Q-MPE
Mechanical properties estimator for hot rolled flat products

BENEFITS
Improvement in Process Monitoring and Quality Control
Reduction in downgraded products
Reduction in sampling
Reduction of cycle time and “time to customer”
Shortening in development of new products
Minimization of resources through the rationalization of the process
ROI < 2 months (on a yearly basis)

PROCESS
Danieli Automation Mechanical Properties Estimator provides an accurate estimation of the mechanical properties of the hot-rolled plates and coils, focusing on yield strength, tensile strength, and elongation, at different points over the length of the piece. Traditionally, samples for mechanical testing are taken from the outer wraps of the coil or the head or tail of the plate, and the specimens are prepared through proper machining. The entire process of sample cutting, sample cooling, specimen preparation, and, finally, the physical testing, takes time and consumes manpower. It means high time-to-customer inventories, and capital commitments. Danieli MPE’s accurate real-time predictions make available for obtaining the desired austenite grain size. The Micro-structural model makes use of semi-empirical relationships to obtain the mechanical properties of the hot-rolled elements during the cooling phases. The monitoring and control of these complex phenomena is fundamentally important because of the repercussions on the final coil strength. The Property Correlation model estimates the mechanical properties using a Hybrid Artificial Neural Network and basing its calculations on the ferrite grain size and the volume fractions of the different micro-structural constituents.

EQUIPMENT
A state-of-the-art suite of mathematical models, internally connected, are the core of the system:
> Thermal model,
> Deformation model,
> Micro-structural model,
> Phase Transformation model,
> Precipitation model,
> Structure-Property Correlation model.

The Thermal model predicts and monitors the temperature evolution of the slab along the mill during the rolling, heating and cooling phases. The model is based on a multidimensional finite-difference technique with physically based boundary conditions, which change during the different processing stages. The Deformation model calculates strain and strain rate associated with each micro-structural constituent separately, providing in-depth monitoring of the strip dynamic evolution and enriching the control on the finished products’ properties. The Precipitation model describes the evolution of the carbides and nitrides of the micro-alloying elements during the cooling phases. The monitoring and control of these complex phenomena is fundamentally important because of the repercussions on the final coil strength. The Property Correlation model estimates the mechanical properties using a Hybrid Artificial Neural Network and basing its calculations on the ferrite grain size and the volume fractions of the different micro-structural constituents.

MPE typically works at the Level 2 of an automation system, with client-server architecture with database for data storage and statistical analysis.

PERFORMANCE ACHIEVEMENTS
The Mechanical Properties Estimator system for flat products is currently available for different steel grades, such as low-, medium- and high-carbon steels, and also High Strength Low Alloy (HSLA) grades with different microalloying elements. The system is tested for the prediction of microstructure and mechanical properties. The accuracy of prediction is found to be ±16 MPa for UTS (σ), ±15 MPa for YS (σ0.2), and ±4.6% for EL (α). This is the overall accuracy when all the grades are taken together, including the HSLA ones.