SURF CON INSPECT

WHITE PAPER



SurfConInspect use cases SCI use cases in 15 minutes: UC1–UC4 at a glance

SurfConInspect White Paper
Series 10/10

About Us

WHO WE ARE

SurfConInspect (SCI) is a European project funded by the Research Fund for Coal and Steel (RFCS). Our consortium brings together leading steel producers, research institutes, technology developers and innovation experts.

The partners combine industrial expertise, academic knowledge and advanced digital solutions to transform the way steel quality is controlled.



OUR MISSION

The steel industry faces increasing pressure to become more sustainable, efficient and competitive—key goals of the European Green Deal.
Our mission is to enable zero-defect manufacturing in flat steel production by:

- Detecting surface defects earlier and more accurately.
- Reducing waste and improving resource efficiency.
- Supporting operators with advanced visualization tools.
- Providing real-time control actions directly in production lines.

MAIN ACTIVITIES

- Industrial trials in tin-plate and automotive steel production.
- Development of AI-based inspection methods.
- Application of AR for real-time operator support.
- Creation of open datasets to enhance research and industrial collaboration.
- Dissemination of results to industry, research and society through events, publications and digital platforms.

EXPECTED RESULTS

- Zero-defect production through optimized inspection and control.
- Reduced waste and energy consumption, contributing to the
  European Green Deal.
- Higher competitiveness for European steel producers.
- Transferable technologies with potential applications beyond the steel sector.
- Improved working conditions, with operators supported by innovative visualization and decision-making tools.

Executive Summary

The SurfConInspect project is built around four industrial use cases, each addressing a specific surface quality management problem on a real production line at one of the two industrial partner facilities. The use cases were selected because together they span the range of quality control challenges that the project's technical architecture, comprising advanced sensing, improved classification, aggregated quality indices, and operator decision support, is designed to address. Two use cases at the thyssenkrupp Rasselstein (RAS) pickling line in Andernach concern the control of topographic defect risk and the optimisation of pickling-line speed. Two further use cases at finishing lines, one at the RAS tinning line and one at the Salzgitter Flachstahl (SZFG) electrolytic galvanising line in Salzgitter, concern the real-time grading of tin-plate and automotive-grade steel on the basis of distributed surface quality information. UC5 demonstrates augmented reality (AR) operator support at the recoiling line at RAS but less focuses on quality control and is thus not topic of WP10.

The first use case, UC1, implements automated cutting control for heavy topographic defects at the RAS pickling line. When the combined 2D/3D inspection system detects a defect whose depth and position exceed the severity threshold associated with coil break risk at downstream rolling mills, the quality processor generates a quality event and the online quality supervisor triggers a cutting signal that removes the defective strip section before it reaches the cold rolling mill. The target is a 20 percent reduction in coil break frequency at downstream tandem rolling mills and continuous annealing lines, reducing the direct production loss cost, in terms of lost line availability, scrap, and maintenance and safety intervention, associated with strip rupture events.

The second use case, UC2, implements process speed optimisation at the same RAS pickling line based on a continuously computed scale affection index. By measuring the fractional coverage of residual oxide on the strip surface in real time and adapting the line speed to the actual dissolution requirements of the material being processed, the system eliminates the productivity loss implicit in the conservative worst-case speed settings that conventional operation requires. The target is a one percent increase in pickling-line yield, a figure whose economic significance at the throughput levels of the RAS Andernach facility is substantial.

The third and fourth use cases, UC3 and UC4, implement online quality grading at the RAS tinning line and the SZFG electrolytic galvanising line respectively. Both translate the output of the inspection and quality processor infrastructure into coil-level quality assessments that support real-time grading decisions: whether the current coil section meets the specification of its intended downstream application, and what in-coil control actions are appropriate if it does not. UC3 targets tin-plate production, where surface defect distribution across the coil determines the grade assignment for electrolytic tinning. UC4 targets automotive-grade galvanised steel, where the non-topographic surface conditions described in WP2 are as significant as topographic defect management.

This white paper provides a concise overview of all four use cases: their production context, the inspection and control technology that enables them, the quality control logic that connects inspection data to process actions, and the quantitative industrial benefits that their successful implementation is expected to deliver. It draws together the technical content developed throughout the SurfConInspect white paper series and presents it in the integrated context of the four industrial applications that define the project's industrial validation scope.

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2. The production chain connecting the use cases
3. UC1: automated cutting control for heavy defects at the RAS pickling line
4. UC2: process speed optimisation based on scale affection at the RAS pickling line
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The four use cases in context

The selection of the four SurfConInspect use cases reflects a deliberate logic about what constitutes a meaningful demonstration of an integrated surface quality control system for flat steel production. Each use case addresses a real operational problem that existing ASIS installations at the partner facilities cannot currently solve, because the gap between detection results and operationally actionable quality decisions has not been closed. The SurfConInspect approach to closing that gap, through the quality processor and online quality supervisor architecture described in WP6, requires use cases specific enough to define concrete performance targets and representative enough to demonstrate the architecture's applicability across the range of quality management challenges encountered in flat steel production.

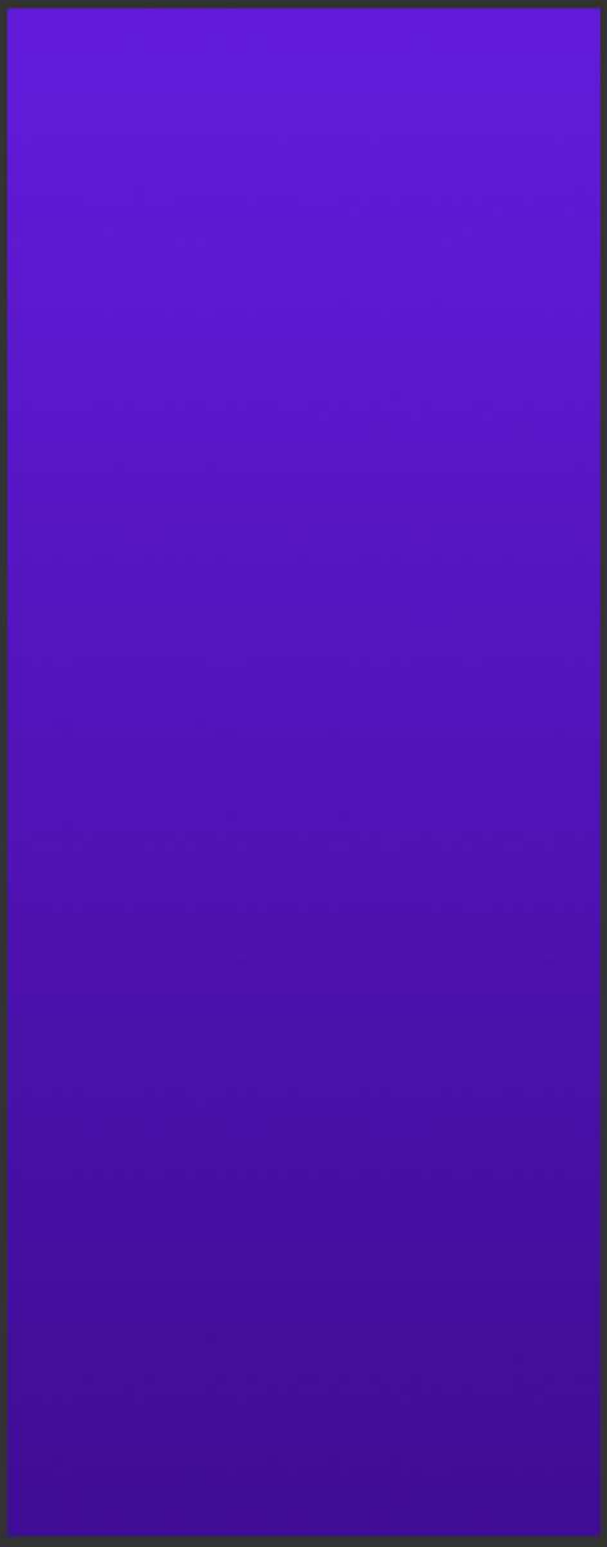


The two pickling-line use cases at RAS address opposite ends of the quality control problem. UC1 targets the detection and removal of localised high-severity topographic defects, events whose individual geometric properties place the downstream material at risk. UC2 targets a distributed surface condition, scale coverage, whose operational significance is determined not by individual event properties but by their cumulative spatial extent across defined coil segments. As documented in WP8, these two problems require fundamentally different inspection paradigms: event-based quality assessment for UC1, aggregated index computation for UC2. The fact that both are implemented on the same production line with the same combined inspection system demonstrates that the quality processor architecture can accommodate qualitatively different quality management objectives within a single operational framework.

The two finishing-line use cases extend the SurfConInspect approach from pickling to coating, and from a single industrial partner to two. UC3 at the RAS tinning line and UC4 at the SZFG galvanising line share the objective of online quality grading: translating distributed inspection data into coil-level quality assessments that support real-time decisions about grade assignment and in-coil process control. They differ in material type, primary defect concerns, and downstream customer requirements. UC3 operates on tin-plate substrate where topographic defect distribution determines grade; UC4 operates on automotive-grade cold-rolled coil where the chemically induced, non-topographic surface anomalies described in WP2 are as operationally significant as topographic ones. The combination of the two validates the architecture's applicability across production contexts with substantially different quality requirements.

Taken together, the four use cases constitute a demonstration spanning the major dimensions of surface quality management in flat steel production: from detection and removal to process optimisation, from single-facility to multi-facility, from topographic to non-topographic defect management, and from fully automatic to human-assisted supervisory control. The industrial validation results obtained across these four dimensions, measured through the longitudinal monitoring infrastructure of the quality processor traceability record, provide the evidence base for the SurfConInspect project's contribution to zero-defect manufacturing practice in European flat steel production.

The production chain connecting the use cases



The four use cases do not operate on independent products. The coils processed at the RAS pickling line in UC1 and UC2 are the upstream inputs to the tinning line addressed in UC3. The strip that passes through pickling, where heavy defects are cut out and scale coverage is monitored, subsequently enters the tinning line, where its surface quality in the form of a distributed defect profile determines the grade assignment for the tin-coated product. The quality control actions taken in UC1 and UC2 therefore have direct consequences for the quality assessment performed in UC3: coils from which heavy defects have been removed arrive at the tinning line with a modified defect distribution, and coils pickled at the correct speed for their scale characteristics arrive with a higher probability of complete scale removal, which in turn affects the adhesion quality of the electrolytic tin coating.

This upstream-downstream dependency is the physical basis for the zero-defect manufacturing vision that motivates the SurfConInspect project. The individual production plants in a flat steel production chain function as stations in a process where quality problems identified early, at the pickling line, prevent the processing of defective material at downstream stages where the cost of failure is higher. A coil break at a tandem cold rolling mill costs more than a pickling-line cut; a surface defect in a tin-coated product delivered to a customer costs more than a coil break. The economic argument for early intervention, documented in WP4 and WP6, rests on the fact that the cost of quality failures escalates as the material progresses through successive value-adding stages. The SurfConInspect use cases address this cost escalation by deploying quality control at the earliest stages where reliable detection and intervention are physically possible.

The SZFG use case, UC4, is not downstream of the RAS use cases in the same direct sense. SZFG processes automotive-grade cold-rolled coils through an electrolytic galvanising line independently of the RAS production chain. The connection between UC4 and the other three use cases is architectural rather than sequential: the same quality processor and online quality supervisor framework, the same classification improvement strategies, and the same operator interface philosophy described respectively in WP6, WP7, and WP3 are applied in a production environment with different material specifications, different primary defect concerns, and a different industrial partner. The SZFG use case validates the transferability of the SurfConInspect approach across production environments rather than its integration within a single production chain.

UC1: automated cutting control for heavy defects at the RAS pickling line

The first use case addresses the most direct quality control intervention available at the pickling line: the physical removal of strip sections containing heavy topographic defects before they enter the cold rolling mill. The defects targeted by UC1, deep dents, severe abrasions, and shell defects in the near-edge zone, are characterised in detail in WP4. Their common property is that their geometric severity, as measured by the three-dimensional inspection channel of the combined system described in WP5, places the strip section at measurable risk of crack initiation during the thickness reduction of cold rolling. The risk is position-dependent: the same defect geometry represents a higher risk when located near the strip edge, where the background tensile stress during rolling is systematically elevated, than when located in the central strip zone.

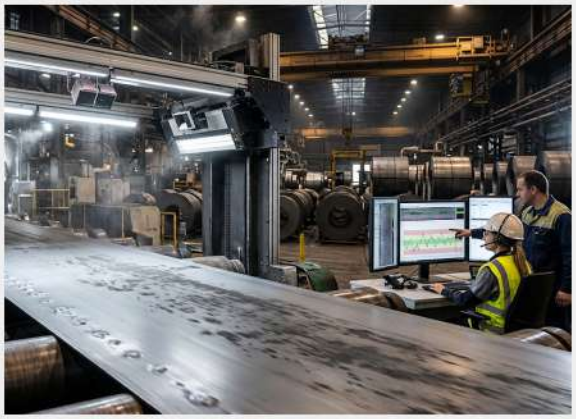
Before the installation of the combined 2D/3D inspection system at the RAS pickling line, the identification and cutting of heavy defects depended on the operator's ability to monitor the conventional 2D inspection display continuously, recognise critical events among the many non-critical ones, and initiate the cutting procedure manually within the available time window. At high strip speeds, this window may be of the order of seconds, and the cognitive demand it places on the operator, described in WP6 in the context of the broader quality control architecture, is not consistently met in production. The 3D inspection channel, whose installation at RAS in 2021 preceded the formal start of the SurfConInspect project, provides the measurement basis for a different approach: severity assessment grounded in the geometric properties of each detected event, applied automatically and continuously without depending on operator attentiveness.

The quality processor for UC1 receives the depth profile, lateral extent, and strip-edge distance of each detected topographic event from the inspection system and computes a severity index that encodes the combined effect of these geometric parameters on coil break risk. Events whose severity index exceeds the cutting threshold generate a quality event forwarded to the online quality supervisor. The supervisor evaluates the event against the operational constraints of the cutting station, verifying the mechanical feasibility of a cut at the current strip position and the absence of conflicting events from the UC2 processor, then generates a cutting signal that initiates the physical cutting procedure. The target performance for UC1, defined in the SurfConInspect project plan, is a 20 percent reduction in the frequency of coil break events at downstream tandem rolling mills and continuous annealing lines served by the RAS Andernach facility.

The validation of this target is conducted through the longitudinal monitoring infrastructure described in WP6: pickling-stage cutting decisions and severity classifications are logged alongside the subsequent coil break events at downstream facilities, enabling a before-and-after comparison of coil break frequency that controls for the material mix and process conditions of each production period. Intermediate validation draws on the industrial measurement results documented during the commissioning of the 3D inspection system: analysis of documented coil-break cases at RAS, as reported in WP1, WP4, and WP5, showed that up to 96 percent of defect events associated with coil break risk carried a clear topographic signature identifiable in the 3D channel, a finding that establishes the detection basis for the automated cutting control logic.

UC2: process speed optimisation based on scale affection at the RAS pickling

The second use case operates on the same production line and the same combined inspection system as UC1 but addresses a qualitatively different quality management problem. Where UC1 targets localised topographic events whose individual geometric properties determine their downstream risk, UC2 targets a distributed surface condition, residual scale coverage, whose operational significance is determined by the cumulative fractional coverage of the strip surface over defined coil segments. The physical basis for this distinction, and its implications for the inspection and control approach, are developed in detail in WP8.

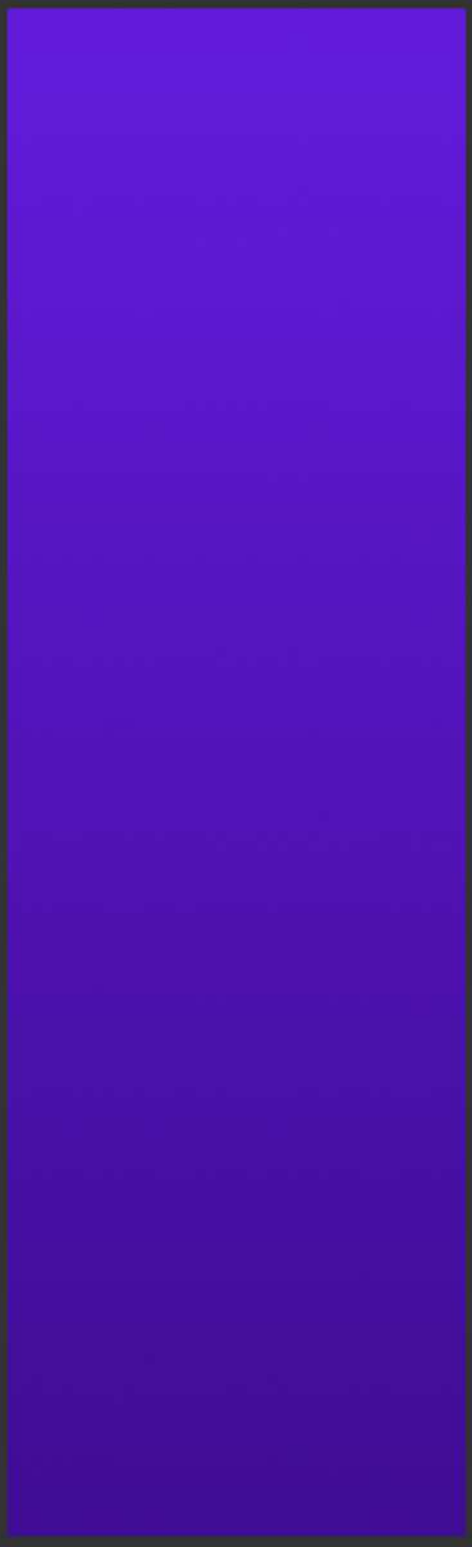


Scale is the iron oxide layer formed during hot rolling and removed by the pickling acid before cold rolling or coating. The completeness of scale removal at any given combination of acid concentration, temperature, and strip speed depends on the dissolution kinetics of the oxide phases present in the scale layer, which vary with the thermal history of the hot rolling process from coil to coil and along the length of each coil. A conservative speed setting that guarantees complete scale removal for the most demanding coil section in a given material grade sacrifices productivity on the majority of sections whose actual scale characteristics are less demanding. The pickling line operates below its achievable throughput whenever the material being processed can support a higher speed than the conservative grade-level setting provides, and this productivity gap is systematic and cumulative across the production campaign.

The quality processor for UC2 computes a scale affection index from the two-dimensional imaging channel, which is sensitive to the reflectance contrast between oxide-covered and metallic surface regions, by aggregating pixel-level coverage estimates over sliding windows of strip length and smoothing the result to match the dynamics of the speed control loop. The index is reported continuously to the online quality supervisor, which compares it against the speed threshold band established for the current process conditions and generates speed adjustment signals when the index falls outside the band. Speed increases are recommended when the index confirms that scale coverage is well below the level that would compromise coating adhesion at the downstream tinning line; speed reductions are recommended when the index indicates that the current speed is not providing sufficient acid residence time for complete scale removal.

UC1 and UC2 operate in parallel on the same coil at the RAS pickling line, each consuming the appropriate channel of the combined inspection system and reporting quality events to the same online quality supervisor. The interaction between the two processors, specifically the adjustment of the scale affection aggregation window when UC1 triggers a cut that removes a strip section from the coil, is managed by the supervisor as described in WP8. The concurrent operation of both processors within a shared quality control framework is one of the clearest demonstrations of the modular architecture principle that underlies the SurfConInspect quality control system: physically independent quality aspects are monitored by independent processors without coupling, and their outputs are synthesised at the supervisory layer where operational coherence is maintained.

UC3: online quality grading at the RAS tinning line



The third use case moves from the pickling line to the tinning line at the same RAS Andernach facility. Electrolytic tinning is the final surface treatment step in tin-plate production: the pickled and cold-rolled steel strip passes through an electrolytic tin-plating bath, where a thin layer of tin is deposited on both surfaces under controlled current density conditions. The quality of the tin-plate product is defined by a combination of tin coating weight, surface appearance, and substrate surface condition; the last of these is the dimension that the SurfConInspect UC3 quality processor addresses.

Surface defects on the cold-rolled substrate entering the tinning line affect the quality of the tin-plate product in two distinct ways. Topographic defects, residual dents or abrasions that were not cut out at the pickling stage because they fell below the UC1 cutting threshold, produce local variations in tin coating thickness at the defect location, where the geometry of the depression or ridge modifies the local current density distribution during electrodeposition. Non-topographic surface conditions, including residual chemical contamination, oxidation residues, and surface films that survived the cold rolling and cleaning stages, affect coating adhesion, producing areas of reduced tin-to-steel bond strength that may manifest as adhesion failures during subsequent forming operations. The online grading processor for UC3 accounts for both dimensions of surface quality in generating the assessment that supports grade assignment decisions.

The quality model for UC3 aggregates the inspection results from the ASIS at the tinning line, including the classification and spatial distribution of topographic and non-topographic surface events, into quality indices that reflect the distribution of surface anomalies across defined coil segments. The grade assignment for tin-plate production is not determined by the presence of individual defects alone but by their distribution: a coil with isolated minor events distributed sparsely across its length may meet a higher grade specification than one with the same total number of events concentrated in a shorter segment. The quality processor captures this distributional dimension by computing coverage-weighted quality indices over segment windows whose length is calibrated to the grade specification criteria of the relevant product standard.

UC3 is implemented as a human supervisory control use case, as described in WP6: the quality processor generates quality events and presents them to the operator through the inspection display with the grading implications of each event clearly identified, but the final grade assignment decision rests with the operator. This design choice reflects the complexity of the tin-plate grading decision, which depends on customer relationship context that is not fully encoded in the quality model. Some customers accept a wider range of surface conditions for non-critical packaging applications; others maintain strict specifications for food-contact or pharmaceutical packaging. The operator's knowledge of the current production order context is required to apply the quality model's output correctly to the specific grading decision at hand.

UC4: online quality grading at the SZFG electrolytic galvanising line

The fourth use case is implemented at the SZFG facility in Salzgitter, on an electrolytic galvanising line producing automotive-grade zinc-coated steel. Automotive-grade galvanised steel is among the most demanding surface quality applications in flat steel production: the steel substrate serves as the structural and corrosion-protection base for external body panels on passenger vehicles, where surface finish, forming behaviour, and coating adhesion must meet specifications that leave extremely limited tolerance for surface anomalies. The inspection challenge at the SZFG galvanising line is compounded by the presence of zinc electrolyte and process additives on the strip surface at the inspection point; these wet physical influences, as established in WP2, modify the optical properties of the surface in ways that conventional 2D inspection systems handle poorly.

The primary quality concerns at the SZFG line are non-topographic. Cold-rolled automotive strip entering the galvanising line may carry surface conditions, including residual rolling oil films, localised oxide patches, and surface contamination from the cold rolling lubricant system, that are invisible or ambiguous in standard brightfield imaging but that compromise coating adhesion and the subsequent forming performance of the galvanised product. As described in WP2, the spectral fingerprint approach developed within SurfConInspect addresses this inspection gap by distinguishing surface conditions through their wavelength-dependent reflectance response rather than through their visual appearance. The UC4 quality processor receives both conventional 2D inspection outputs and spectral analysis results from the detection channel developed within the project and combines them in a quality model covering both topographic and non-topographic quality dimensions.

The implementation of UC4 follows the human supervisory control model, as for UC3, but in a different operational context. At the SZFG galvanising line, the grade assignment decision for automotive-grade product carries direct commercial implications: a coil classified at a lower grade than its actual surface quality would support represents a missed revenue opportunity, while a coil classified at a higher grade than its surface quality can sustain represents a product liability exposure that may generate customer claims and warranty costs. The economic asymmetry between these two types of grading error varies across the customer portfolio and the product mix. The operator, supported by the quality event information presented through the inspection display and, where available, through the augmented reality interface described in WP3, bears responsibility for grade assignments that reflect both measured surface quality and the commercial context of the production order.

The UC4 implementation at SZFG also serves a distinct technical validation function within SurfConInspect: it provides the industrial demonstration context for the hyperspectral and spectral band-specific detection approach developed in WP2, validating the transition from the laboratory-scale feasibility of spectral fingerprint discrimination to the production-scale reliability required for online quality grading. The performance of the spectral detection channel at the SZFG line, measured by its ability to correctly distinguish the non-topographic surface conditions relevant to automotive-grade galvanised steel, constitutes one of the most technically ambitious validation targets in the project.

The shared quality control architecture across all four use cases

The four use cases share the quality processor and online quality supervisor framework described in WP6, whose modular design allows it to accommodate use cases with fundamentally different quality objectives, measurement channels, aggregation logics, and control modes within the same operational infrastructure. This shared architecture is the central engineering contribution that SurfConInspect makes beyond the individual technologies, 3D inspection, hyperspectral sensing, hybrid classification, that each use case deploys.



The modular quality processor concept allows each use case to define its own quality model independently of the others, while sharing the same data acquisition infrastructure, position synchronisation system, and supervisory layer. The UC1 quality processor and the UC2 quality processor at the RAS pickling line are physically co-located and consume data from the same combined inspection system, but their quality models, threshold structures, and event generation logic are entirely independent. Their interaction is mediated exclusively through the online quality supervisor, which maintains a coherent account of the quality state of the coil across both dimensions simultaneously. The same independence holds between the RAS processors and the SZFG processor for UC4: the supervisory framework is shared architecturally, but the quality models reflect the specific physics and process conditions of each line.

The shared architecture also enables the reuse of classifiers and detection models across use cases that address the same defect categories. The hybrid classification system described in WP7, which combines rule-based logic for well-characterised defect categories with image-based analysis for borderline cases, is a shared component across UC1, UC3, and UC4, each of which depends on reliable topographic defect classification for the severity assessment that drives its quality model

The operator interface philosophy connecting the quality control architecture to human decision-making is also shared across the four use cases, though implemented differently according to the control mode of each. UC1 in its automatic supervisory control mode generates cutting signals without operator involvement; UC2 in its adaptive speed control mode generates speed recommendations that may be automatic or operator-confirmed depending on the clarity of the scale affection signal; UC3 and UC4 in their human supervisory control modes present grade assessment information to the operator for decision. The augmented reality interface described in WP3, which anchors quality information spatially on the physical coil for direct operator perception, is applicable across all four use cases and is validated at the RAS facility as UC5.

Expected industrial benefits and their quantitative basis

The expected industrial benefits of the four use cases are expressed as quantitative targets defined in the project plan and grounded in the analysis of historical production data from the RAS and SZFG facilities. The targets are specific to the industrial contexts in which the use cases are implemented, and their extrapolation to other facilities requires accounting for differences in material mix, production volumes, and process conditions.

For UC1, the 20 percent reduction target for coil break frequency at downstream facilities is based on the fraction of historical coil breaks traceable to topographic defects in the near-edge zone of the strip, defects that the 3D inspection system can detect and characterise, and on the expected detection and intervention rate of the automated cutting control system under production conditions. As documented in WP4, approximately 90 percent of coil break events at tandem rolling mills and continuous annealing lines are associated with topographic defects in the near-edge zone. The 20 percent reduction target implies that the UC1 system successfully intervenes on approximately 22 percent of the defects in this category, a conservative estimate relative to the detection rates observed in the trial data from the 3D inspection system installation. The economic value of this reduction is substantial at the throughput levels of the downstream facilities served by RAS, given the combination of lost line availability, scrap, and maintenance burden that each avoided coil break represents, with additional benefits from reduced equipment damage risk and improved operator safety.

For UC2, the one percent yield improvement target at the RAS pickling line is derived from the analysis of historical speed setting records and the frequency distribution of scale affection levels across the material mix processed at the facility. As described in WP8, the productivity gap from conservative speed management is proportional to the frequency with which actual scale affection falls below the worst-case grade assumption; the historical ASIS data at RAS supports estimating this frequency with reasonable confidence. At the production volumes of the RAS Andernach facility, a one percent yield improvement represents a material quantity of additional throughput capacity released without capital investment, with a direct cost reduction in the pickling operation and an indirect benefit in the utilisation of downstream finishing capacity.

For UC3 and UC4, the quantitative targets are expressed in terms of grading accuracy improvement and customer claim reduction rather than direct production loss reductions. A five percent reduction in customer claims attributable to surface quality defects in tin-plate and automotive-grade galvanised steel, the combined target for UC3 and UC4, reflects the expected improvement in the reliability of the grade assignment decision when the operator is supported by real-time quality indices based on distributed inspection data rather than on the individual event assessment provided by conventional ASIS displays. The economic value of this reduction, which includes returned material, rework, transport, and commercial penalties, is typically a multiple of the direct material cost of the affected coils. A 30 percent reduction in ASIS classifier maintenance effort, targeted through the improved pre-trained classifiers developed in WP7 and WP9, represents an additional operational benefit reducing the total cost of ownership of the inspection system across all four use cases.

Transferability and applicability beyond the demonstration sites

The four SurfConInspect use cases are implemented at two specific industrial facilities under the production conditions and material specifications that characterise those facilities. Their validation at RAS and SZFG provides an industrial evidence base for the SurfConInspect approach, but the broader applicability of that approach depends on how well the technical and architectural components generalise to other facilities and production contexts.

The quality processor and online quality supervisor architecture described in WP6 is designed for transferability. The modular quality processor concept imposes no constraints on the specific quality model implemented within each processor, the measurement channel from which it receives data, or the threshold logic it applies. A facility operating a pickling line with a different acid system, a different material mix, or a different downstream process sequence than RAS can implement the same architectural framework with quality models calibrated to its specific process conditions, without modifying the supervisory layer or the operator interface infrastructure. The open-source components of the SCI framework, built on the FADI-based data platform managed by CETIC within the consortium, are designed to facilitate this adaptation by providing a configurable deployment environment that does not require facility-specific software development for the core quality control functions.

The classification improvement strategies described in WP7 and WP9 are transferable in the sense that they address structural data quality problems affecting all ASIS deployments in flat steel production. The class imbalance from critical defect rarity, the domain gap between facilities, and the absence of production-representative public benchmarks are characteristics of the ASIS deployment context in general, as documented in the literature reviewed in WP9. The open dataset assembled within the project, governed by FAIR-aligned, creates a shared resource that benefits the broader ASIS development community and lowers the data acquisition barrier for facilities that wish to implement hybrid classification systems without building their own labelled training datasets from scratch.

The sensing technologies that underpin specific use cases, the combined 2D/3D inspection system for UC1 and UC2, and the spectral detection channel for UC4, have narrower transferability in their current form because they require physical installation and calibration to the specific optical and process conditions of each facility. The 3D inspection technology was first demonstrated at a flat steel pickling facility at the RAS installation, constituting, as documented in D1.3, the world's first combined 2D/3D surface inspection system for flat steel production. Its transferability to other pickling lines is supported by the progressive maturity of the triangulation-based technology.

Conclusions

The four SurfConInspect use cases, UC1 and UC2 at the RAS pickling line in Andernach and UC3 and UC4 at the RAS tinning line and the SZFG electrolytic galvanising line in Salzgitter, constitute a demonstration of integrated surface quality control spanning the principal dimensions of quality management in flat steel production. From event-based defect detection and removal to area-based process optimisation, from single-facility to cross-facility deployment, from fully automatic to human-assisted control, the four use cases collectively exercise every component of the technical and architectural approach that SurfConInspect has developed.



The quantitative performance targets, a 20 percent reduction in coil break frequency, a one percent yield improvement in pickling, a five percent reduction in surface-quality-related customer claims, and a 30 percent reduction in ASIS classifier maintenance effort, are grounded in the analysis of historical production data from the partner facilities and in the detection and classification performance data generated during the commissioning of the inspection systems. They are conservative relative to the theoretical performance limits of the deployed technologies, reflecting the operational uncertainties of continuous industrial production and the adaptive tuning process that is part of the demonstration phase at both facilities.

The white paper series of which this document is the final instalment has traced the technical path from the physical measurement principles that make advanced inspection possible, three-dimensional topography in WP1, spectral material discrimination in WP2, augmented reality decision support in WP3, through the defect knowledge and inspection system design that translate those principles into operational tools in WP4 and WP5, through the quality control architecture and classification strategies that connect inspection outputs to process decisions in WP6, WP7, WP8, and WP9, to the four industrial applications that demonstrate the integrated result. The four use cases are the point at which all of these components come together in the production environment for which they were designed.

Taken as a body of work, the series documents a transition in how surface quality control in flat steel production is understood and practised: from inspection systems that report what is on the strip to quality control systems that act on it. The industrial validation results from the SurfConInspect demonstration phase at RAS and SZFG will establish, on an empirical basis, the conditions under which this transition from detection to control delivers measurable industrial benefits. That evidence base is the project's primary contribution to the advancement of surface quality management in European flat steel production.

SURF CON INSPECT

The Consortium

SurfConInspect unites a diverse group of partners:

- **Steel producers:** thyssenkrupp Rasselstein (RAS), Salzgitter Flachstahl (SZFG)
- **Research & Academia:** VDEh-Betriebsforschungsinstitut (BFI), Scuola Superiore Sant'Anna (SSSA), CETIC
- **Technology developers:** Clecim France (CLECIM)
- **Communication & dissemination experts:** yourscienceEDU (YSE)



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