Summary ICT with Industry

Goal

TNO meta case: Digital Twinning made factor 1,000 cheaper
While engaging the two applied cases for twins with industry partners we're interested both in how to solve these cases and which difficulties you run into during the process. TNO's goal is to collect these insights and apply them on a national level in a wider audience to achieve a factor 1,000 savings in the development of digital twins.

Industry partner case 1: Tata Steel
The HIsarna plant from Tata is a revolutionary new way of producing high-quality steel that saves 50% in terms of CO_2 output. The process however is much more complex than the traditional methods and poses challenges in the real-time control of the process given the variability in the materials and process environment.

Challenge: We want to propose new data analysis techniques to optimize the production of steel in the HIsarna plant.

Industry partner case 2: ASM-PT
ASM-PT manufactures wire bonder machines which are high-speed, high-performance robots that link small-scale chips to wires on a PCB. The performance places heavy demands on the small parts of the machine. ASM-PT has created a model to estimate the performance and strain on the machine based on the customer requirements in costs and quality.

Challenge: We want to calibrate the parameters of the model to better fit the measurements of the training and validation set of measurements.

Result

Tata Steel:
The participants proposed a new measure based on the a priori knowledge of the process and the available data, in order to allow them to get better relationship with the rest of the data. Based on this new indicator, occurrences of instability can be detected in an earlier stage. A data-driven random forest model was trained to estimate the indicator value with over 95% accuracy. This however seems like overfitting given the large differences between production runs and start, ongoing and end phases of the process. A more conservative training/validation set method led to 85% accuracy of the stability indicator. A major improvement compared to the current indicator, which lags 50 seconds behind, the model is able to estimate the indicator value with the current measured values and is thus 50 seconds ahead of the existing indicator. Further work is required to train (dynamic) predictive models to see if the indicator can also be predicted instead of estimated.

ASM-PT
The participants have improved the calibration settings for the model of ASM-PT. Several methods for quality, optimization strategies and validation of both have been explored. As a side result, the code structure of the model has been improved to allow optimization and parallelized runs of the model. Three quality functions have been explored, the optimization results were visually compared for the three strategies. The logsum strategy delivered the best results. In terms of optimization strategies the built-in Matlab optimization strategy performed faster and delivered the same results as more arduous optimization strategies. This led to the conclusion that the strategy is not stuck in a

local optimum. The whole process has been automated such that ASM-PT can now run these experiments themselves on the same model and is able to expand the use to more complicated models.

TNO meta case:
The participants have used digital twinning as a frame to start the week and get acquainted with the industry cases. It was clear during the week that the knowledge gap between the participants and the cases was quite large, let alone the knowledge gap between the participants and digital twinning meta case. This meant that the added knowledge in terms of digital twinning would be superficial at best. At the same time the participants ran into the same issues as domain experts run into:

- A lot of domain expertise is required to make it work
- standard methodology and approaches are there, but relatively unknown,
- the creation of a model is an arduous process and validation or applying the model for the right purposes remains a big challenge.

While not solving these issues, the participants at least experienced the same problems.

Evaluation of the ICT with Industry week

At the start of the week we asked all participants to make their expectations explicit. These were:

- Participants: Have fun (succeeded)
- Participants: Get to work on real industry cases (succeeded)
- Participants: Get to know more on Digital Twinning (partly succeeded)
- Participants: Increase network (succeeded)
- Industry: Get new insights into cases (succeeded)
- Industry: Get new insights into Digital Twinning (partly succeeded)
- Scientific lead: Get to know more candidate PhD students (succeeded)

Both Industry partners and scientific lead did not expect any scientific breakthroughs based on just one week of work. To manage the expectations further, the datasets and models were further scoped and prepared in order to allow the participants a flying start. Just like the participants, problem owner TNO did not have any prior knowledge or experience in the industry cases, limiting the possible results and resulting in a more facilitating role in the workshop.