Suitability of Quality Management Methods for Adhesive Bonding Processes

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CINDE
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June 18 - 20
River Cree Resort & Casino
Edmonton, Alberta

Technische Universität Braunschweig

ifs Institute of Joining and Welding

Technische Universität Braunschweig
- Founded 1745

Institute of Joining and Welding
- Prof. Dr.-Ing. Klaus Dilger
- app. 60 research assistants

Research interests in NDT

Thermography
- Adhesive Bonds
- Composites
- Welds
- Riveting
- …

Computer tomography
- Void analysis in welded joints
- Stress distribution in adhesive bonds
- …

DIN 2304-1: Quality requirements for adhesive bonding processes
Part 1: Adhesive bonding process chain

„ The user must integrate this standard into a quality management system (QMS).“

DVS 3310 guideline: Quality requirements in bonding technology

„ As a basic prerequisite for the application of this guideline, the user must apply a quality management system (QMS), e.g. in accordance with
DIN EN ISO 9001.“

How can a quality management system (QMS) for adhesive bonding process be applied?

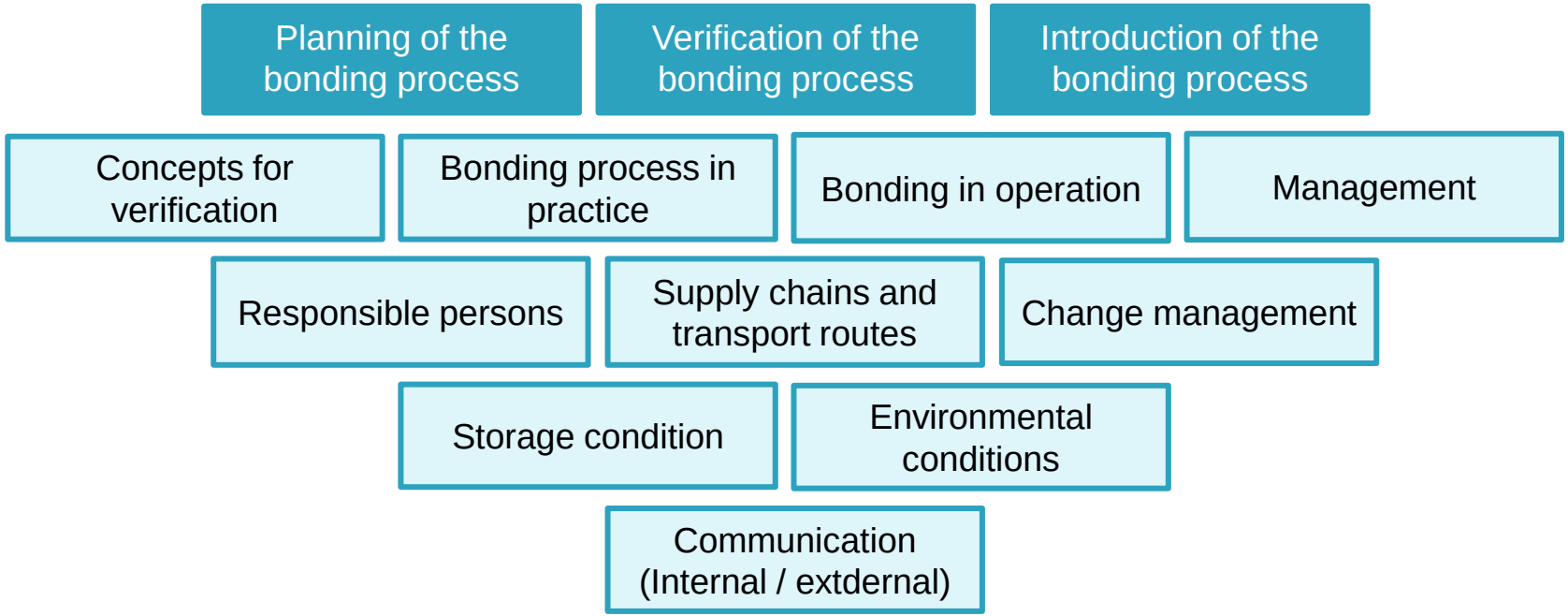
Research hypothesis

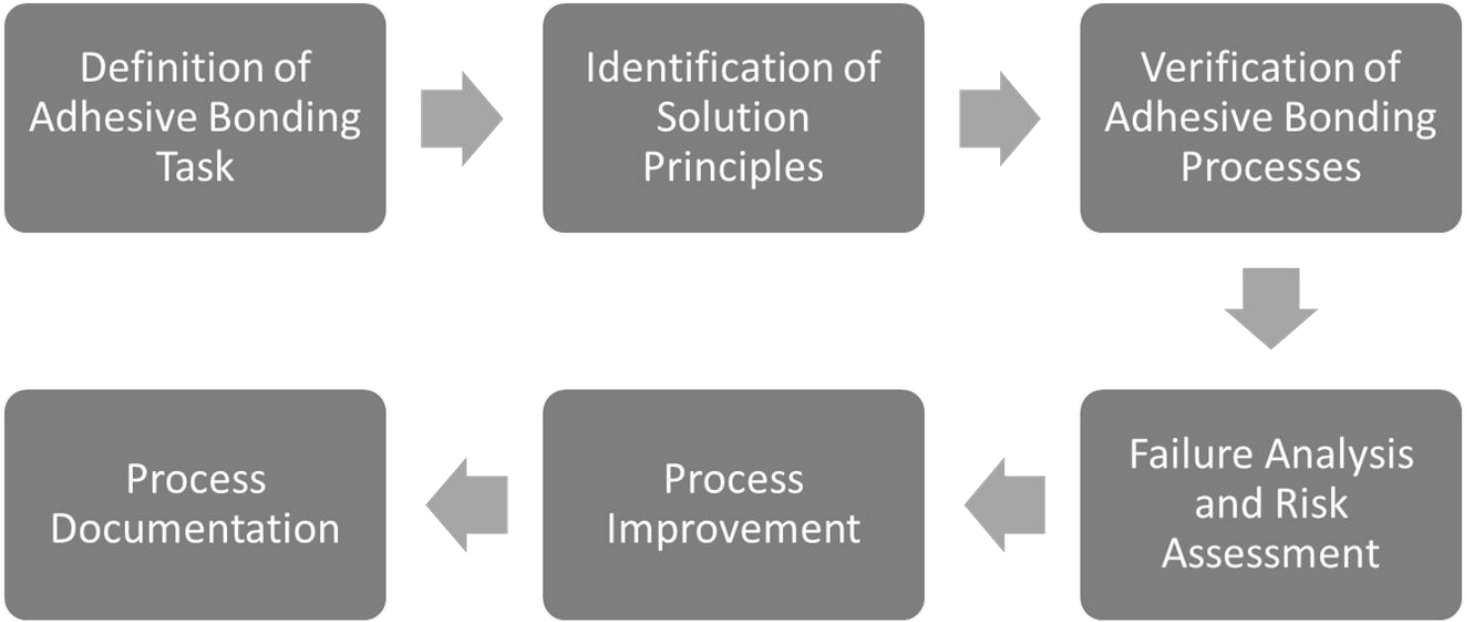
"The quality of elementary bonded structures can be assured by the application of a quality management system (QMS) tailored to the bonding process and the monitoring of defined process parameters".

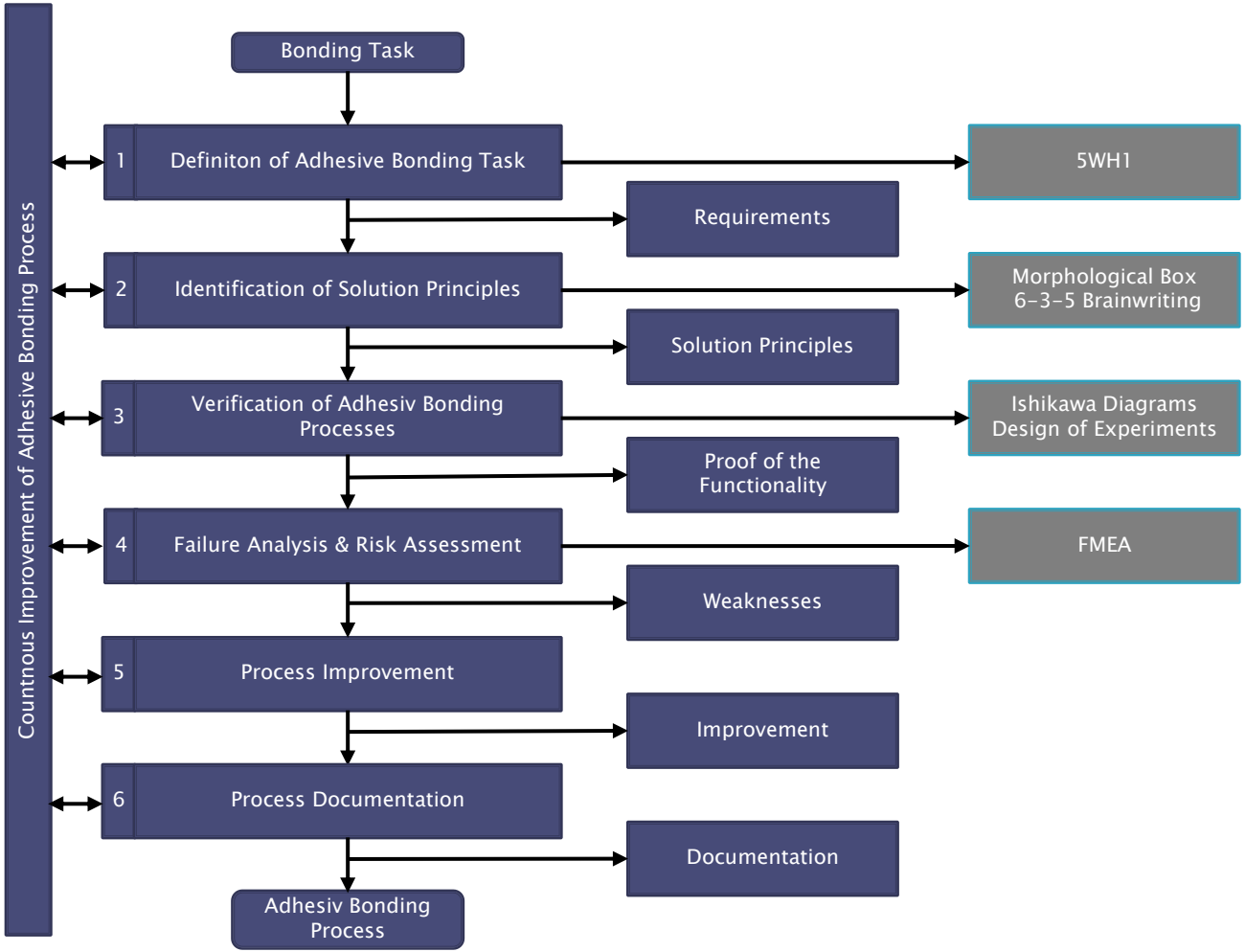
Project objectives:

- Derivation of a modular QMS for bonding technology based on the analysis of sample and real processes
- Creation of a methodology for easy identification of the process-determining parameters
- Description of the effects of parameter deviations and identification of possibilities for recording the causes on the basis of quality management methods
- Methodology for the definition of process windows for the implementation of stable bonding processes
- Securing the economic feasibility of the QMS
- Evaluation of standard methods for destructive and non-destructive testing of bonded joints and their suitability for quality assurance within the scope of a QMS
- Identification of possibilities for targeted monitoring of process parameters Translated with www.DeepL.com/Translator

Quality management systems ensure that system quality. Process quality and product quality are checked and improved within an organization. The goal of a quality management system (QMS) is a permanent improvement of the company's performance.




Definition of Adhesive Bonding Task
Identification of Solution Principles
Verification of Adhesive Bonding Processes
Failure Analysis and Risk Assessment
Process Improvement
Process Documentation


Countnous Improvement of Adhesive Bonding Process
Bonding Task
1
Definiton of Adhesive Bonding Task
5WH1
Requirements
2
Identification of Solution Principles
Morphological Box
6-3-5 Brainwriting
Solution Principles
3
Verification of Adhesiv Bonding Processes
Ishikawa Diagrams
Design of Experiments
Proof of the Functionality
4
Failure Analysis & Risk Assessment
FMEA
Weaknesses
5
Process Improvement
Improvement
6
Process Documentation
Documentation
Adhesiv Bonding Process

- Who is involved in the process planning?
- Who is responsible for the adhesive bond?
- What materials/parts should be adhesively bonded?
- Why should the materials be bonded adhesively?
- How does the production process look like?
- What production requirements have to be considered?

Requirements
and
boundaries

Mechanical, thermal, medial loads ▪ Fabrication ▪ tTansport ▪ Assembly ▪ Operation	Manufacturing process ▪ Process steps ▪ Cycle times ▪ Manufacturing environment ▪ ….	Geometry ▪ Bonding Area ▪ tolerance specifications ▪ ….
Adherends ▪ Surface condition ▪ Thermal resistance ▪ Moisture absorption ▪ Delaminations ▪ …	Requirements and boundaries	Normative requirements ▪ Safety classes ▪ Specific requirements ▪ ….
glue ▪ Application ▪ Pot life ▪ Curing ▪ …	Responsibilities ▪ Project leader ▪ Overall project ▪ Input ▪ ….	functions ▪ Thermal insulation ▪ Corrosion protection ▪ Conductivity ▪ ….

Morphological box

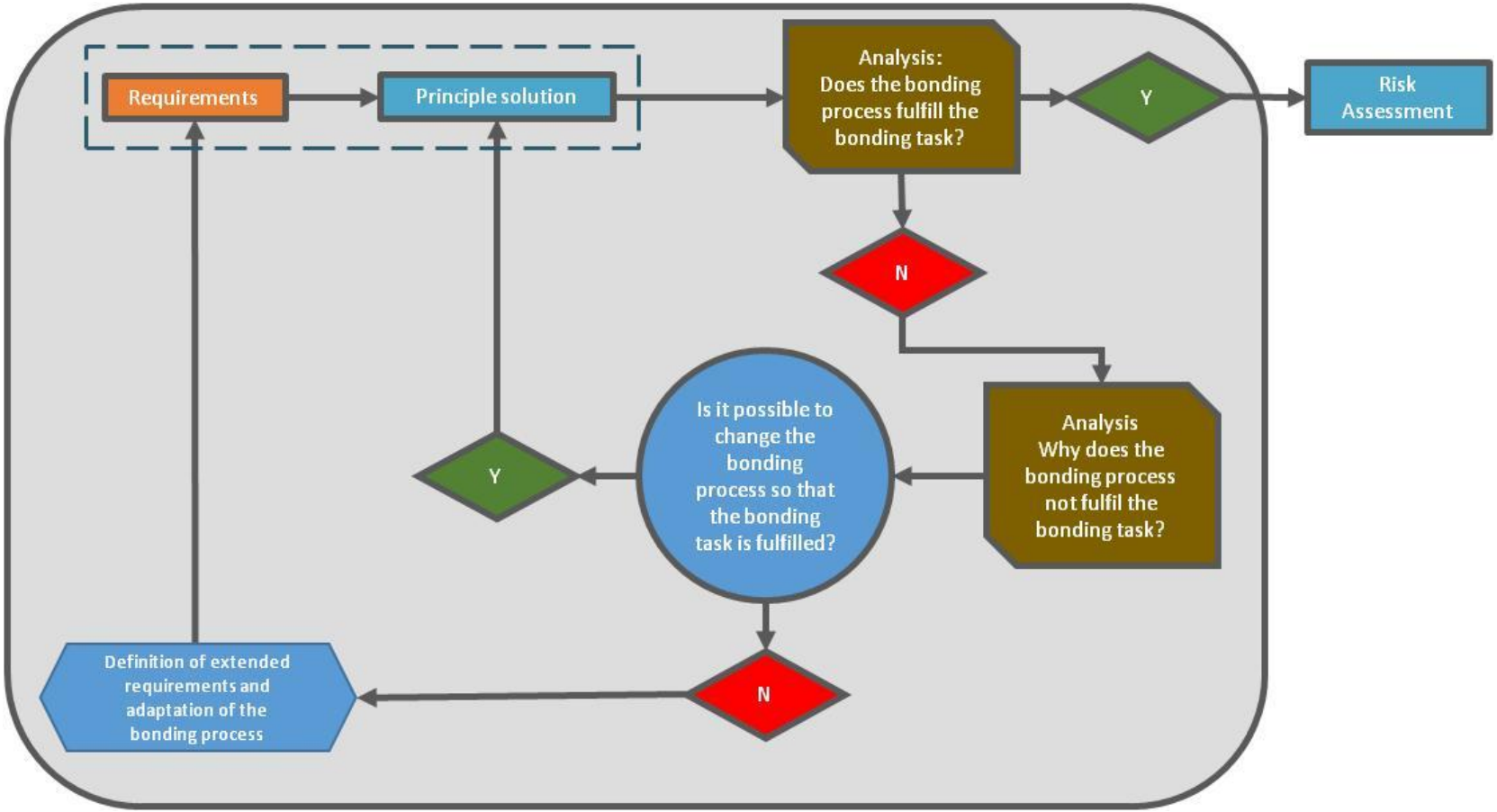
Approach
1.) Identification of adhesive
2.) Identification of surface pre-treatments
3.) Identification of application technique
4.) Identification of curing process

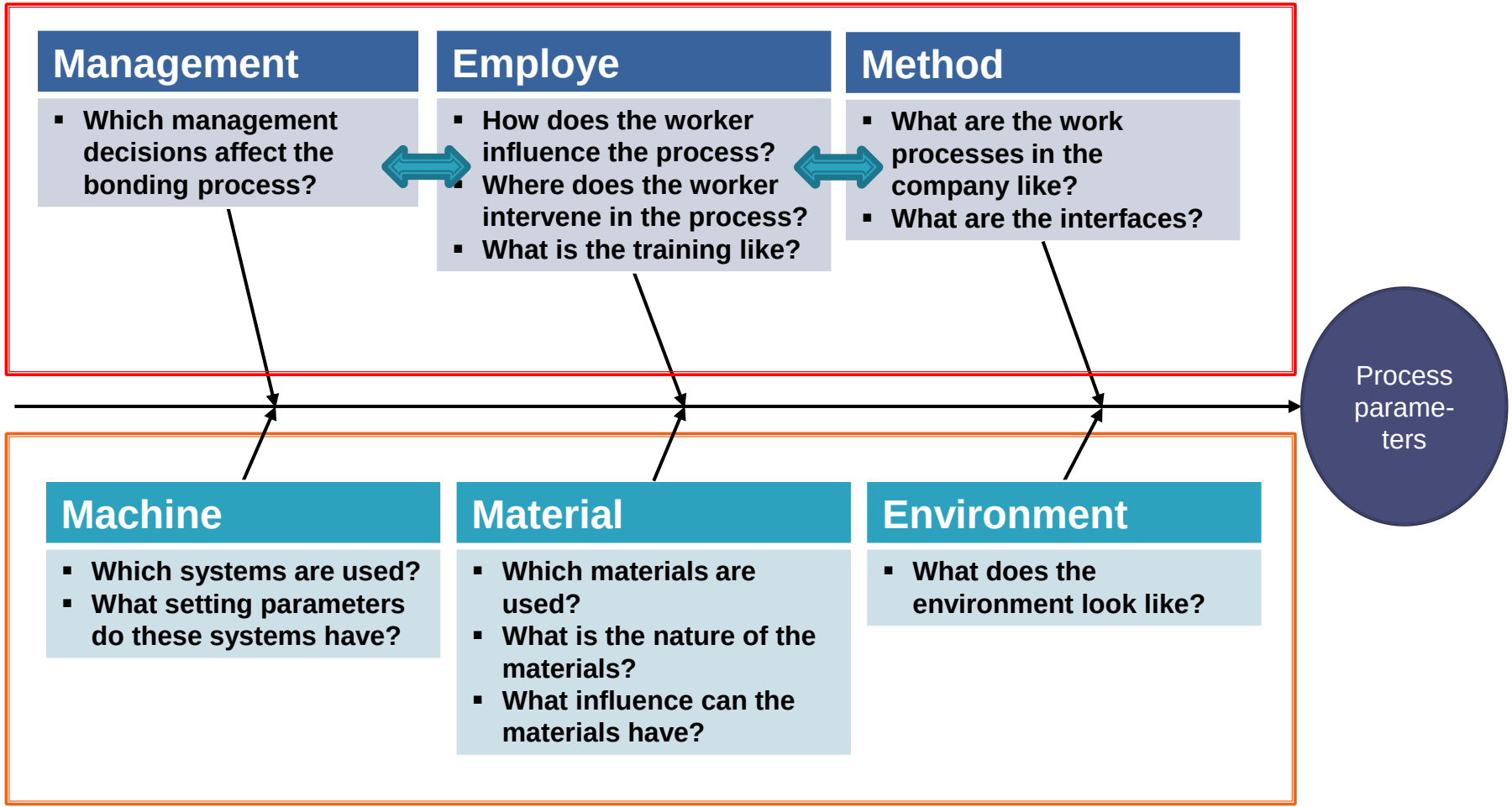
+ Many solution principles
+ Identification of new solutions
- Selection of most significant solution may be difficult

6-3-5 Brainwriting

Approach
1.) Development of initial solutions
→ 3 ideas by 6 participants
2.) Continuous refinement of the ideas
→ Identification of curing process

+ Easy documentation
+ All ideas are respected
- Overlap of solutions → limited number of Solutions

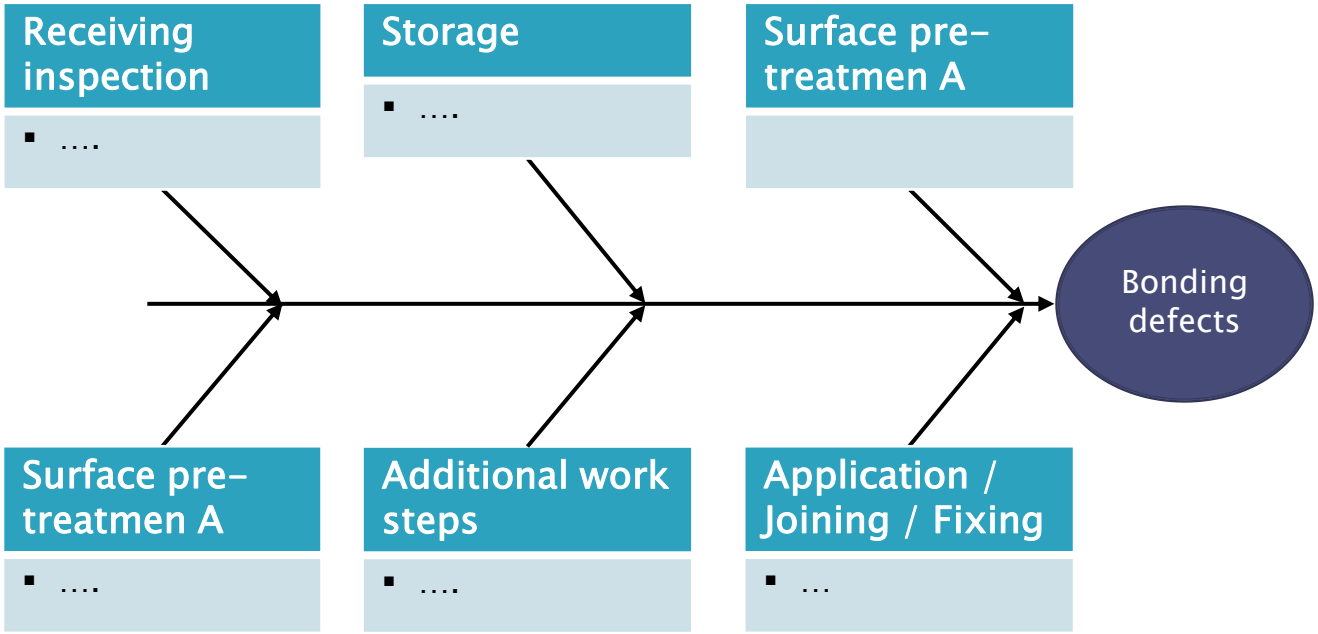

Requirements
Principle solution
Analysis:
Does the bonding process fulfill the bonding task?
Y
Risk Assessment
N
Analysis
Why does the bonding process not fulfil the bonding task?
Is it possible to change the bonding process so that the bonding task is fulfilled?
Y
N
Definition of extended requirements and adaptation of the bonding process

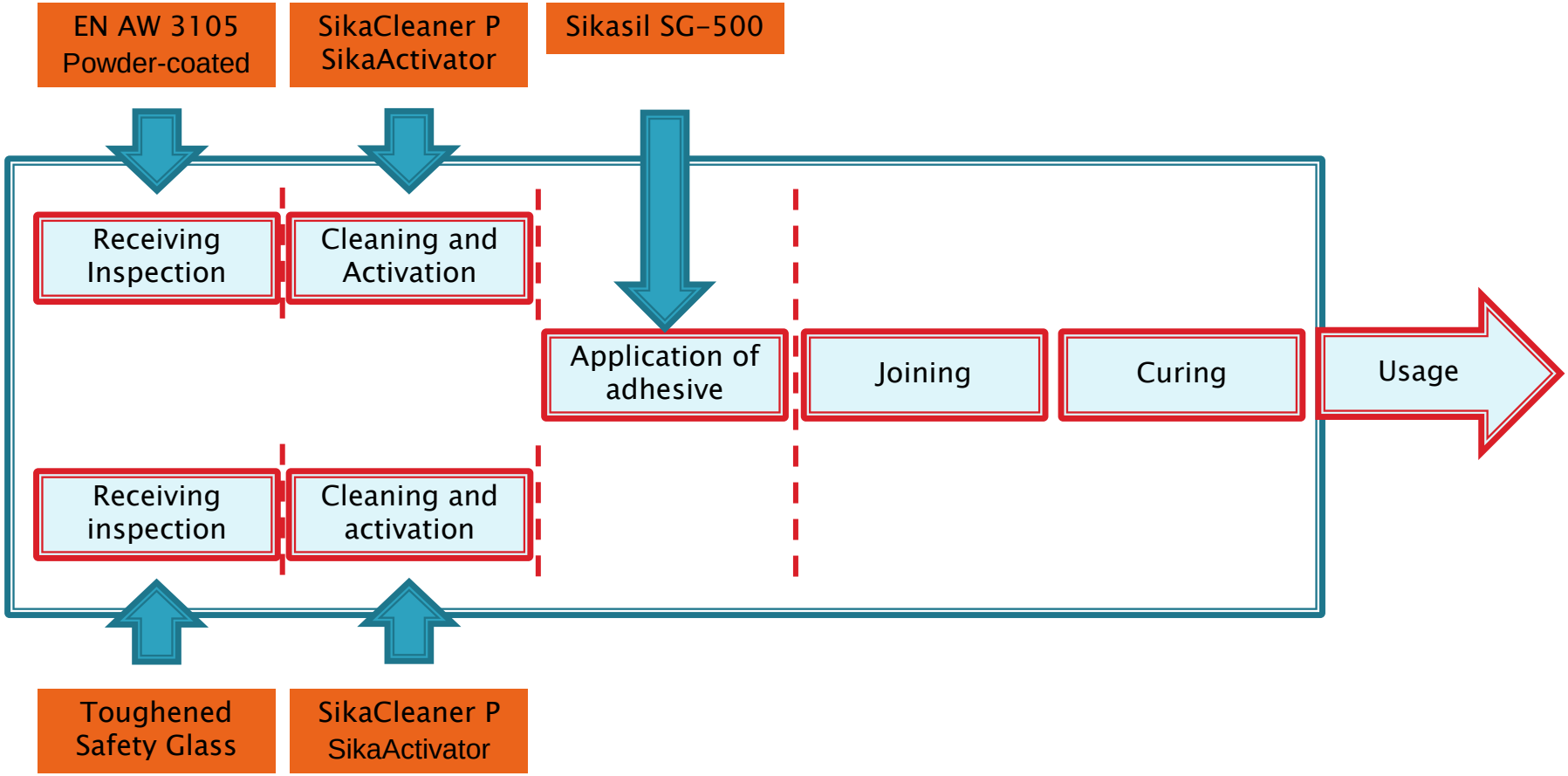

Management
Which management decisions affect the bonding process?
Employe
How does the worker influence the process?
Where does the worker intervene in the process?
What is the training like?
Method
What are the work processes in the company like?
What are the interfaces?
Process parame-ters
Machine
Which systems are used?
What setting parameters do these systems have?
Material
Which materials are used?
What is the nature of the materials?
What influence can the materials have?
Environment
What does the environment look like?

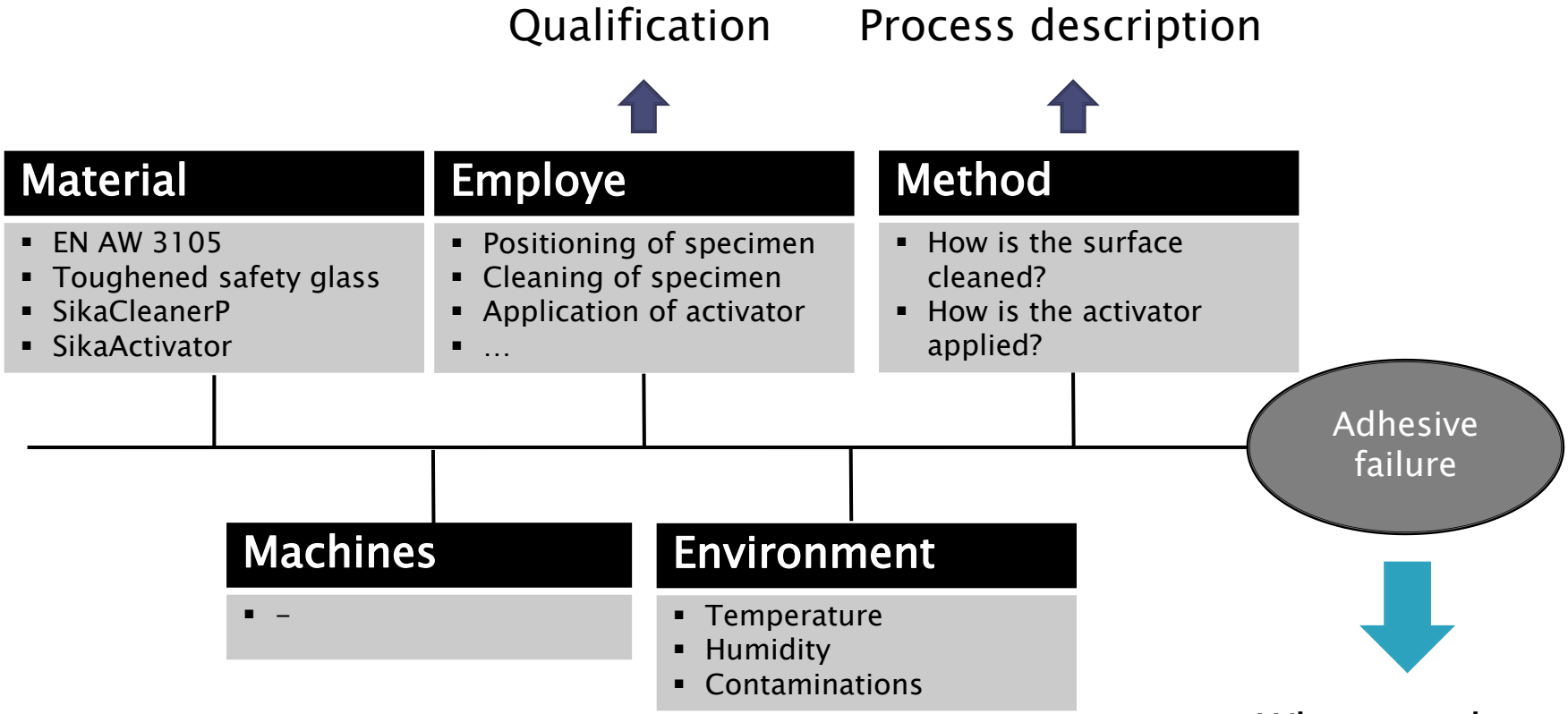
Subdivision of the process into incremental process steps

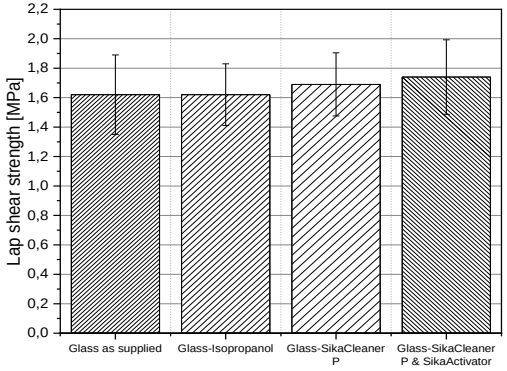
Separate consideration of each incremental process step

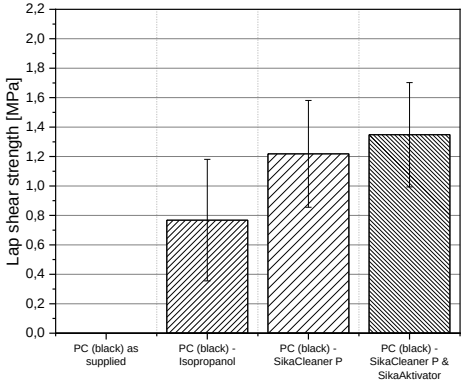
Questions:
What can happen?
What are the effects?
What is the cause of the error?

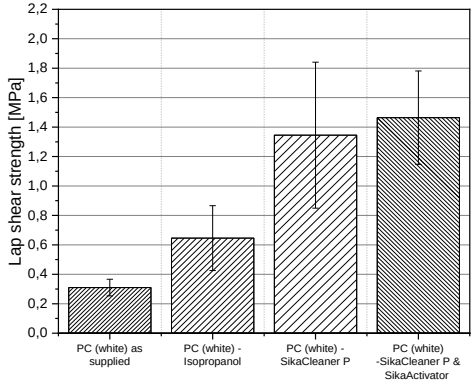



EN AW 3105
Powder-coated
SikaCleaner P
SikaActivator
Sikasil SG-500
Receiving Inspection
Cleaning and Activation
Application of adhesive
Joining
Curing
Usage
Receiving inspection
Cleaning and activation
Toughened Safety Glass
SikaCleaner P
SikaActivator


Qualification
Process description
Material
EN AW 3105
Toughened safety glass
SikaCleanerP
SikaActivator
Employe
Positioning of specimen
Cleaning of specimen
Application of activator
…
Method
How is the surface cleaned?
How is the activator applied?
Adhesive failure
Machines
–
Environment
Temperature
Humidity
Contaminations
What are the worst conditions?







Zusammenfassung

- Differences in the influencing parameters become clear
- Glass is more "tolerant" to the solvent used
- Activator improves adhesion of glass only minimally
- Bonding of powder coating is critical

Basis for risk assessment

- Which factor has which influence?
- Is the adhesive factor an exclusion criterion?
- How strongly do the results scatter?
- How high is the measuring accuracy?
- Can the error be detected in the process?

Continuous update based on experiences and process improvements

Probability of appearance P

Severity S

Probability of detection D

Risk priority number (RPN)

Improvement of measure techniques

Adherends	Fault				
Glass	No surface pre-trea				
Glass	Use of wrong cleane				
Glass	No activator	2	1	1	2
PC (white)	No surface pre-treatment	2	5	5	25
PC (white)	Use of wrong cleaner and no activator	2	4	5	40
PC (white	No activator	2	2	1	4
P	No				
P	se				
PC (black	No				

Basis for the implementation of a functioning QMS

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Thank you for your attention!

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