MODELLING OF CASTING OF STEEL INGOTS BY ARTIFICIAL NEURAL NETWORKS
Proposal of Activities for Toscelik Nikšić and Tosyali Group

THE MAIN AIMS OF THE PROJECT ARE

1. Development of a felxible and powerful environment for modelling processes related to steel ingot casting, based on artificial neural networks;
2. Predicting influence of variation of process parameters on the final properties of products;
3. Better understanding of interconnected process parameters;
4. Decision support tool for enabling quick adjustment of process parameters with respect to the current requirements;

The following final properties may be considered in the model (dependent on the company needs):

- Elongation
- Tensile strength
- Yield stress Hardness after rolling
- Necking

The developed modeling procedures will have great potential value also for other companies of the Tosyali Group. We will do our best to demonstrate advantages of services provided by us in terms of increased productivity and competitiveness in industrial environment of Toscelik. In this respect, the project can serve as showcase for introduction of artificial neural networks – based support in companies of the whole group.

MODELING APPROACH

Prediction of overall process performance and outcomes will be based on modeling with artificial neural networks (ANN), supported by advanced software framework to achieve optimal results.

REQUIREMENTS

In order to be able to develop adequate process models based on artificial neural networks, we need sufficient amount of historical data from previous realizations of the process. All influential process paremeters and the corresponding outcomes (such as final properties of the product) must be captured for each casting process and stored in a database. It must be possible to output data (pairs of tables of process parameters with corresponding tables of process outcomes) in the reauired format suitable for processing by the modelling tools.

DEVELOPMENT STRATEGY

Development and validation of a simple model first, simultaneous development of benchmark cases for experimetal validation of procedures, then improvement of modelling procedures, analysis of data and finally building the true industrial models.

VALIDATION

1. Predictive models will be cross validated by splitting data in two independent sets, of which one is used only for prediction and the other only for validation.
2. Additional validation will be performed by comparing new data aginst model predictions.

PREDICTION METHODOLOGIES

1. Training-prediction-validation cycle;
2. Data filtering: corrupted data elimination, statistical filtering (detection of outliers);
3. Iterative model refinement;
4. Analysis of spatial distribution of data;
5. Identification of low trust regions;
6. Model refinement by smoothing;
7. Cross checks by localized low fidelity modeling probes;
8. Combined use of industrial and model-based data;
9. Benchmark case construction for estimation of data sufficiency;
10. Advanced error minimization techniques.

PRODUCT – ANN-BASED MODELLING

1. Advanced toolbox for construction of models, operated by provider;
2. ANN-based models for particular cases;
3. Reports on model response and targeted results;
4. Tool for exploring the model – evaluation of individual responses and parametric studies providing graphs of dependencies;
5. User manual.

FORESEEN BASIC PHASES OF THE PROJECT

1. **PHASE 1 (deliverable after 6 months from begin):**
   - Basic ANN-based modelling kit;
   - Definitions of formats for data exchange;
   - Specification of relevant process parameters and process output to be measured.
   - Demonstration of model capabilities on data from case archive;
   - Identification of targeted models.

2. **PHASE 2 (deliverable after 12 months from begin):**
   - Initial models based on industrial data, with accompanying reports;
   - Benchmark model based on data obtained by numerical model;
   - Tools for data filtering and identification of optimal trainiing set-up.

3. **Phase 3 (deliverable after 24 months from begin):**
    - Advanced training techniques with improved convergence;
    - Tools for analysis of spatial distribution of data and error estimates;
    - Smoothing and local probing techniques;
    - Model of process chain on basis of data gathered in industry; estimation of data sufficiency and eventual potential for improvement of data acquisition procedures;
    - Model explorer.

Prepared by dr. Igor Grešovnik,
Centre of Excellence for Biosensors, Instrumentation and Process Control
March 2013