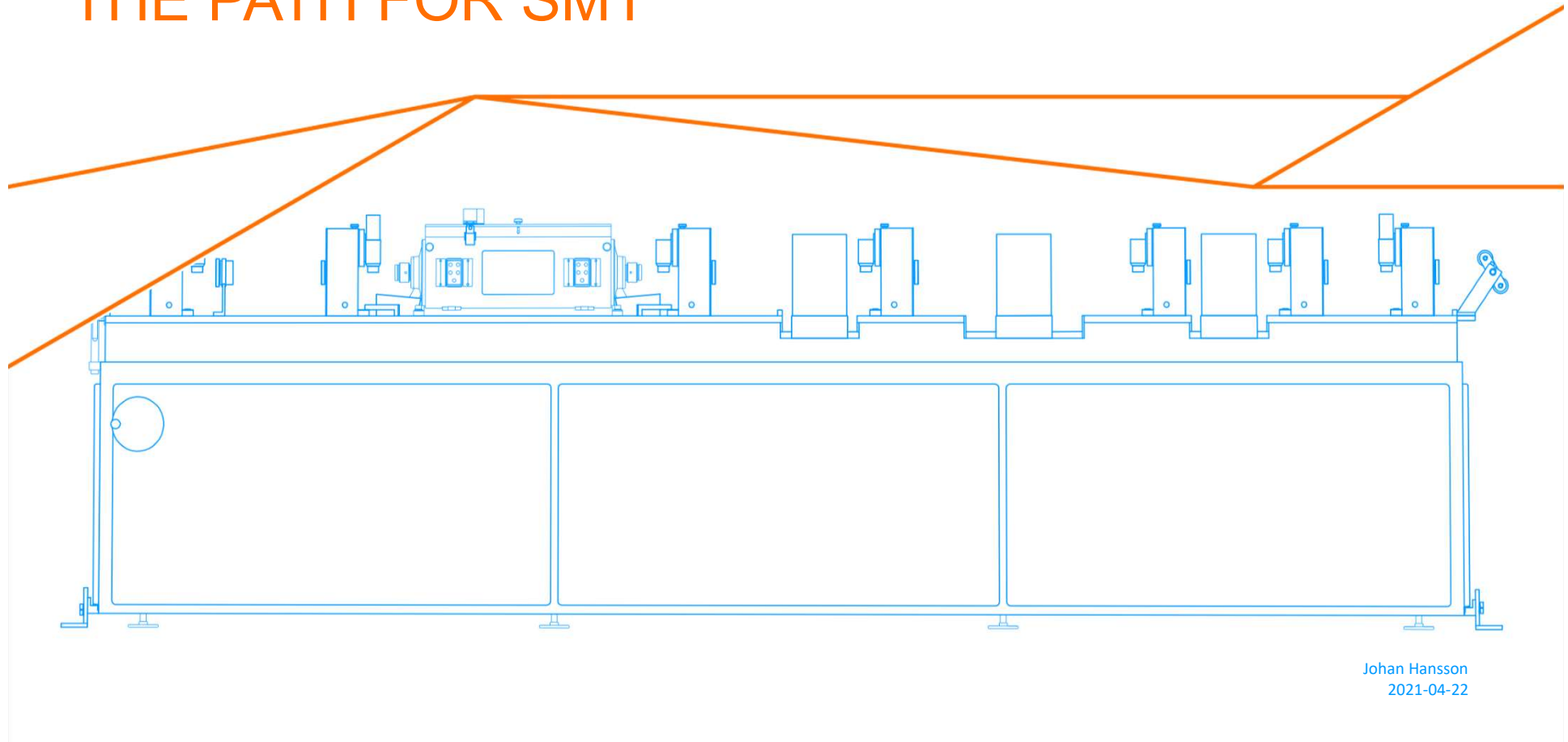


NDE 4.0

THE PATH FOR SMT



Johan Hansson
2021-04-22



SANDVIK MATERIALS TECHNOLOGY

OUR INDUSTRY OFFERING

SUPPLYING PRODUCTS FOR THE MOST DEMANDING INDUSTRIES



NUCLEAR POWER
GENERATION



RENEWABLE
ENERGY



OIL & GAS



CHEMICAL



INDUSTRIAL
HEATING



AEROSPACE

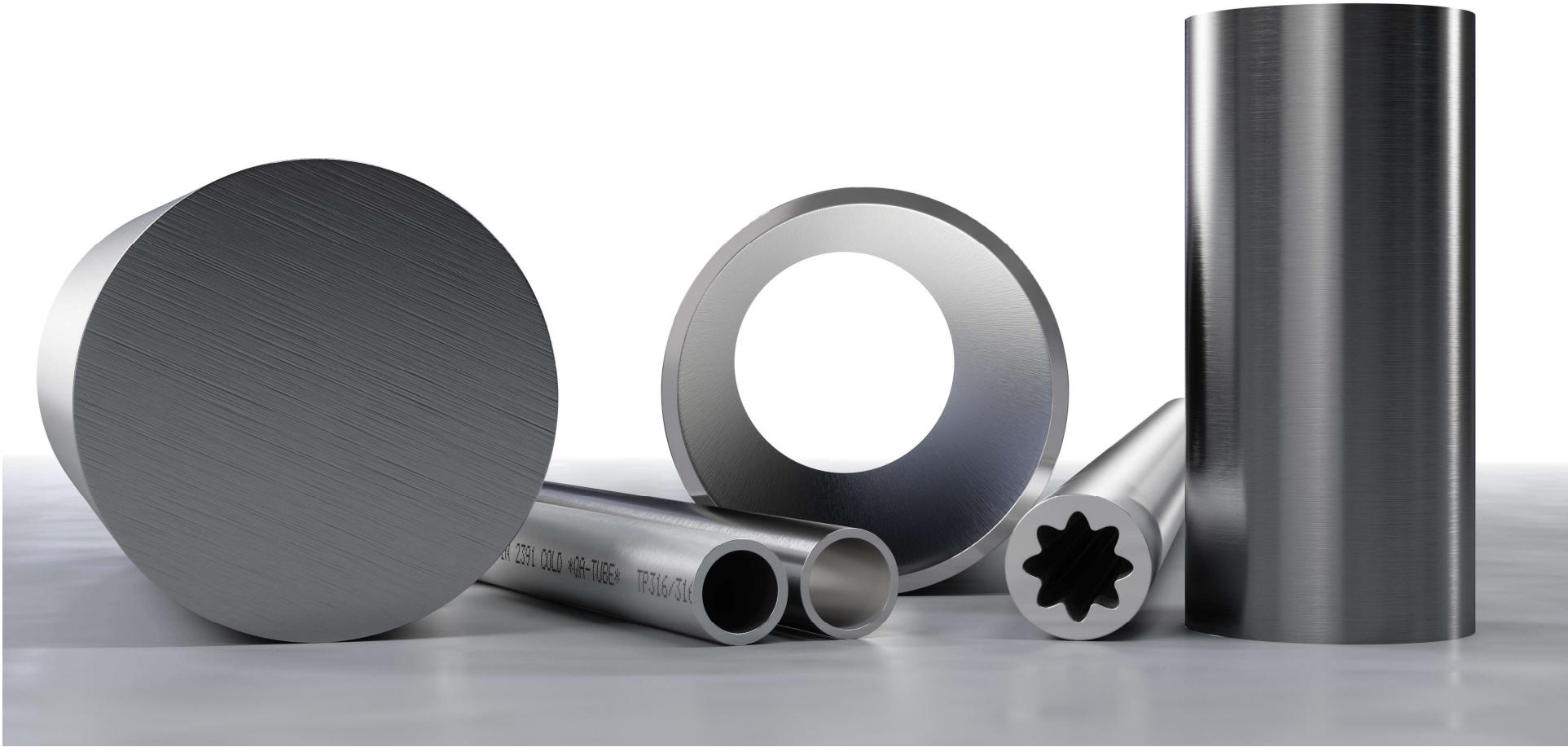


AUTOMOTIVE



MEDICAL







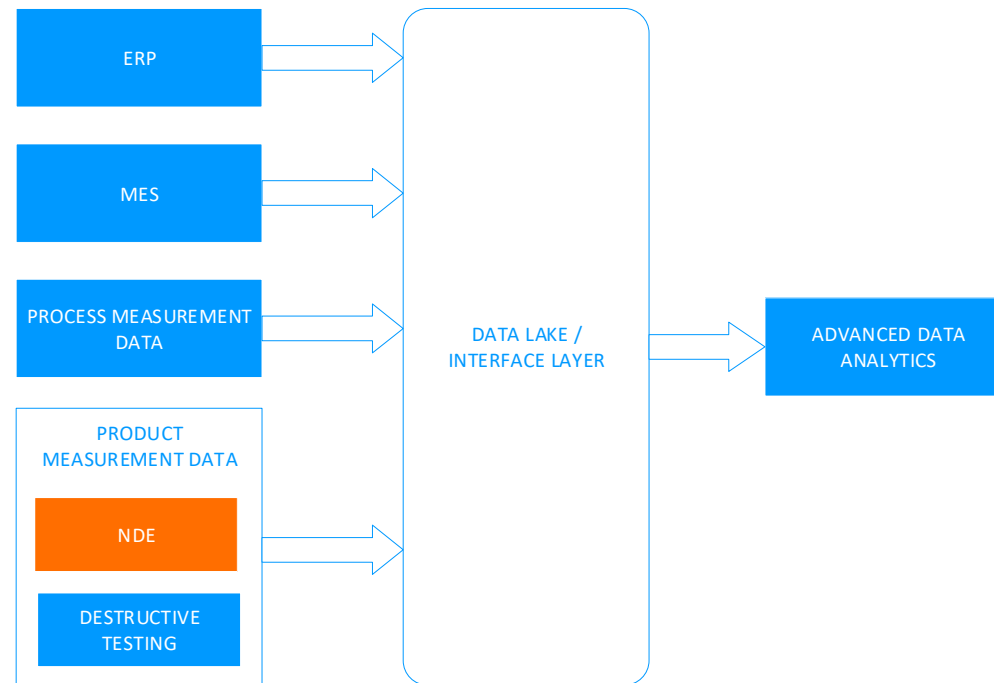
BACKGROUND


SMT AND NDE

- SMT are using NDE inline in production – UT, ET, RT, PT, VT
- Primarily testing using automated NDE lines
- Usually, 100% testing
- A diverse production environment with many systems and suppliers
- Still heavy reliance on qualified personnel to run machines and review all NDE data (to fulfil customer and standard requirements)
- Ongoing automation and digitalization for decades

- SMT sees NDE 4.0 a way to using analytics and machine learning for process improvement and fully automated production

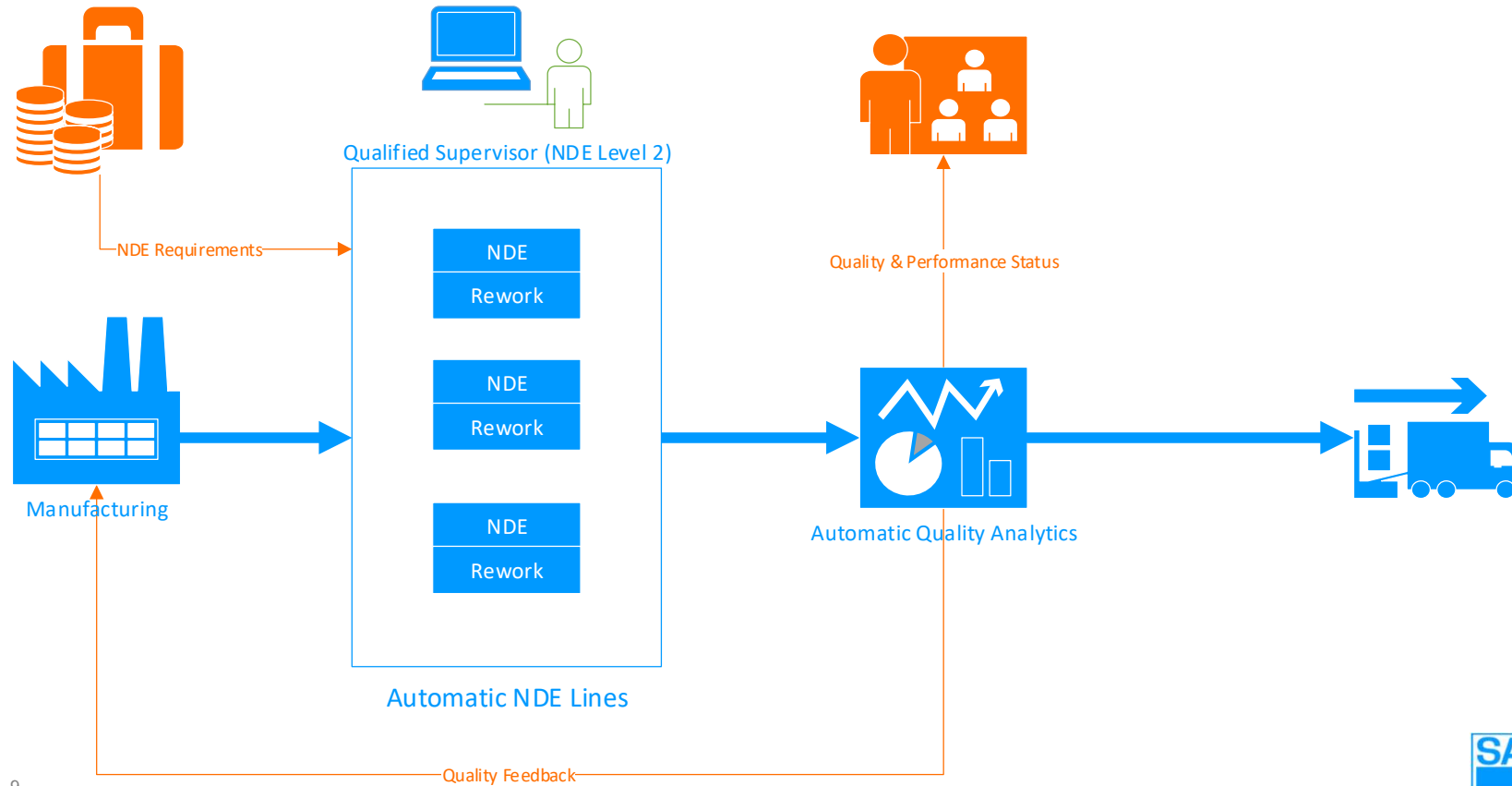
NDE IN INDUSTRY 4.0



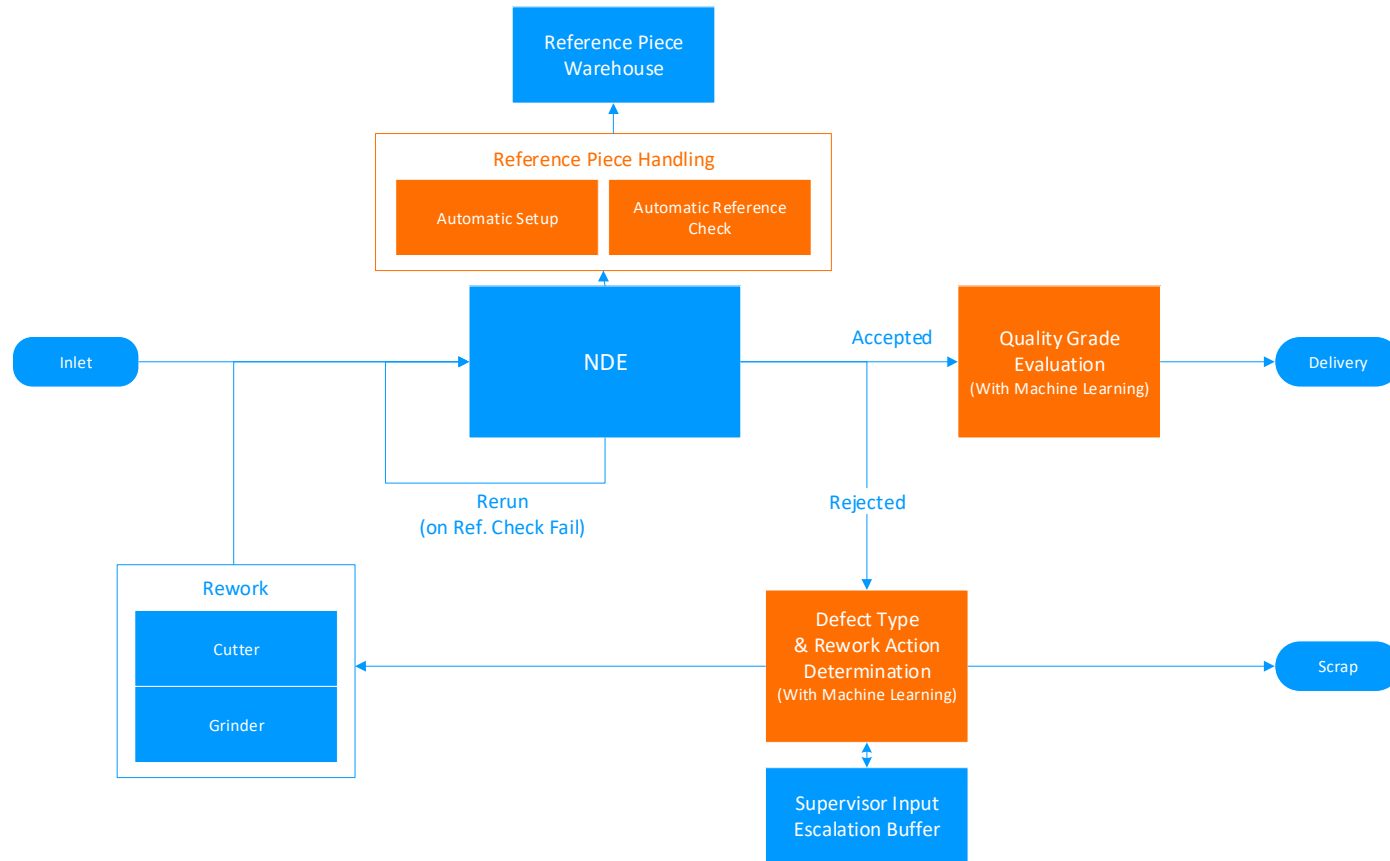


NDE 4.0 - VISION

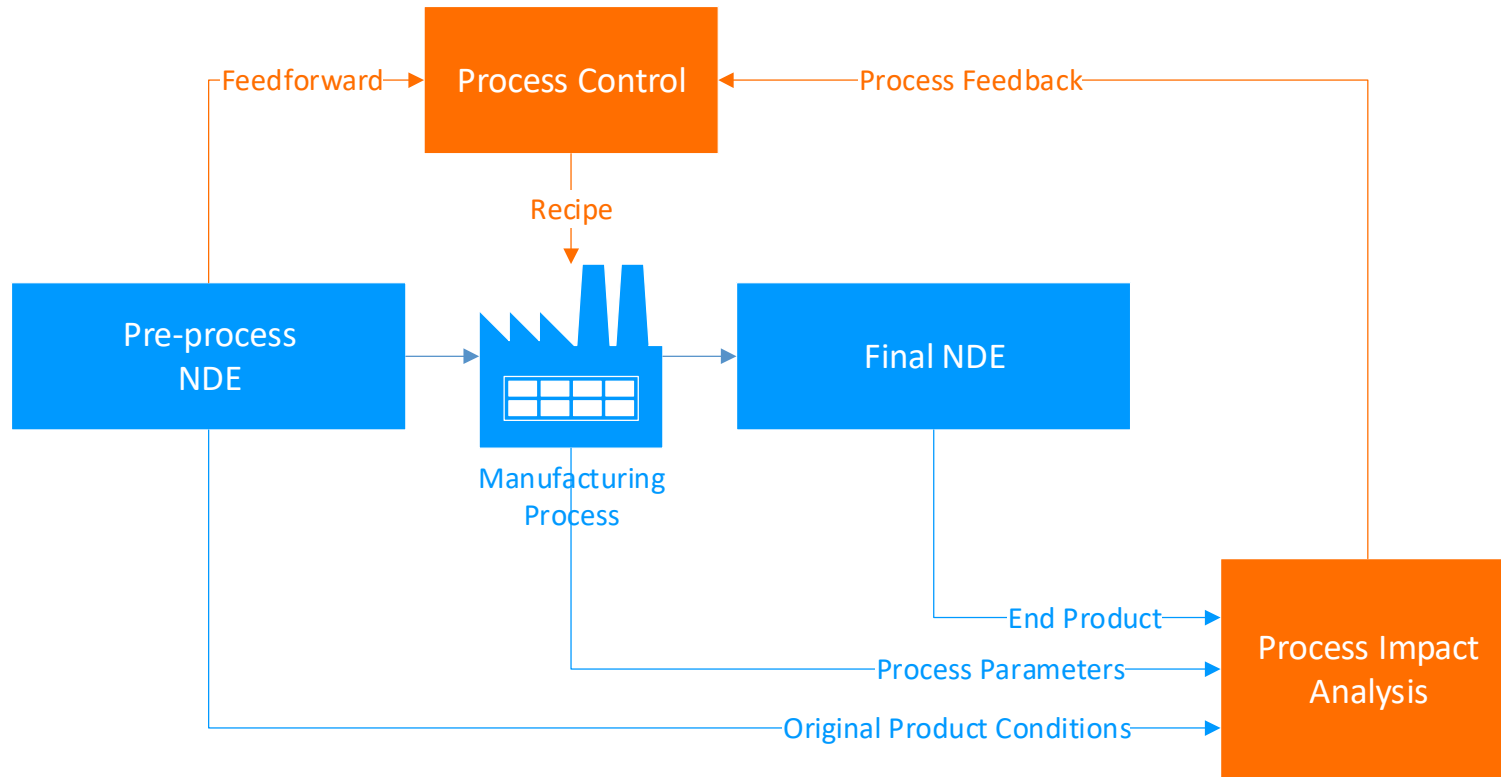
OVERVIEW



FULLY AUTOMATED NDE LINE



NDE FOR CONTINUOUS PROCESS IMPROVEMENT





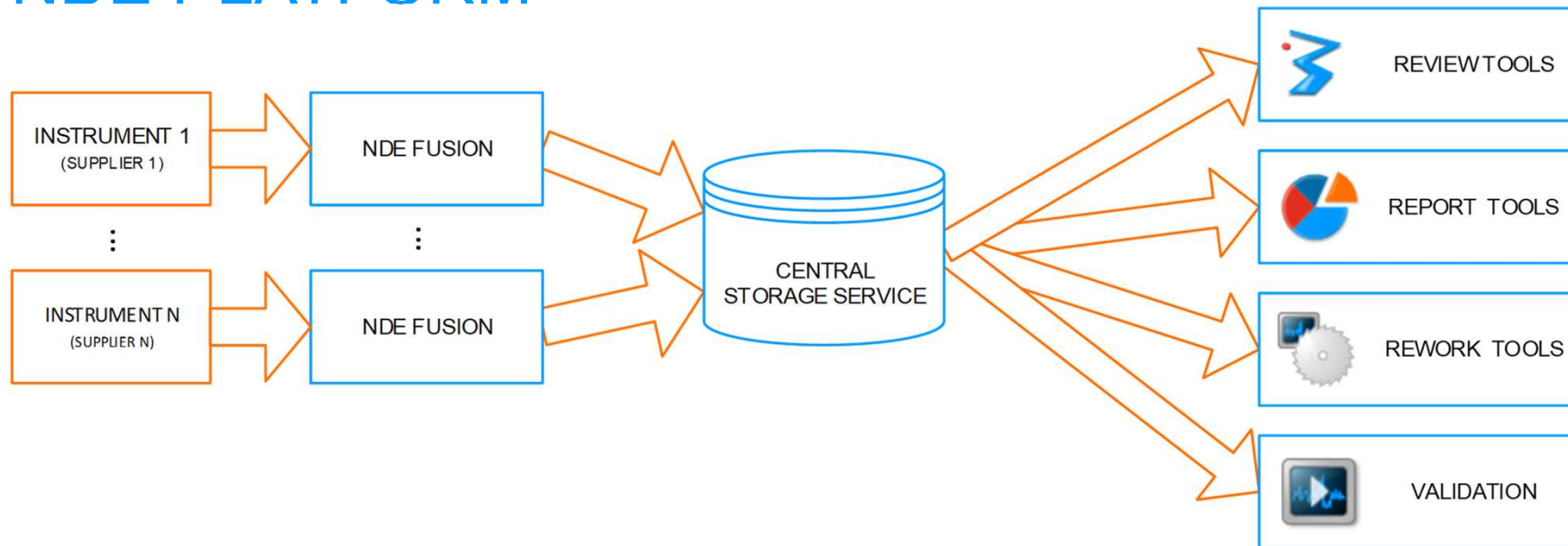
FOUNDATIONS

REQUIREMENTS AS FOUNDATION

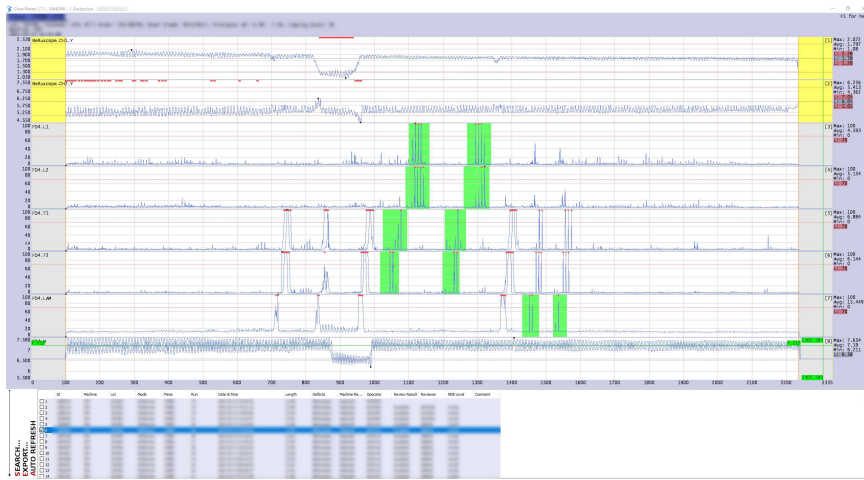
- Identity tracking on individual pieces throughout all production steps
- Common way of storing NDE data
- Seamless interconnectivity with MES & SCADA

- Note that in reality the production environments are a never going to adhere single common systems
 - More feasible to create adaptor layer

NDE PLATFORM



NDE PLATFORM



The screenshot shows the NDE REPORTS application window. The title bar reads "NDE Reports 1.18.1". The main header includes the SANDVIK logo and "NDE REPORTS". Below this, there are fields for "Machine/Station" (354) and the user name "Johan L Hansson - ds81917 (Level3) + Admin". The interface is divided into several sections:

- Reports**: A list of report types including Lot Summary, Lot Summary (SCPT), Mill Order Summary, Reference Check Report, Log Book, Log Book (SCPT), Machine Run List, Machine Usage Report, Channel Statistics, Histogram Report, Raw Data Export, and SZ Reports.
- Work Order**: A section for configuring report parameters, including a "Year" dropdown set to 2021 and a "Save Report" button.
- Measurement Statistics**: A section with checkboxes for including various data elements like Defect Summary, Piece List, Test Run History, Machine Parameters, Review Information, and Strip Charts.
- Queue**: A section with "Add" and "Run" buttons.



LESSONS LEARNED FROM PLATFORM

- Modular adaptors have made it possible to introduce platform without extensive changes to other systems
 - Less development cost
 - Faster introduction times
 - More acceptance in local organizations
- Platform have functions that means direct benefits in production and possible analytics have been bonuses
 - Business cases on direct benefits
 - Acceptance high among end-user since direct benefits
 - The enabled analytics have been a welcome bonus

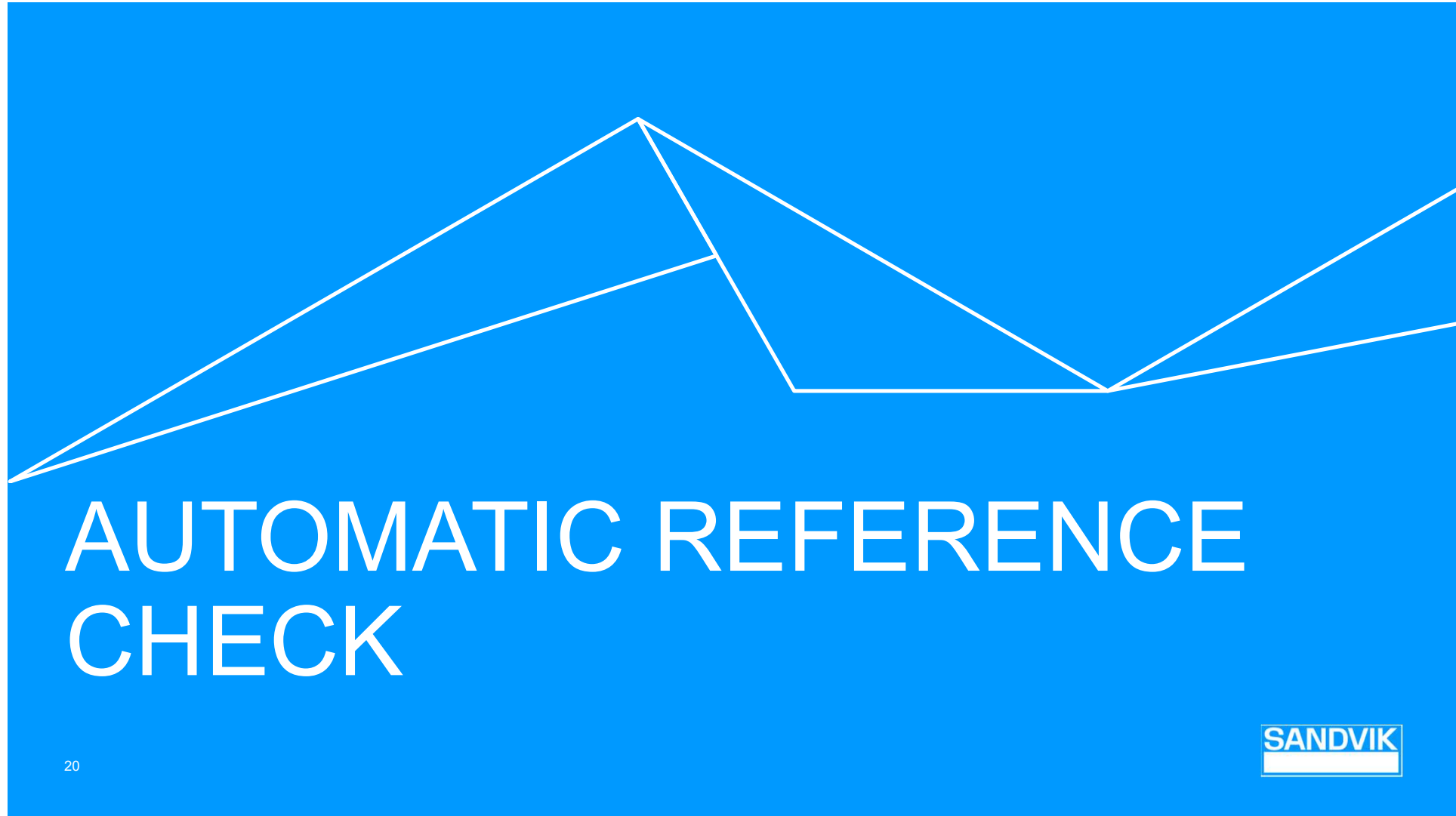
LEASSONS LEARNED FROM PLATFORM

- Have a long-term plan towards NDE 4.0 but implement it in small clear steps that are immediately useful

PROGRESS

WORK ON NDE 4.0 UNTIL NOW

- Some progress was made in investigating and developing features for NDE 4.0
 - Automatic reference checks
 - Machine Learning for evaluating NDE measurements

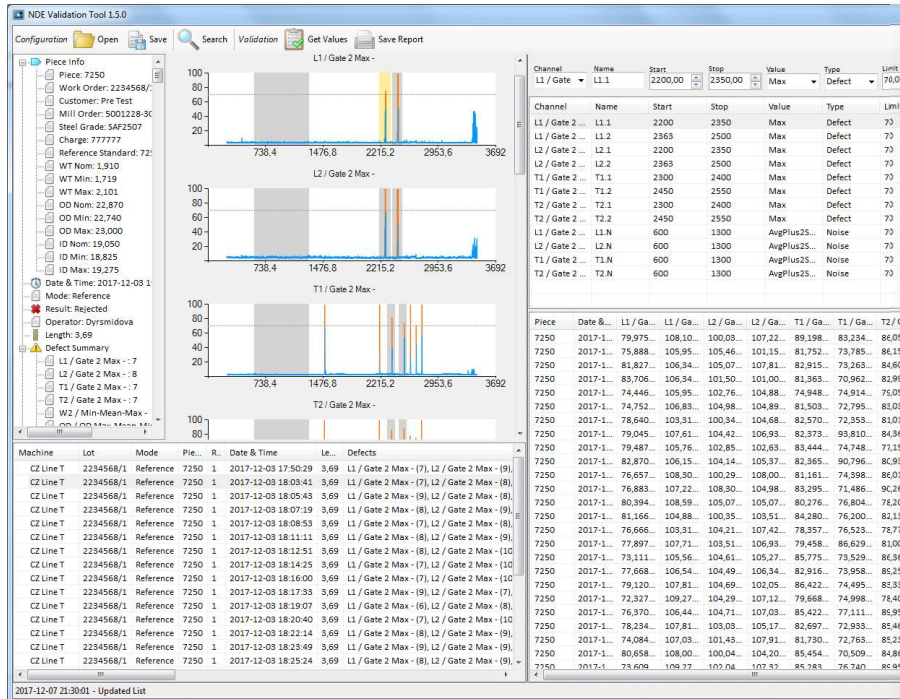


AUTOMATIC REFERENCE CHECK

SUPPORT ZONES FOR REFERENCE REVIEW



MACHINE PERFORMANCE VALIDATION



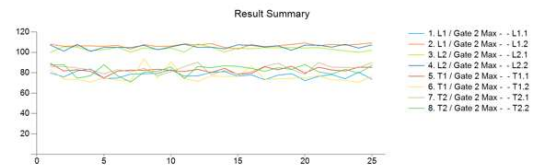
AB SANDVIK MATERIALS TECHNOLOGY
NDE VALIDATION REPORT

NDE VALIDATION REPORT 2017-12-07

Machine CZ Line T
 Piece 7250
 Date & Time 2017-12-03 17:50:29 - 2017-12-03 18:41:54
 Number of runs 25

RESULT SUMMARY

Channel	Defect	Capability	Average	Standard Deviation	Least Additional Gain	SNR(Min)
L1 / Gate 2 Max - L1.1	L1.1	1.517	77.820	3.019	1.524	14.328
L1 / Gate 2 Max - L1.2	L1.2	4.138	106.808	1.518	1.080	20.384
L2 / Gate 2 Max - L2.1	L2.1	2.947	103.310	2.062	1.393	15.295
L2 / Gate 2 Max - L2.2	L2.2	3.042	105.400	2.038	1.403	15.478
T1 / Gate 2 Max - T1.1	T1.1	1.707	82.586	2.847	1.525	21.021
T1 / Gate 2 Max - T1.2	T1.2	0.770	76.390	5.834	2.685	20.529
T2 / Gate 2 Max - T2.1	T2.1	1.305	83.784	3.777	1.996	24.306
T2 / Gate 2 Max - T2.2	T2.2	1.020	82.445	4.756	2.412	22.383

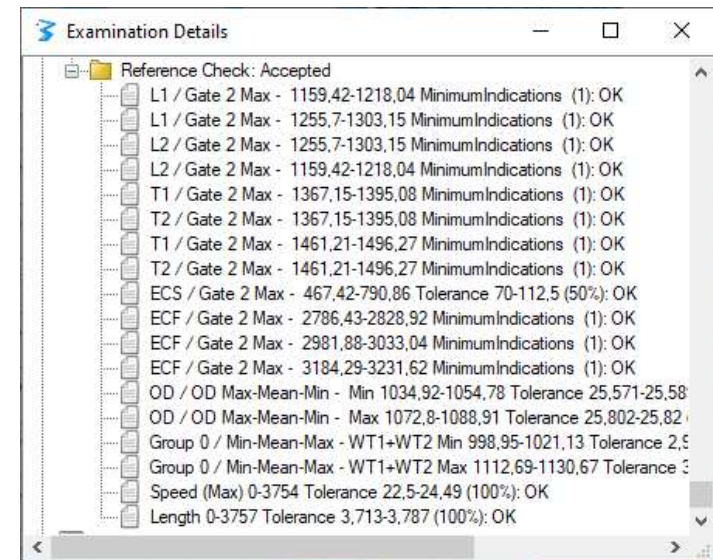


USE ZONES IN MACHINE

- Let machine use the check zones to automatically evaluate reference runs
 - Gets the zones that was set up in review tool
 - In long run, set up zones based on requirements and reference piece definition
- Sort piece according to evaluation. Allows for fully automated reference check where production runs could continue if accepted check
- Indication max value can be retrieved for automatic performance validation

FEASIBILITY PILOT

- During all of 2020 Pilot study have been made with the system running on a few selected NDE lines.
- Reference runs automatically evaluated according to zones (in the background)
- Result stored but no sorting active
- Comparison with Inspector result to evaluate accuracy and feasibility to use the zones



SUMMARY OF PILOT

- Very high correspondence between reference check and inspector
- Still needs additional zone type for end blocking indications
- Overall, the use of automatic reference check for production is feasible



MACHINE LEARNING FOR NDE EVALUATION

MACHINE LEARNING FOR NDE

- Machine learning already in use for evaluating image and video type of data
 - SMT is using machine learning system for evaluation X-ray images of welds. After a training period the system was shown to be at least as effective as a human inspector
 - Ongoing project for video inspection of tube surfaces.
- Most of NDE at Sandvik are UT and EC and are presented and stored as graph-type data.
 - As most machine learning/pattern recognition systems are focused on images, the used of these systems on UT and EC data must be evaluated.

DEFECT TYPE & REWORK ACTION

- Machine Learning for Evaluating and Categorizing Non-Destructive Examination Results
- Investigate possibilities of using machine learning to:
 - Evaluate the data to determine if it is Accepted or Rejected
 - Evaluate the data to determine quality index
 - Assess if the piece can be repaired or shall be scrapped
 - Categorize the type of flaw
 - Suggest possible repair action

SUMMARY

NECESSARY STEPS FOR A SUCCESSFUL IMPLEMENTATION

- A vision for the future
- To see the benefit with that vision
- Divide the progress towards the vision into small steps
- Every step should be beneficial by itself

