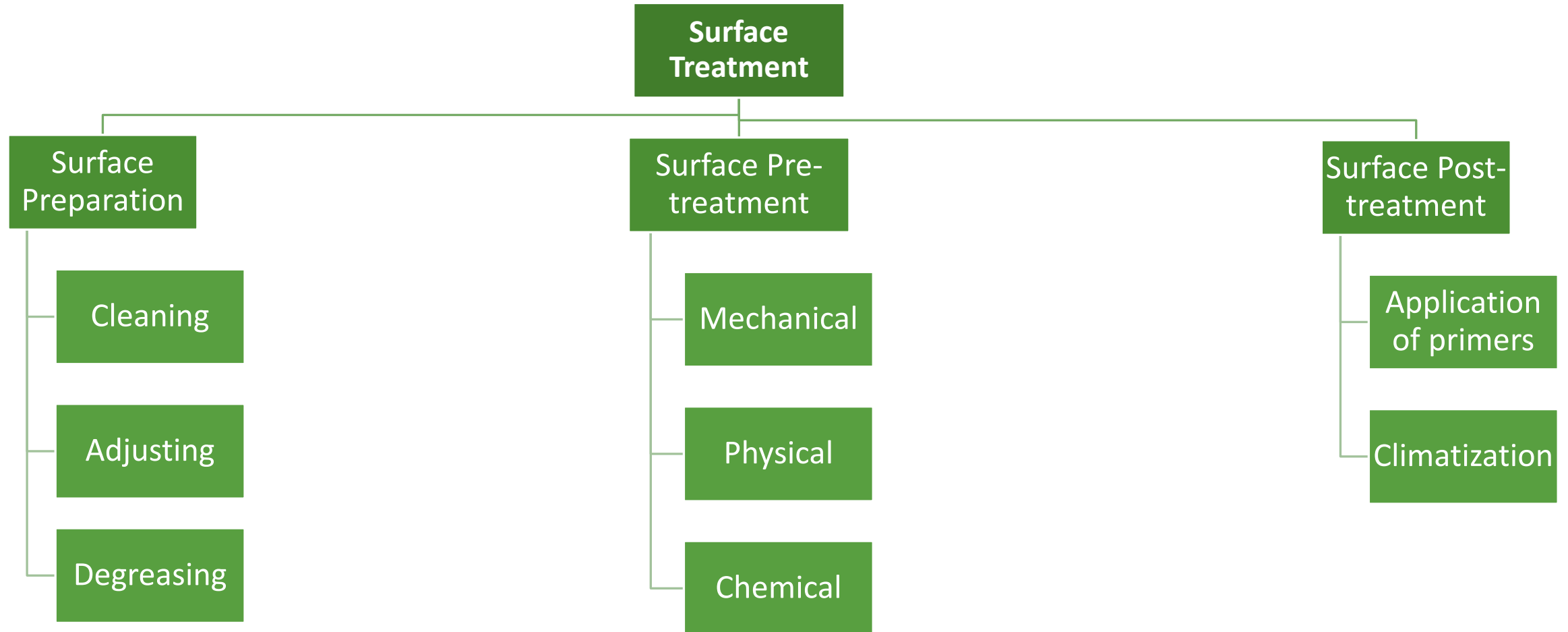
- an oversized component which is too large, too heavy, too expensive.

⇒ **uncompetitive**

Risk Assessment – Surface Treatment [7]



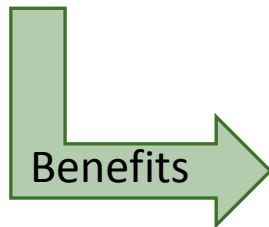
Risk Assessment – Surface Treatment [8]



Additional requirements for “non-hazardous” adhesives [9]



Although in a few applications no surface pre-treatment is necessary, it is accepted that to obtain the **optimum performance** from an adhesive joint a pre-treatment is required.



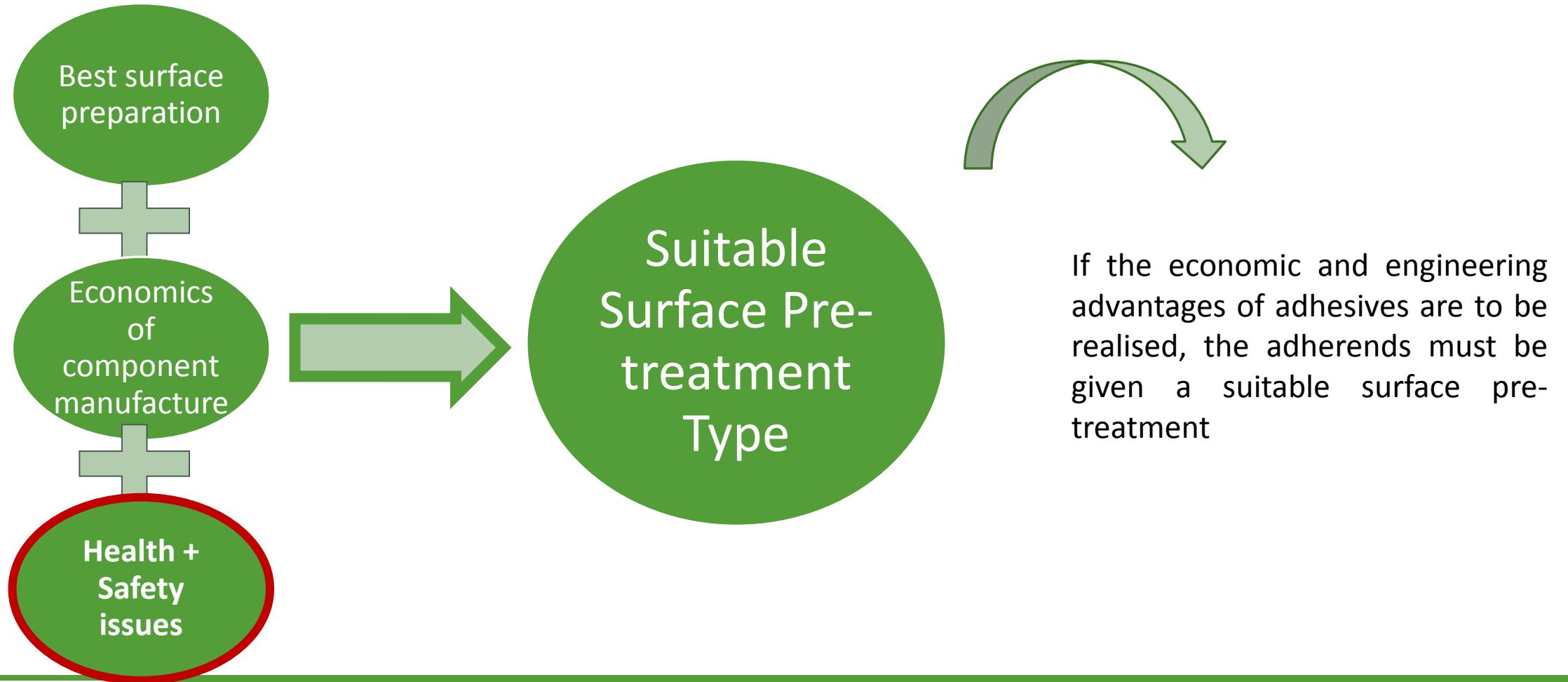
- Enhanced mechanical performance of joint
- Improved joint durability in aggressive environments
- Increased service-life of component
- Ability to bond difficult adherends, e.g. polyolefins and polytetrafluoroethylene

Additional requirements for “non-hazardous” adhesives [9]

Purpose of pre-treatment

- To remove completely, or to prevent formation of weak boundary layers.
- To optimise the degree of intimate molecular contact adhesive/adherend in order to form an effective bond , which may be brought about by chemical modification of the adherend surface.
- To protect the adherend surfaces before bonding. This is often necessary, particularly with metals which after surface pre-treatment have a surface that is highly reactive not only towards adhesives but also to atmospheric contaminants. To preserve the integrity of the adherend surface it is usually necessary to bond the surface within a few hours of treatment, or to coat it with a primer which is compatible with the adhesive to be applied later. A primed surface can protect the adherends for up to several months.
- To produce a specific adherend surface topography, thereby altering the surface profile, and possibly increasing the bondable surface area, that is, to roughen the surface.

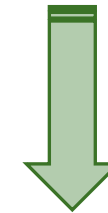
Additional requirements for “non-hazardous” adhesives [9]



Additional requirements for “non-hazardous” adhesives [8]



A surface post-treatment does take place, if the adhesive properties of a surface shall be further enhanced or bonded joints are exposed to particularly high stress (e.g. by moisture and corrosion)



It has to be considered that longer periods under frequently uncontrolled storage conditions may occur between production and processing of material to be bonded

Additional requirements for “non-hazardous” adhesives ^[10]



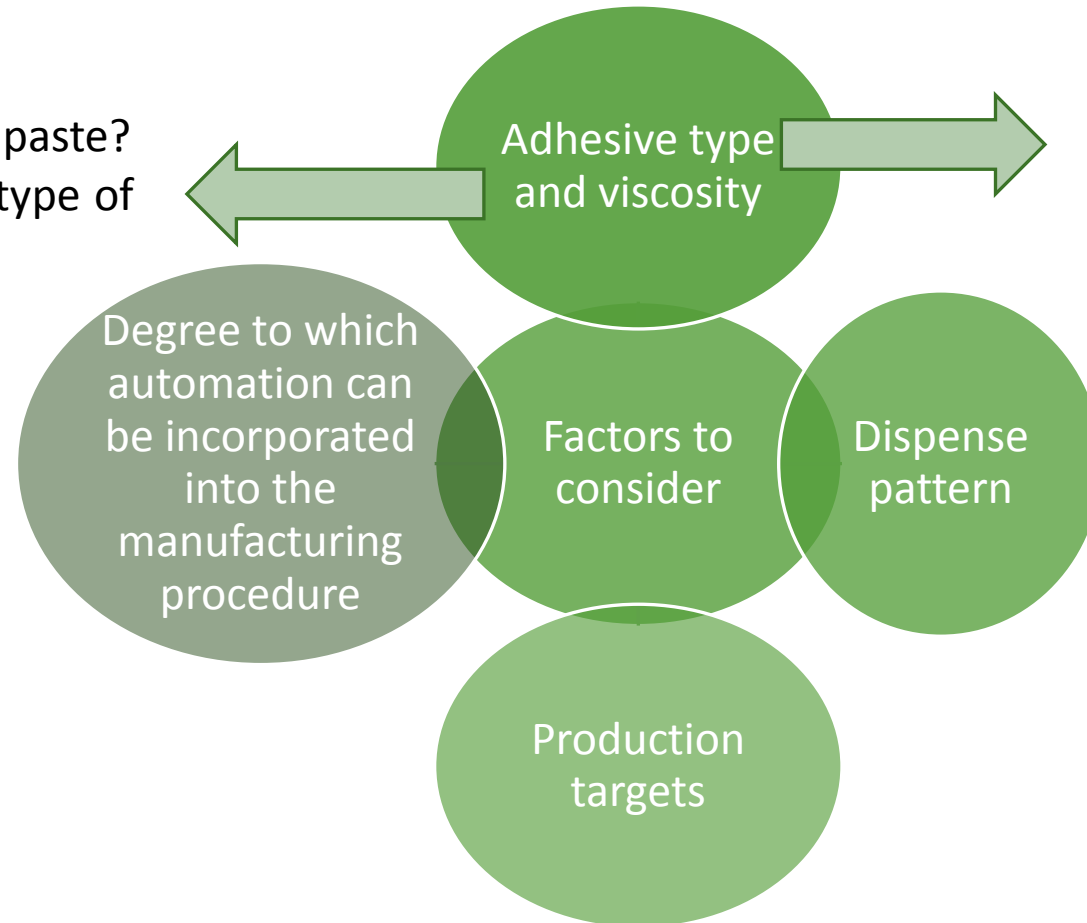
The post-treatment of surfaces is set of chemicals materials (activators and primers) used in conjunction with the adhesive during the application phase and are intended to:

- ↑ wetting properties
- ↑ adhesion substrate/ adhesive

- Create active surface on the substrate.
- Generate compatible surfaces with the adhesive resin
- ↓ surface roughness

Risk Assessment – Adhesive dispensing [11]

❖ Is the adhesive liquid or paste?
 → This will determine the type of equipment required

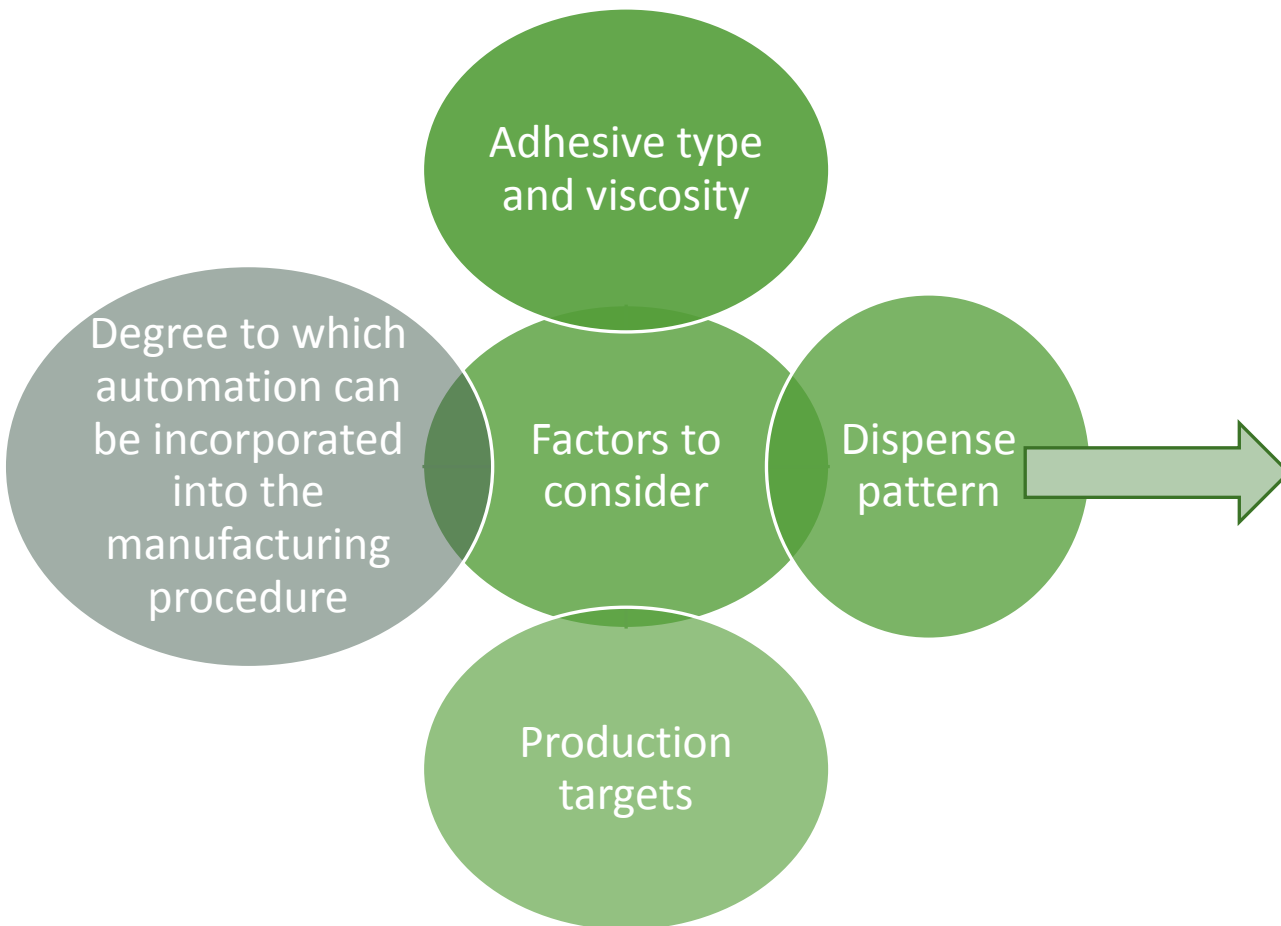


❖ Is it single part or dual component?
 → If it is 2-C ⇒ Requires mixing before or during application



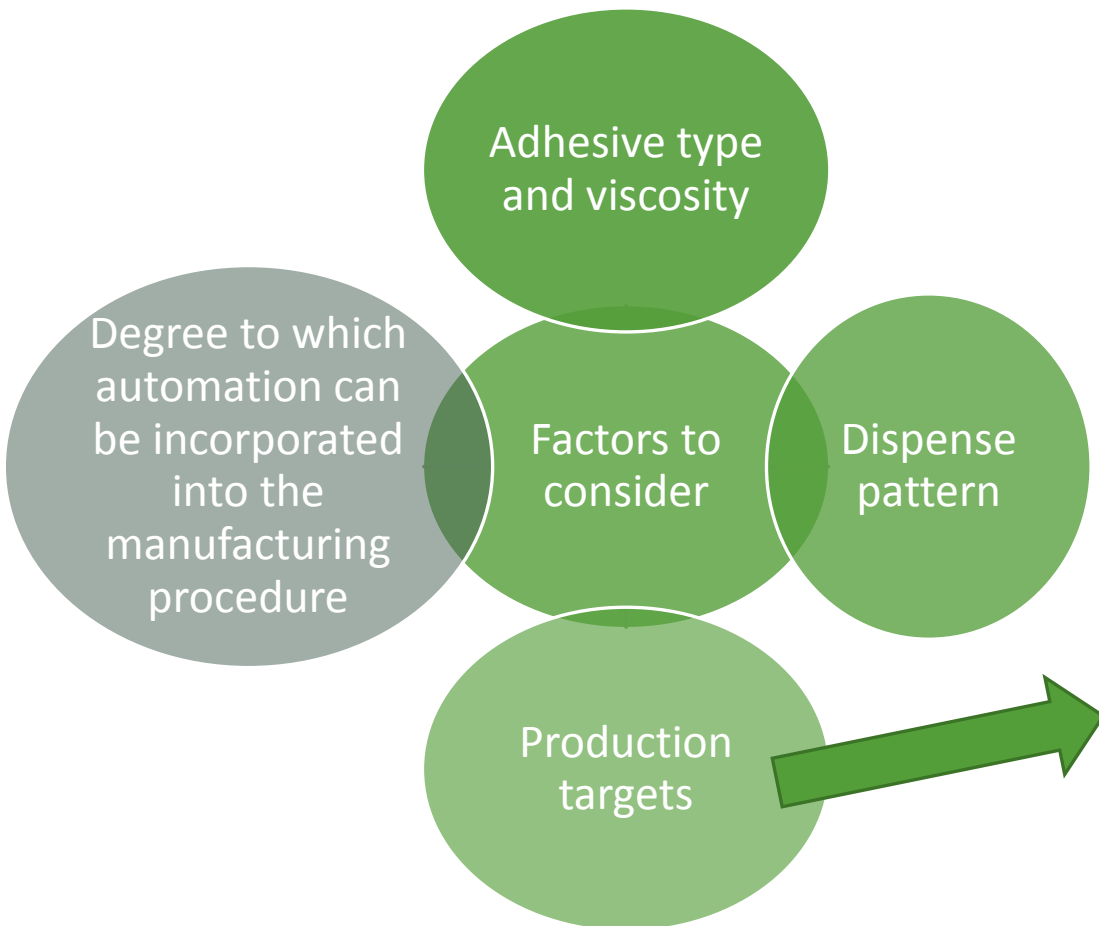
Anaerobics - cure on metal surfaces when deprived of oxygen
 ⇒ Require an equipment which incorporates no metal
 + The adhesive must be dispensed from a container that allows the presence of some air

Risk Assessment – Adhesive dispensing [11]



- ❖ **It can embrace:**
 - single and multiple spots
 - linear beads
 - uniform coating of the inside of bores.
- ❖ For **spots** – with a size $\geq 0.01\text{ml}$ - metering the adhesive is crucial for effective application
 - ⇒ The equipment has to include such a device
- ❖ Products such as **gasket sealants** are most effectively dispensed by high-pressure pumps capable of 'tracing' around a specified profile. Such units are usually connected to an anthropomorphic or a Cartesian robot.
- ❖ Where the adhesive needs to be applied to the **bore of a circular component** (e.g. engine core plugs) a rotaspray configuration can be used.

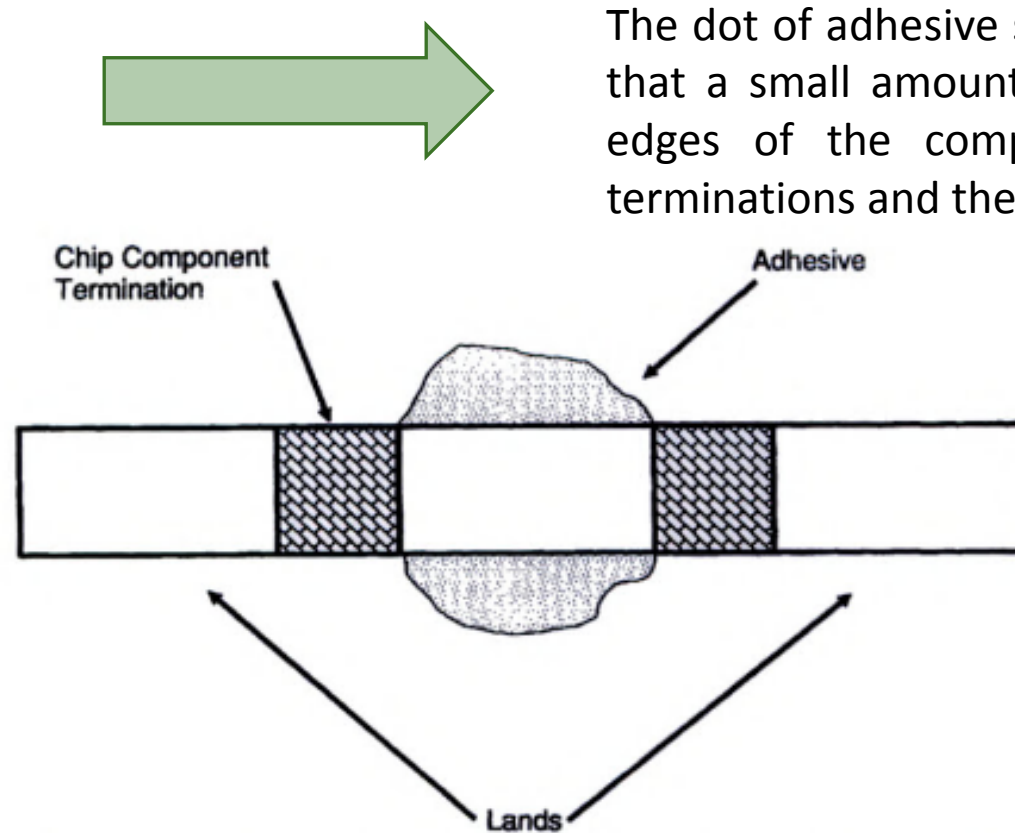
Risk Assessment – Adhesive dispensing [11]



- ❖ The decision to employ automation will frequently be dictated by production volumes
- ❖ Larger the throughput ⇒ +justification for capital expenditure.
- ❖ The application equipment has to provide payback in terms of quality and financial returns.

Risk Assessment – Adhesive dispensing [12]

If the adhesive requires UV cure



The dot of adhesive should be placed or formed so that a small amount extends out from under the edges of the component, but away from the terminations and the leads

The exposed adhesive is necessary to initiate the UV cure

R. Blackwell, Ed., The Electronic Packaging Handbook, CRC PRESS, 2000, pp. 10-12.

Risk Assessment – Adhesive dispensing [12]

- The dot size is controlled by:
 - Pressure
 - Time
 - Tailing (dragging of the adhesive's "tail" to the next location over components and substance surface)
⇒ it is a function of the adhesive viscosity - which can change with T
- **Tailing** can cause serious problems of solder skips on the pads
 - It can be reduced by making some adjustments to the dispensing system, like:
 - Smaller distance board/nozzle
 - Larger diameter nozzle tips
 - Lower air pressure
- **Skipping** of adhesive is another common problem in adhesive dispensing.
 - It can be caused by:
 - Clogged nozzles – the nozzles generally clog if adhesive is left unused for a long time. To avoid them: the syringe should be discarded after every use or a wire can be put inside the nozzle tip
 - Worn dispenser tips
 - Circuit boards that aren't flat
 - Very high viscosity

Risk Assessment – Adhesive dispensing [12]

- When using automatic dispensers in pick-and-place systems:
 - Care should be exercised to keep gripper tips clean of adhesive
 - A minimum amount of pressure should be used to bring the component leads or termination down onto the pads

- If contact with adhesive occurs during component placement, the gripper tips should be cleaned with isopropyl alcohol.

Risk Assessment – Adhesive dispensing ^[13]

- Care should be taken when applying adhesives.
- An **air-filtering mask** that is designed to provide protection from airborne particulates should be worn whenever there is a risk of the uptake of hazardous substances into the body.
- Good **ventilation** is recommended for all adhesive applications.
- **Ventilation hoods** may be necessary for certain types of adhesives and building designs.

Risk Assessment – Adhesive dispensing ^[13]

- Additional protection may be required when applying water-based natural latex adhesives.

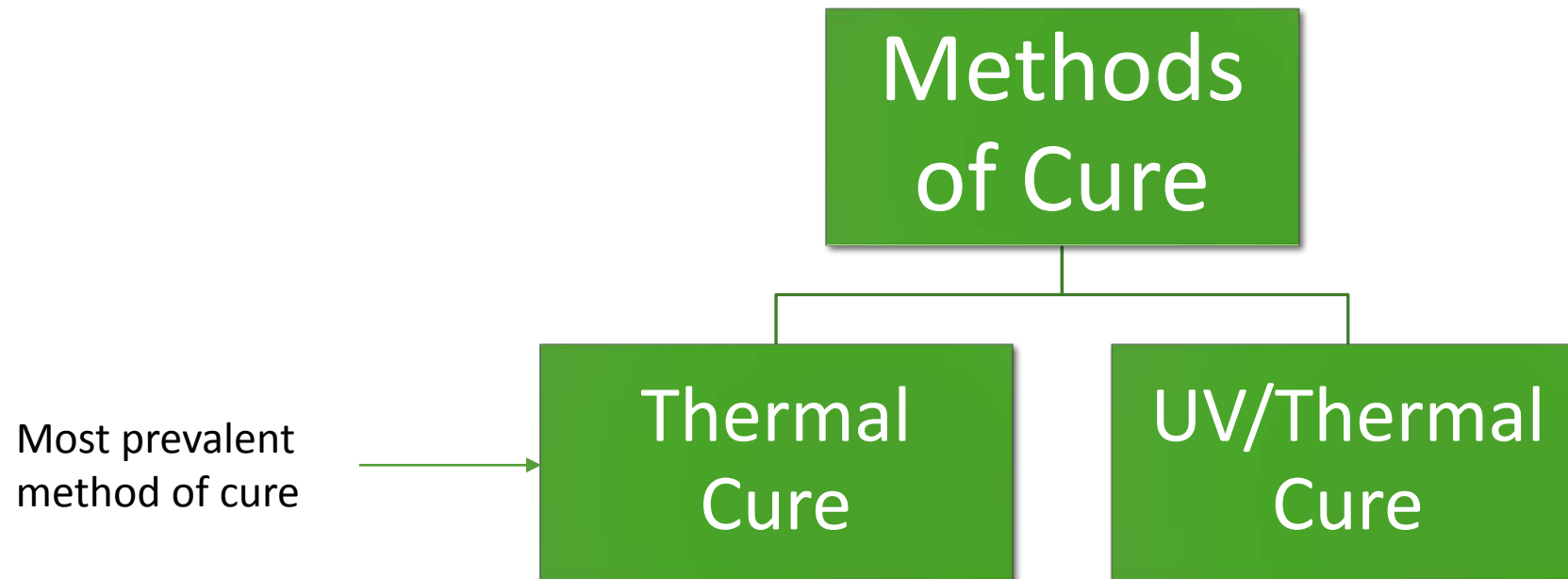


Persons allergic to latex should not apply the product!

- Some carriers, such as formulations containing acetone, may have a low flash point, therefore requiring specialized fire detection and suppression equipment.

Risk Assessment – Curing ^[12]

- Once adhesive has been applied, components are placed.
- Now, the adhesive must be cured to hold the part through the solidification process.



Risk Assessment – Curing ^[12]

Most epoxy adhesives

are designed for

Thermal
Cure

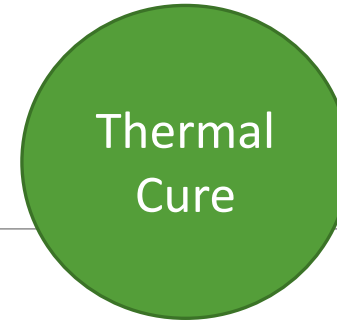


- ❑ The single-part epoxy adhesives require a relatively longer cure time and $\uparrow T$.
- ❑ When using $\uparrow T$, care should be taken that boards do not warp and are properly held!

Can be accomplished in:

- A conventional oven
 - Requires longer time but $\downarrow T$
- An IR oven
 - Can also be used for curing
 - Same results in less time due to $\uparrow T$

Risk Assessment – Curing [12]



Most of the adhesive gets its final cure during the preheat phase

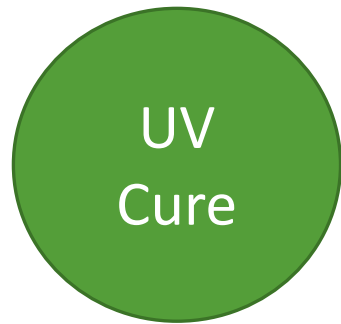


It's not absolutely essential to accomplish the full cure during the curing cycle

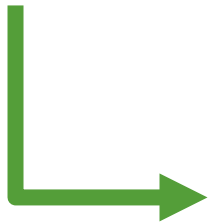
- ❑ Adequate cure is necessary to hold the component during the joining process



Risk Assessment – Curing ^[14]

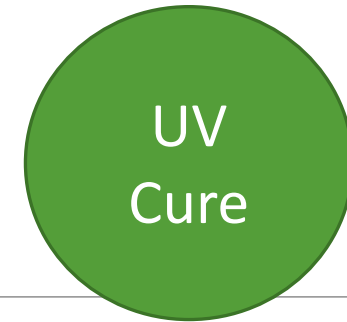


speed curing process in which high-intensity UV light is used to create a photochemical reaction that instantly cures the adhesive

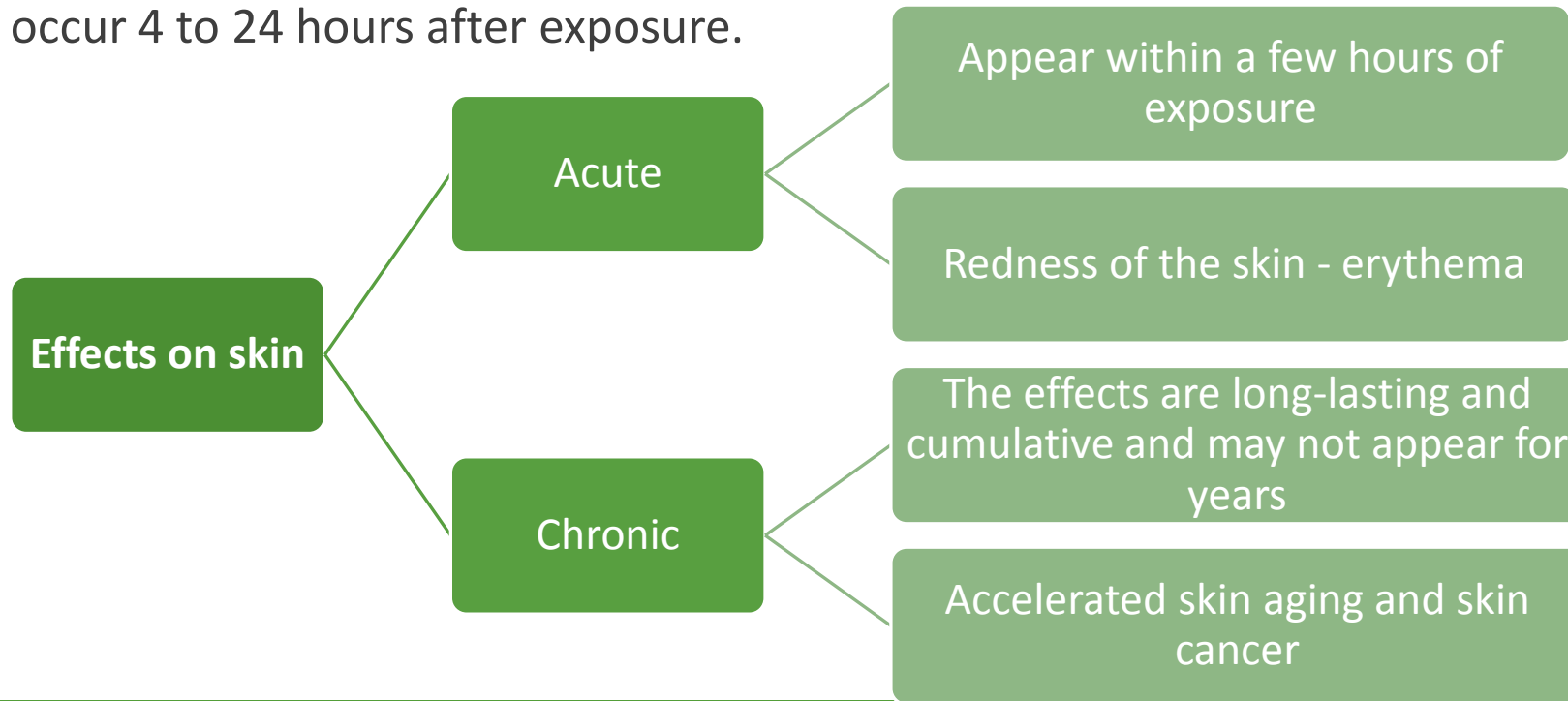


UV curing systems produce light radiation from UV through visible light

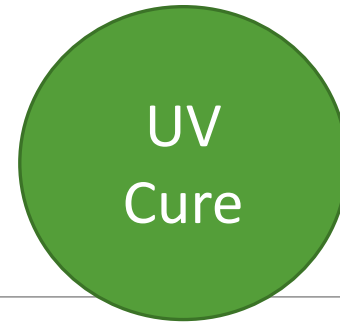
Risk Assessment – Curing ^[14]



- The biggest hazard comes from the UV radiation. UV radiation cannot be seen and is not felt immediately, but it is harmful to human tissue in the eyes and skin.
- The user may not realize the danger until after the exposure has caused damage. Symptoms can occur 4 to 24 hours after exposure.

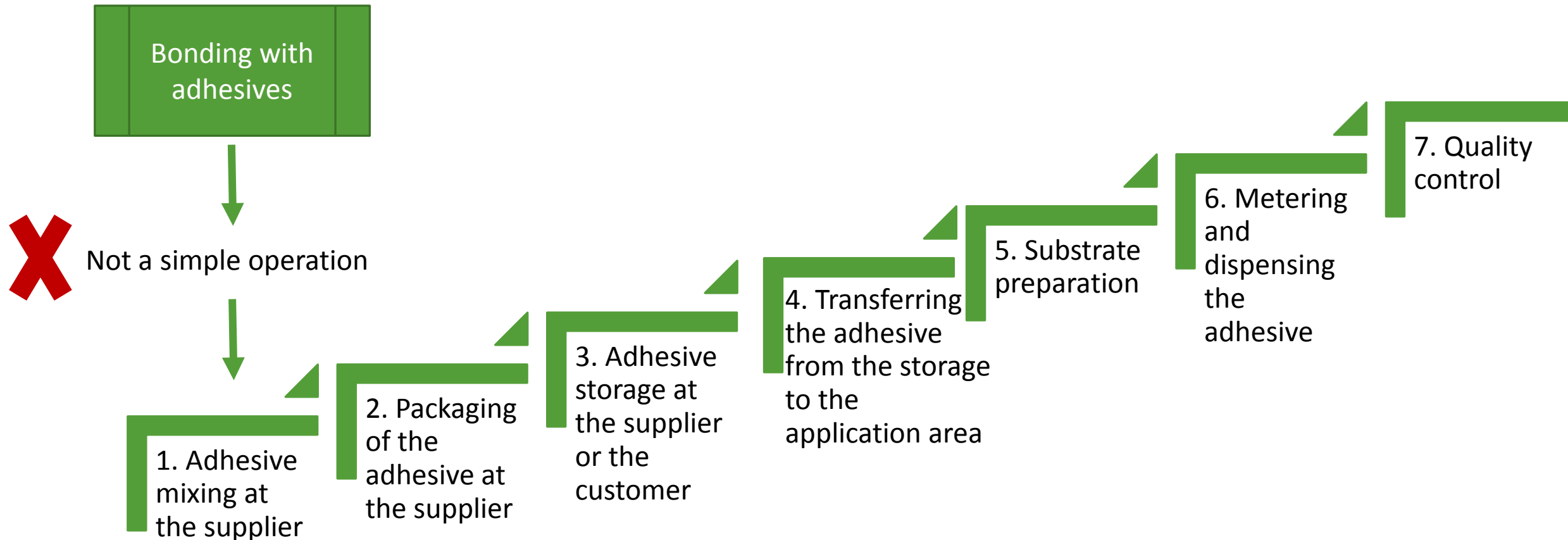


Risk Assessment – Curing ^[14]





- Control measures must be in place to limit exposure to eyes and skin and to prevent cumulative exposure.
- The precautions needed depend on the risk assessment.
- Control measures designed to eliminate the risk of exposure to UV at its source, such as engineering and administrative controls and personal protective equipment (PPE), must be implemented wherever possible.
- A key element in achieving the goal of reduced UVR exposure is worker training and awareness.

Steps of the adhesive process [15]



Preventive Measures While Storing the Adhesive ^[15]

New GHS/CLP Regulation	CHIP Regulations used in the past
Applies to both the supply/use and transportation of chemicals	Applies only to supply and use of chemicals
Aligning supply with transport regulation	Supply labelling and transport labelling are ≠
GHS – Pictograms with a white background and red border 	Orange Hazard Symbols 
Term “Mixture”	Term “Preparation”
Term “hazardous”	Term “dangerous”
H-Phrases/Statements	Risk (R) phrases with the code numbers, e.g. R43
P-Phrases/Statements (5 types)	Safety (S) phrases with the code numbers, e.g. S24

A. Ö. R. D. A. Lucas F M da Silva, Ed., Handbook of Adhesion Technology, Springer, 2011, p. 945.

Preventive Measures While Storing the Adhesive ^[15]

Containers should be stored

- In dependence of their used **chemistry**
- **In a dry and cool** place: Preferably $T < 25\text{ °C}$
 - Some reactive or solvent-containing adhesives would require cooler storage
Preferably $T < 10\text{ °C}$ or even $T < 0\text{ °C}$
- **Above collecting trays** to prevent pollution in case of a leakage or spill
- Depending on their **hazardous potential**:
 - Flammable material should be stored in rooms which are especially fire resistant and explosion protected
 - Adhesives which have a strong odor should be stored in a room with special ventilation

Preventive Measures While Working with the Adhesive [15]

Check Safety Data Sheet to obtain detailed information about the precautions regarding a specific adhesive

The personal protection should at least consist of

Long-sleeved lab coats

Protecting glasses or goggles

Gloves

Should be regularly and professionally cleaned

Should be thick enough to prevent the adhesive from migrating through the woven to the skin

Disposable

Changed regularly

Its material should prevent the penetration of the adhesive through the glove into the skin

If epoxy adhesives: not latex but nitril

Preventive Measures While Working with the Adhesive [15]

	Special Prevent Measures	
--	---------------------------------	--

Epoxy-, rubber-, or acrylic resin-based formulations

- Skin sensitizing
- Require special gloves

Acrylic-based adhesives and hardener compounds of 2-part formulations

- Can have a strong odor
- Require proper ventilation

Solvent-containing adhesives

- Contain flammable solvents
- Must be kept away from any heating source

Preventive Measures While Processing [15]

- Adhesives can be applied automatically by pumping the material out of a pail or drum and transferring it through hoses and possibly a dozer to the nozzle.
- The adhesive is applied from the nozzle to the substrate.
- Certain pressures and T are applied to guarantee a good flow of the adhesive from the pail or drum over the dozer to the nozzle

Preventive Measures While Processing ^[15]

Recommended Precautions

Avoid overheating of the adhesive which could lead to an ↑ of the viscosity and eventually can block the hoses or the dozer

Shield the equipment properly because it is under pressure

Switch off the heat and pressure after longer breaks like overnight or over the weekend

Use heated follower plates and do not use heated pail or drum jackets

Work on specially sealed floors or use collection trays to be prepared in case of a spill

Preventive Measures While Processing [15]

Special Precautions

- When applying manually adhesives for:
 - chemical-resistant floor protections
 - tile
 - carpet bonding



Special masks should be worn in addition to the other recommended equipment to protect against the odour of the adhesive or against evaporation of a solvent.

- After the application of the adhesive, other operations can be additionally applied like:
 - spot welding in case of joining doors for cars
 - grinding of parts after the repair of cars.
- In such cases, special precautions need to be taken in addition like:
 - Installing a proper ventilation if thermal joining methods are applied through the adhesive
 - Wearing of dust masks during the grinding operation

Checklist- Work Safety [16], [17]

- ✓ Carry out a risk assessment considering the following steps:
 - 1) Sound assessment of possible undesirable properties of substances based on recorded data
 - 2) Determine quantities of material involved and the nature and degree of any possible contact
 - 3) Investigate whether an undesired effect of a material can be caused as a result of this contact

For each step answer this questions:

- Substance: What's the hazard? → Check Safety Data Sheet to obtain detailed information about the precautions regarding a specific adhesive
- What harm?
- What are you doing already? What improvements do you need?
- Action
- Review your assessment

Checklist- Work Safety ^[17]

✓ Adapt the production process and materials/equipment to maximize work and environment protection. Take special caution with the:

❖ DESIGN

- Compare load x safety factor and load limit
- Check if the joint has peel stresses and, if it has, verify if it's possible to avoid them
- Check if the media is harmful for the adhesive films → If it is protect it
- Check if the bonded joint has stress peaks → If so, verify if it's possible to avoid them

❖ SURFACE TREATMENT

If hazardous substances such as primers and etching solutions are used, check the safety data sheets

Checklist- Work Safety ^[17]

✓ Adapt the production process and materials/equipment to maximize work and environment protection. Take special caution with the:

❖ ADHESIVE DISPENSING

- Check if the adhesive is single part or dual → That will influence the mixing
- Choose the equipment for adhesive dispensing taking into account:
 - if the adhesive is liquid or paste
 - the dispense pattern
 - production targets
- Avoid tailing and skipping by making some adjustments to the dispensing system, like:
 - Smaller distance board/nozzle
 - Larger diameter nizzle tips
 - Lower air pressure

Checklist- Work Safety ^[17]

- ✓ Adapt the production process and materials/equipment to maximize work and environment protection. Take special caution with the:
 - ❖ CURING PROCESS
 - Choose an adequate method of cure: thermal or UV-Thermal
 - If it is thermal cure: When using $\uparrow T$, care should be taken to prevent burns
 - If it is UV-Thermal cure, control measures should be taken in order to avoid contact with eyes and skin
- ✓ Point out any health risks and explain how these risks can be avoided in each preparation step:
 - 1) Adhesive mixing at the supplier
 - 2) Packaging of the adhesive at the supplier
 - 3) Adhesive storage at the supplier or the customer
 - 4) Transferring the adhesive from the storage to the application area
 - 5) Substrate preparation
 - 6) Adhesive dispensing

Checklist- Work Safety ^[17]

- ✓ Stipulate measures for work protection such as:
 - Air extraction
 - Inhalation prevention
 - Avoid contact with the skin

- ✓ Provide first aid information

- ✓ Only use containers that are labelled in accordance with regulations

Checklist- Work Safety ^[17]

- ✓ Stipulate how waste must be disposed
- ✓ Stipulate what skin cleaning and skin-care products must be used
- ✓ Make instructions for use available
- ✓

Bibliography

[1]	A. Ö. R. D. A. L. F. M. d. Silva, Ed., Handbook of Adhesion Technology, vol. 2, Springer, 2011, p. 1000.
[2]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=3_8 . [Acedido em 31 07 2017].
[3]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=3_20 . [Acedido em 25 07 2017].
[4]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=3_23 . [Acedido em 25 07 2017].
[5]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=3_25 . [Acedido em 25 07 2017].
[6]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=3_30 . [Acedido em 25 07 2017].

Bibliography

[7]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=5_7 . [Acedido em 26 07 2017].
[8]	G. Habenicht, Applied Adhesive Bonding: A Practical Guide for Flawless Results, 4 ^o ed., Wiley-VCH, 2006, pp. 64-70.
[9]	[Online]. Available: http://www.adhesivestoolkit.com/Docu-Data/SurfacePreTreatment.xtp . [Acedido em 31 07 2017].
[10]	[Online]. Available: http://www.adhesiveandglue.com/surface-preparation.html . [Acedido em 31 07 2017].
[11]	[Online]. Available: https://www.industrialtechnology.co.uk/products--answers-on-adhesive-dispensing.html?thread=No . [Acedido em 28 07 2017].
[12]	G. R. Blackwell, Ed., The Electronic Packaging Handbook, CRC PRESS, 2000, pp. 10-12.

Bibliography

[13]	W. Andrew, Adhesives Technology Handbook, 2 ^o ed., S. Ebnesajjad, Ed., 2008, pp. 316-317.
[14]	[Online]. Available: http://www2.lbl.gov/ehs/safety/nir/assets/docs/uv/UV%20curing%20system%20safety%20tips.pdf . [Acedido em 26 07 2017].
[15]	A. Ö. R. D. A. Lucas F M da Silva, Ed., Handbook of Adhesion Technology, vol. 2, Springer, 2011, pp. 942-945.
[16]	[Online]. Available: http://www.hse.gov.uk/coshh/riskassess/workshop.htm . [Acedido em 31 07 2017].
[17]	[Online]. Available: http://onlineguide.klebstoffe.com/english/index.php?section=7_9 . [Acedido em 31 07 2017].