**Production Stakeholders & Questions (VDI 2206)**

Quality Manager

Prod.Sys. Engineers
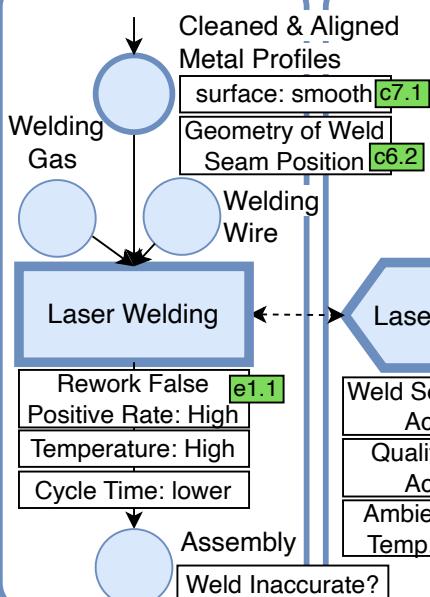
Stakeholder questions:

Resource function: When is the **Rework Selection False Positive Rate** high?
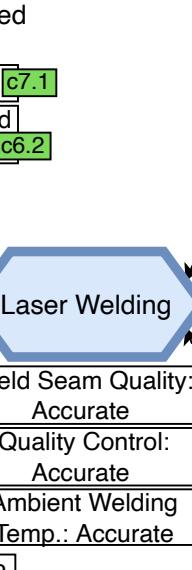
Production quality: Why is the **Welding issue rate** high?

Product, Process & Resource Assets (PPR, PAN, VDI 3682) with Logistics for a Flexible Production System

Products & Processes

Cleaned & Aligned Metal Profiles
- surface: smooth `c7.1`
- Geometry of Weld Seam Position `c6.2`

Welding Gas

Welding Wire

Laser Welding

- Rework False Positive Rate: High `e1.1`
- Temperature: High
- Cycle Time: lower

Assembly

Weld Inaccurate?

Process Skills

Laser Welding

- Weld Seam Quality: Accurate
- Quality Control: Accurate
- Ambient Welding Temp.: Accurate
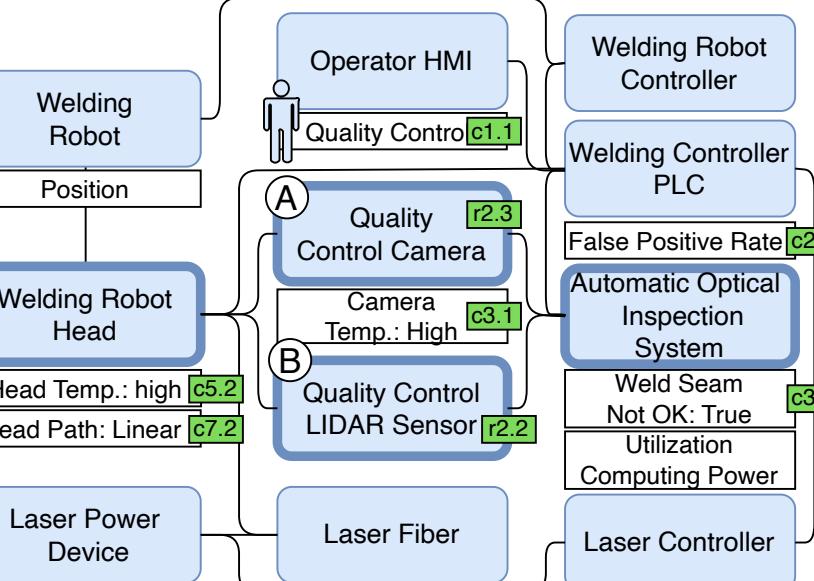
Manufacturing Resources

Welding Robot

- Position

Operator HMI
- Quality Control `c1.1`

Welding Robot Controller

Welding Controller PLC
- False Positive Rate `c2.1`

Welding Robot Head
- Head Temp.: high `c5.2`
- Head Path: Linear `c7.2`

(A) Quality Control Camera `r2.3`
- Camera Temp.: High `c3.1`

(B) Quality Control LIDAR Sensor `r2.2`

Automatic Optical Inspection System
- Weld Seam Not OK: True `c3.2`
- Utilization Computing Power

Laser Power Device

Laser Fiber

Laser Controller

Production Data Space (PDS, VDI 2206)

Production system variability model and configurations `r2.3` `r2.2`

Product AAS: Profile `c7.1` `c6.2`

Resource AAS: Welding Robot `c5.2` `c3.1`
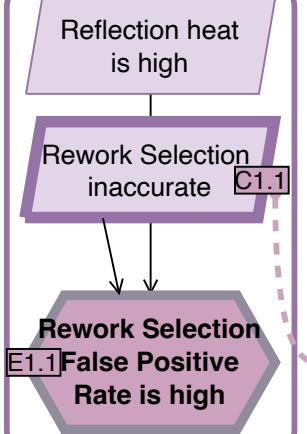
Resource AAS: Automatic Optical Inspection System `c3.2` `c3.1` `c2.1`

Production Operation Data
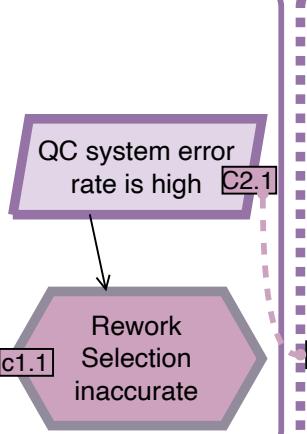
Process Recipes (required accuracy)

FMEA Cause & Effect Network (CEN, DIN 60812)

Process Laser Welding

Reflection heat is high

Rework Selection inaccurate `C1.1`

Rework Selection False Positive Rate is high `E1.1`
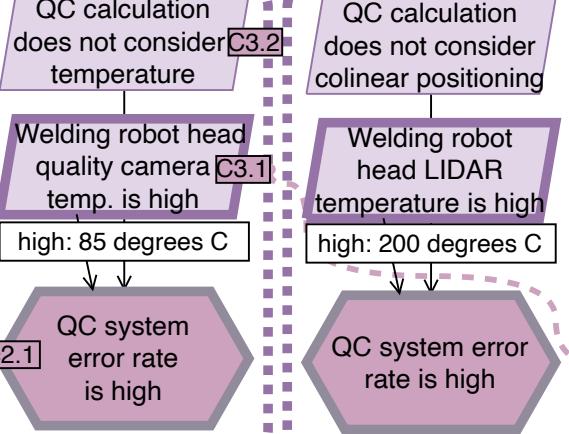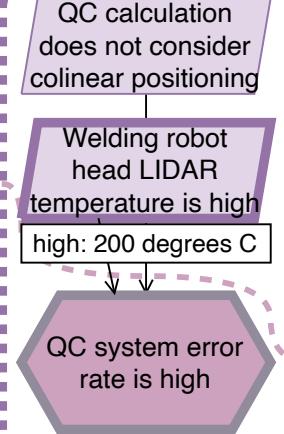
Process Laser Welding Skills

QC system error rate is high `C2.1`

Rework Selection inaccurate `c1.1`
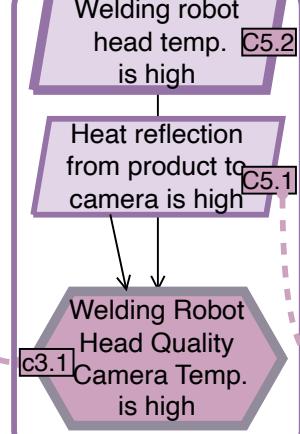
(A) Welding Seam Inspect. Sys. w/camera

QC calculation does not consider temperature `C3.2`

Welding robot head quality camera temp. is high `C3.1`

high: 85 degrees C

QC system error rate is high `c2.1`
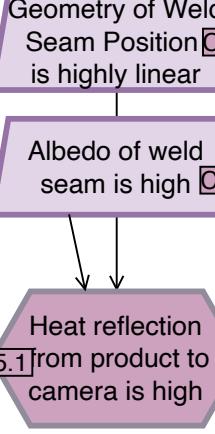
(B) Welding Seam Inspect. Sys. w/LIDAR

QC calculation does not consider colinear positioning

Welding robot head LIDAR temperature is high

high: 200 degrees C

QC system error rate is high
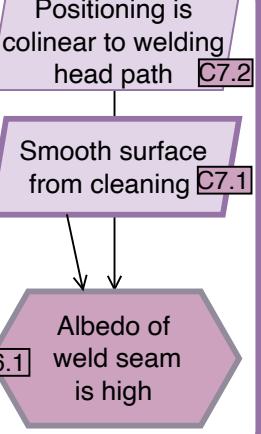
Welding System Resource with camera

Welding robot head temp. is high `C5.2`

Heat reflection from product to camera is high `C5.1`

Welding Robot Head Quality Camera Temp. is high `c3.1`

Input Products

Geometry of Weld Seam Position is highly linear `C6.2`

Albedo of weld seam is high `C6.1`

Heat reflection from product to camera is high `c5.1`

Pre-Processing

Positioning is colinear to welding head path `C7.2`

Smooth surface from cleaning `C7.1`

Albedo of weld seam is high `c6.1`

Legend:

Cause

Effect

CEN Concept

PPR/PDS Property

Product Asset

Process Asset

Resource Asset

Production Data Asset

Dependency Links: (arrows are marker pairs):
- ← Product-Process
- ⇠ Process-Resource
- → Cause-Effect

`e1.1` `E1.1` PPR-to-CEN Dep.
`c2.1` `C2.1` PDS-to-CEN Dep.
`c1.1` `C1.1` CEN Dependencies

Upper case letter marks *arrow head*; *Lower* case letter marks *arrow base*.