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Consistent ladle tracking for optimisation of steel plant logistics and product quality

TrackOpt

Public

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Deliverable 1.2 – Acquisition and storage of ladle tracking data

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Project summary

The project will implement automated ladle tracking systems to ensure consistent factory-wide tracking of the product from steelmaking via casting to delivery. The wireless tracking system in harsh steelworks environment will provide mandatory input data for projects on digitalisation (“Industry 4.0”). Automated, reliable information on actual position of ladles result in increased factory output (avoided hold-ups or downgrading of products due to mix-up of ladles) and in improved safety in steelworks. Furthermore the ladle tracking system will be used to optimise ladle logistics during both smooth production conditions and in case of sudden disturbances in production plan.

1. Acquisition and storage of ladle tracking data

To realise the automated, reliable information on actual position of ladles and its visualisation for the plant operators, a ladle tracking software needs to be put into practice. A ladle tracking database forms the basis for this work.
Parameters of data to be stored in ladle tracking database at FENO were defined as:

- Reader ID (number or name of read-out station)
- Ladle ID
- SAW tag temperature (for maintenance purpose)
- Time stamps for ladle position (start and end of tapping, start and end of LF treatment, start and end of casting, …)
- Treatment duration at different stations of process route (tapping, LF, casting, reheating/ladle preparation)
- Transport times between stations
- Ladle empty time
- Preheating time after relining or maintenance
- Ladle maintenance time (in cycle and out of cycle)
- Heat number
- Steel temperature (last measurement per aggregate)
- Steel grade
- Liquidus temperature at LF (or steel analysis at LF)
- No. of heats for ladle (ladle age)
- No. of heats for sliding gate plates
- No. of heats for sliding gate nose
- No. of heats for sliding gate upper nose
- No. of heats for porous plug
- Tapping weight

For implementation of a database within existing process computer system at FENO steel plant to store ladle tracking data acquired with the ladle tracking system, all relevant variables have to be assigned to separate data tables (see below). The relation between the different data tables are shown in **Figure 1**.

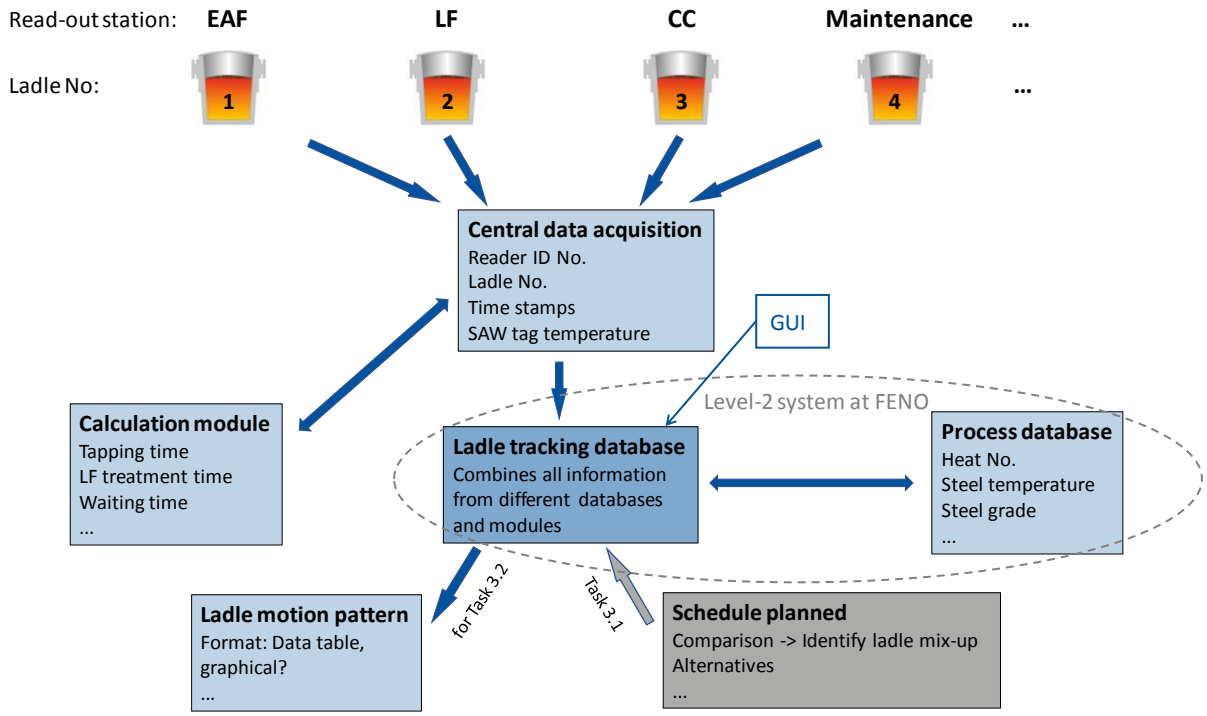

Figure 1: Layout of software tool for ladle tracking

The readers will be connected via network cables and deliver the information about a ladle at the read-out station to a central data acquisition in form of time stamps. Here also the correlation between ladle number and tag ID has to be realised. The data will be stored in the ladle tracking database. From the reader data (time stamps) a calculation module will calculate the treatment times at each station as well as relevant process durations (e.g. transportation times, ladle empty/full time,...). Further relevant process data (e.g. heat number) will also be stored in the ladle tracking database. The software tool will be extended later in WP3 to receive information about planned schedule for detection of ladle mix-up and to evaluate ladle motion patterns. An Oracle interface will link software modules and database.

Interface definition between Calculation module and Central data acquisition

Central data acquisition --> Calculation module

Description	**Unit**	**Data type**	**Length (Bytes)**
Ladle ID		Single	2
Time stamps for ladle position (start and end of tapping, start and end of LF, start and end of casting, …)		DD/MM/YY hh:mm:ss	

Calculation module --> Central data acquisition or (directly to) Ladle tracking database

Description	**Unit**	**Data type**	**Length (Bytes)**
Ladle ID		String	2
Treatment duration at different stations of process route (tapping, LF, casting, reheating/ladle preparation)	min	Single	3
Transport times between stations	min	Single	3
Ladle empty time	min	Single	4
No. of heats for ladle (ladle age)		Single	2
Preheating time	min	Single	4
Repair time (Maintenance)	min	Single	4

Data transfer with or without demand, frequency (writing of data in database/module) is still to be defined. Database can act as client or server of a TCP/IP connection.

Interface definition between Central data acquisition and Ladle tracking database

Description	**Unit**	**Data type**	**Length (Bytes)**
Reader ID (number or name of read-out station)		Integer	2
Ladle ID		String	2
Time stamps for ladle position (start and end of tapping, start and end of LF, start and end of casting, …)		DD/MM/YY hh:mm:ss	
Treatment duration at different stations of process route (tapping, LF, casting, reheating/ladle preparation)	s	Single	4
Transport times between stations	s	Single	3
Ladle empty time	s	Single	4

No. of heats for ladle (ladle age)		Single	2
Preheating time	h	Single	2
Repair time (Maintenance)	h	Single	2

Data transfer with or without demand, frequency (writing of data in database) is still to be defined, database can act as client or server of a TCP/IP connection.

Interface definition between FENO process database (Level-2) and Ladle tracking database

FENO process database --> Ladle tracking database

Description	**Unit**	**Data type**	**Length (Bytes)**
Heat number		Single	6
Steel temperature at EAF	°C	Single	4
Steel temperature at LF	°C	Single	4
Steel temperature at CCM	°C	Single	4
Steel grade			
Liquidus temperature at LF (or steel analysis at LF)	°C	Single	4
No. of heats for ladle (ladle age)		Single	2
No. of heats for sliding gate plates		Single	1
No. of heats for sliding gate nose		Single	1
No. of heats for sliding gate upper nose		Single	1
No. of heats for porous plug 1		Single	2
No. of heats for porous plug 2		Single	2
Tapping weight	t	Single	3

Data transfer with or without demand, frequency (writing of data in database) is still to be defined, via data exchange table.

Ladle tracking database --> FENO process database

Description	**Unit**	**Data type**	**Length (Bytes)**
to be defined			

The layout of the software tools for ladle tracking and processing of tracking data from all readers placed at different stations throughout the steel plant is illustrated in Figure 1.
A first draft for the layout of a graphical user interface (GUI), or human machine interface (HMI), was prepared to display the ladles at the different stations in the steel plant (**Figure 2**) with additional information about a selected ladle (**Figure 3**), and with display of ladle mix-up (**Figure 4**). The GUI was tested using a simulated database.

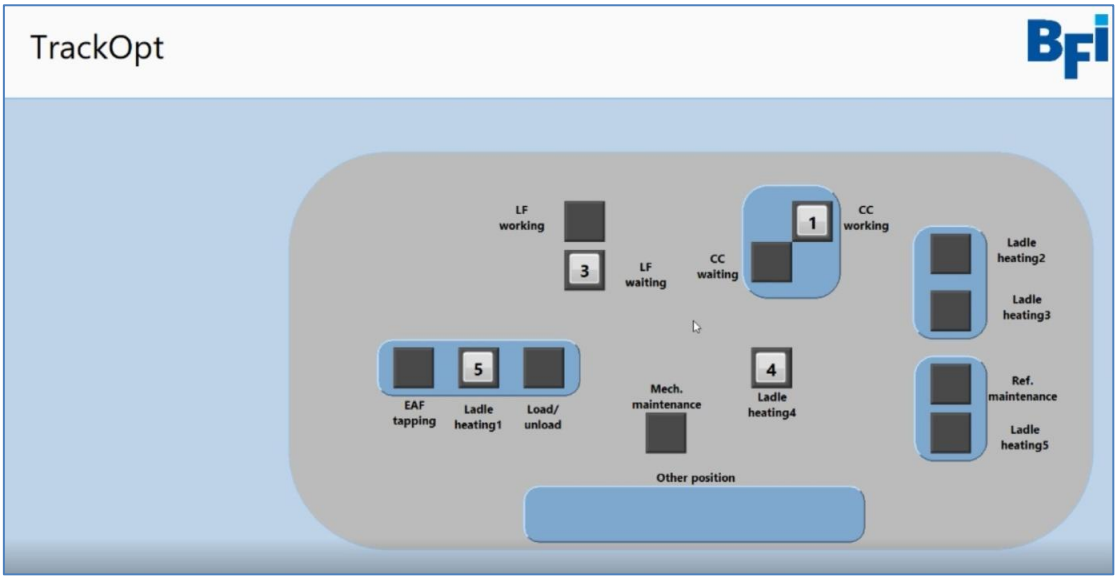

Figure 2: GUI displaying ladles at different stations

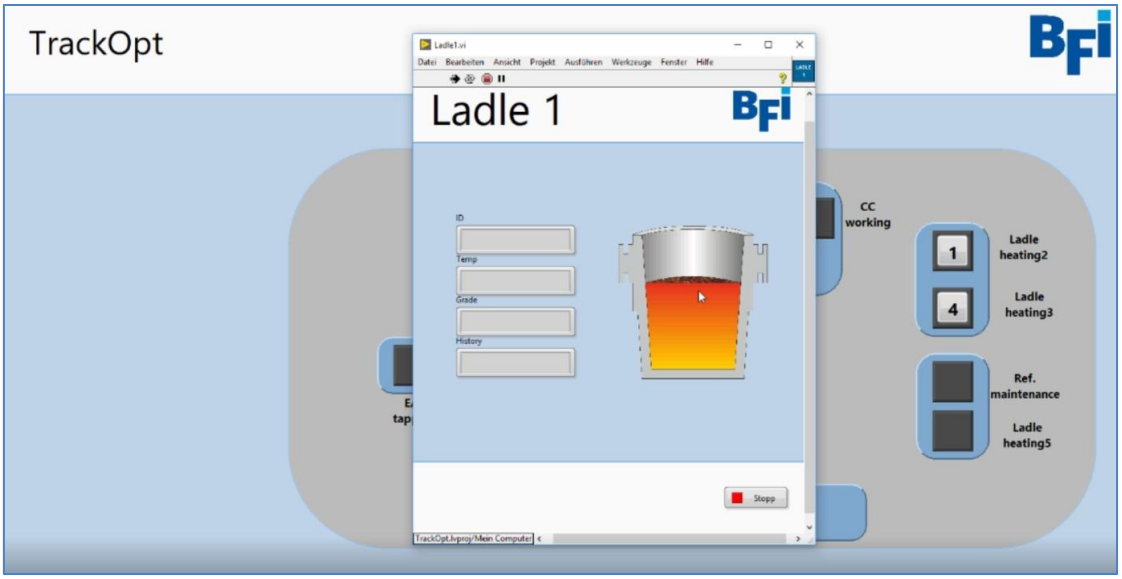

Figure 3: GUI displaying additionally information about a single ladle

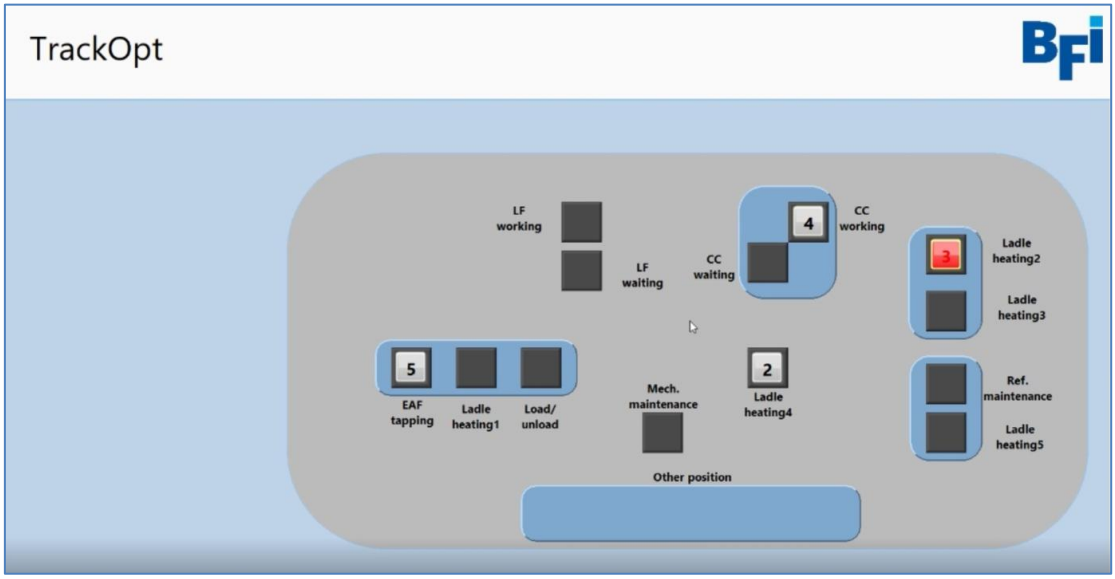

Figure 4: GUI displaying ladles at different stations with ladle mix-up in position "Ladle heating 2"

2. Summary

The implementation of a ladle tracking database and a ladle tracking software (to be realised within WP2 in 2019) was prepared by defining a software structure, parameters to be stored and interfaces, as well as by drafting a GUI for the visualisation of the data.

3. Next steps

Following this preparation, the data definition (including frequency of data transfer) will be completed and the implementation of database and software in FENO steel plant will be realised.