STEEL CLIP:

Jürgen Hellmich:

isam, making processes run automatically

isam AG, Gesellschaft für angewandte Kybernetik (company for applied cybernetics) is located in Mülheim, a city in the Ruhr-region well-known for raw materials and steelmaking industry as well as for new technologies. Developing in an environment active and stimulating like this, the company has become well-known for its turn-key automation projects in industrial applications all over the globe. Accordingly, isam evolved into industry's partner for automation and process optimization. A high-skilled team of specialists in the fields of information science, physics and engineering is ready to create customized solutions. All effort directed to optimise processes always brings about added value as it makes best usage of existing rationalisation potentials. Simultaneously, running stable processes means improved plant availability and product quality. Altogether, this leads to an increase in efficiency, simultaneously lowering production costs.

In tackling new problems, our experts are supported by profound knowledge and wide experience gained in raw materials handling, steel making, metal treatment, aviation and aerospace. This is the best precondition no matter whether we have to employ proven methods or to break new grounds.

History. The company was originally founded by Jürgen Hellmich (a computer science major) in 1983 and has grown from 4 employees to more than 50 highly skilled engineers, computer scientists and physicists in the past two decades. Today, isam is managed jointly by Jürgen Hellmich as CEO, Bernd Jotzo (Finance and Human Resources) and Bernd Mann (Development and Technology), all three forming the Board of Directors. Since the merger with German software development firm inma in 1993 the company is offering the full range of industrial automation projects from the field instruments (Level 0), via PLC (Level 1) and process control systems (Level 2) to logistics and production planning systems (Level 3/4). In 2002 isam was converted to a stock corporation to secure the necessary funding for future expansion, however, it is wholly owned by eight private investors three of them forming the Board of Directors.

Fig. 1: Combined stacker reclaimer handling raw materials

Scope of services

The scope of services isam offers to its customers basically covers all kind of industrial automation and data processing. Going into more detail, the latter ranges from the development of company-specific concepts including the generation of customised software over planning and implementation of enterprise networks to the integration of heterogeneous IT environments. Experience and service as far as industrial automation is concerned cover measurement and control techniques, process visualisation and control, data handling and, of course, quality assurance, throughout the complete hierarchy. Individual image processing and image analysis is another matter of concern. Here, genetic algorithms provide the basis for material flow control, single part tracking and machine automation control systems.

Scope of activities

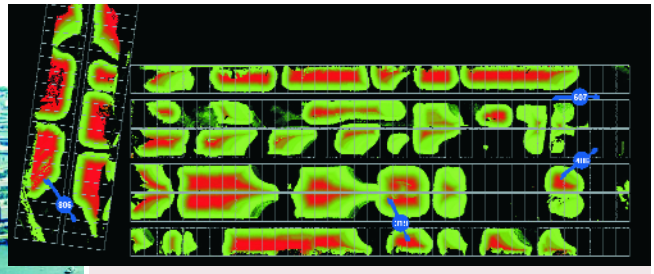
For a company rooted in Germany´s heavy industry, especially iron and steel making, it is not surprising that it has implemented automation in almost any segment of the supply chain from iron ore to galvanized coils. Extending its area of expertise isam holds a strong position in port automation and bulk material handling, pipe production and the aerospace industry.

Additionally, the operation area has been extended from Germany all over the world. Today, isam is generating more than 80 % of its revenue outside its home market and has become a globally acting enterprise with projects in India, the P.R. China, the United States of America, Russia and all European countries, as well as with some subsidiaries outside Germany.

Some finished projects proving expertise are listed below ordered according to the supply chain:

- automation of unattended stacker reclaimers;
- automation of train loading station for bulk materials, such as coal and ore;
- level 1 and 2 automation of steel meltshops;
- control and visualisation implemented into a steelmaking plant from BOF shop to finishing train;
- mould level control systems for continuous casting and thin slab casting plants;
- integration of automatic systems for inside, outside and spiral welding of pipes;

a) real environment



b) false colour image of stockpile altitude

Fig. 2: View of the stockpiling at Hansaport

- quality assurance systems for large diameter pipes;
- welding robots for laying pipelines;
- a control system for welding of air intakes;
- digital light arc control and seam tracking systems.

Further projects successfully carried out affect subjects such as pure cost accounting systems and operational data acquisition systems, management information systems, shot hole drill carriage, tip height measurement and, automatic cutting-off/bevelling machines. It is obvious that only a few applications are left which isam has not yet automated. In the following, some projects of exemplary nature explicitly illustrate what isam can do for you.

Experience in raw materials

Iron ore and coal. Taking a closer look at specific projects for the steel industry we start at the very beginning of the production chain, i.e. raw materials supply, especially iron ore and coal. As the European steel industry imports most of its iron ore, coal and coke, the major steel producers and their port operators need advanced automation systems to lower handling costs and increase capacity. The bucket wheel stacker reclaimer, especially if running automatically, proves a very economical means for bulk materials handling from pellets through fine ore to coal and coke. isam redesigned the electrical engineering of such a handling device resulting in the first unattended stacker reclaimer for iron ore and coal, **fig. 1.**

A real-time terrain model is created based on the 3-dimensional time-of-flight laser scan technology and satellite based navigation, **fig. 2a, b.** The high precision of this model is achieved by the high scanning rate of 28000 pixels/s and the high-speed GPS receiver, both allowing for intelligent equipment operation. This further results in high and constant con-

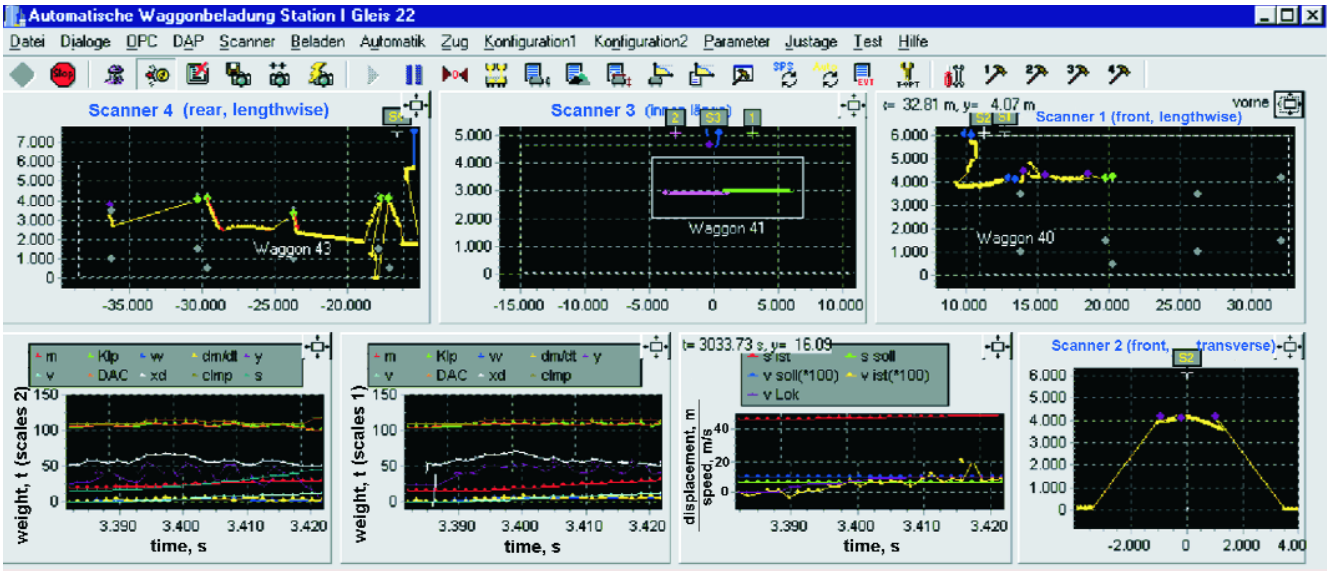


Fig. 3: Fully automated waggon loading station for bulk materials, such as coal and ore at Hansaport Hafenbetriebsgesellschaft mbH, Hamburg

veying rates. Thus, manpower can be reduced significantly without overloading the equipment.

The model works with an accuracy of ± 5 cm, and is being kept up-to-date automatically. The only thing the operator has to do is to click on a stockpile and select the amount of material required. Thereafter, the combined stacker reclaimer with a capacity of up to 6000 t/h is automatically positioned in the stockyard and the desired material is reclaimed without any further user intervention. One single operator can easily control up to 6 devices, thus significantly increasing handling efficiency. Furthermore, in maintaining a more homogeneous material flow this automated and, thus, smooth operation leads to a reduction in wear occurring on the mechanical parts, and to a substantial increase in overall throughput.

Fig. 4: Visualisation of the steel making sequences as they may occur in an EAF shop

Dual-channel design of the equipment overload protection allows the classification in accordance with DIN EN 954-1 Safety Class 3 as it prevents equipment from being damaged even if major system components fail.

Two applications are in operation at Hansaport Hafenbetriebsgesellschaft mbH Hamburg, with 12 million t/a the largest German site for loading and unloading of bulk goods, and Emo Rotterdam, the largest bulk material trans-shipment center in the world as far as import is concerned with over 40 million t/a.

Transport. On its further way to the blast furnace coal and iron ore are loaded onto trains by a likewise automated train loading station in which 2-dimensional laser scanners track each waggon. The hydraulically operated shunting robot as well as the entire loading process is controlled automatically based on this data, **fig. 3.** This system run by Hansaport Hafenbetriebsgesellschaft mbH, Hamburg comprises the following main features:

- automatic shunting of the waggons in the station by using remote controlled shunting robots;
- administration of all data including capacity in terms of volume and mass for all types of waggons;
- automatic scan of arriving waggons to detect any residual quantity and, accordingly, potential fill volume;
- volume-flow controlled loading taking into account material state and weather.

Integrating train loading station, conveyor belts and stacker reclaimers the whole trans-shipment process can be run 24 hours a day/7 days a week with a minimum of manual user intervention.

Experience in steel making

As already mentioned, isam once started its automation service in the iron and steel industry. Here, some of the latest projects are presented illustrating the automation of steelmaking operations during melting, casting and solidification as well as forming.

Melting. isam has recently implemented the complete level 1 and level 2 automation into a new steelmaking facility in Asia. An electric arc furnace (EAF) of Conarc design serves for melting a mixture of scrap, DRI and hot metal. The distinguishing feature of this application is the combination of melting and blowing in the same vessel. An integrated process model jointly developed with the customer is employed to govern steelmaking operation. It allows the prediction of steel composition and temperature at different process sequences. An appropriate electrode synchronization model ensures optimum usage of the transformer which, speaking in terms of the process, always keeps one shell subject to arcing, **fig. 4.**

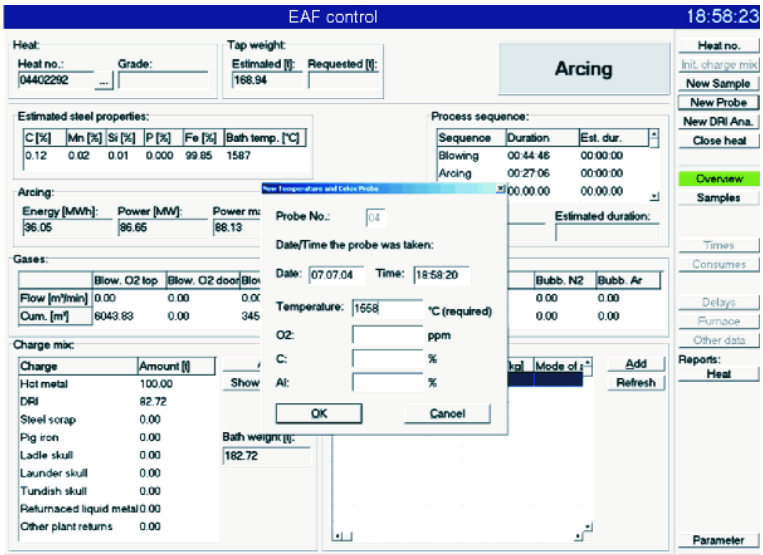


Fig. 5: EAF control. Screenshot illustrating the operator´s view of one of the steelmaking periods performed in an electric arc furnace

In 2005, level 2 was extended to the complete steel melting shop including ladle furnace, vacuum degassing and alloy optimisation. Pre-defined standard operating procedures provide the basis for a continuous production quality independent of the operator, who is automatically guided through

all production steps. A single level-2 system is available to integrate the whole steel melting shop with associated laboratories. Supporting the operators in day-to-day operation it also ensures 100-% documentation of production. Nevertheless, the end of the flagpole has not yet been reached, as far as level-2 automation is concerned. An online cost calculation and optimization module is currently being developed to take advantage of charge mix flexibility. Incorporation of such a tool into a meltshop automation will reduce production cost and increase yield based on the respective availability of raw materials and energy. Energy availability is especially important considering the Conarc operation with two shells. An example of application, i.e. one vessel which isam equipped with level 2 and all the PLC and HMI systems, is already in production, **fig. 5.** A simulation environment of the complete control system was set up based on the knowledge gained with the level 2 automation of another Conarc EAF. Application of this environment resulted in a total hot commissioning period of less than 5 days from end of IO test to actual production.

The system architecture as already employed with an EAF module already in operation can completely be redesigned for further shells. Level 1 allowing for the control and visualisation of the double vessel EAF is now based on five Siemens S7-400 PLCs and an Intouch HMI system with fully redundant servers and eight operator stations. For the first time, all auxiliary systems such as gas cleaning plant and cooling systems are also included in the central HMI providing the operator with a homogeneous user interface with identical look-and-feel.

Casting. Further following the route of steel making, the next production step is casting and solidification. isam executed several projects on these issues. Only a few years after its start-up the company delivered its first complete level 1 and HMI for a slab caster based on the then brand-new Siemens S5 and Coros LSB. The system already included a dual automatic mould level control (for Bertold and NKK) as well as dynamic spray cooling. Additional jobs include the first automatic start of casting at HKM Hüttenwerke Krupp Mannesmann, Duisburg, control and visualisation of a resonance mould, a break-out prevention system for carbon steels and peritectic grades at Salzgitter AG, Germany, as well as implementation of several mould level controls. One of these operates on the continuous slab caster at Essar Steel, India, another, again, at HKM, Germany. The latter also awarded isam with an order to equip their thin-slab caster with a mould level control system, which was succesfully adapted to the special demands of this latest technology plant.

Fig. 6: Hot rolling mill at Salzgitter Stahl (photo: Salzgitter AG)

With all these projects, isam always relies on joint compilation of control algorithms and design of open and closed-loop control software under step 5.

Rolling. The first process data management system for hot rolling mills was developed for Salzgitter AG, Germany and implemented into their roughing and finishing train, **fig. 6**. It is designed to handle far more than 2500 channels and to integrate the full production line from furnace to downcoiler with sampling rates of more than 1 kHz for each channel.

For the first time, one single system provided process engineers and maintenance staff with an integrated view of all control system and production data, and, note that this happens at sampling rates required by the very fast hot rolling processes. Long term storage of each and any coil data allows the continuous improvement of production quality. Furthermore, a detailed analysis performed after one year of operation showed that production downtime had been reduced significantly.

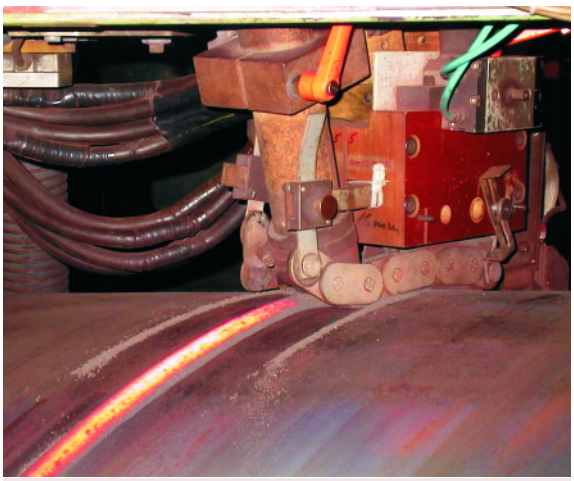


Fig. 7: Welding head joining tubes (photo: Salzgitter AG)

Experience in welding

Tube and pipe welding. Automation activity for pipe mill applications, **fig. 7,** began in 1998 both for hot rolled seamless tubes as well as for longitudinally and spirally welded pipes.

The development of the first digital arc controller for multi-wire submerged arc welding (SAW) in 1999 and its application to all production facilities at Europipe´s Mülheim site, **fig. 8,** marks isam´s breakthrough in welding and pipe mill automation. Characteristic features of this control system cover digital closed-loop control of both welding voltage and current, acquisition and real-time display of measured data, as well as long-term archiving. Soon, other spiral pipe manufacturers, such as Salzgitter AG, made use of this system, too. In the meantime it was extended to MAG welding at

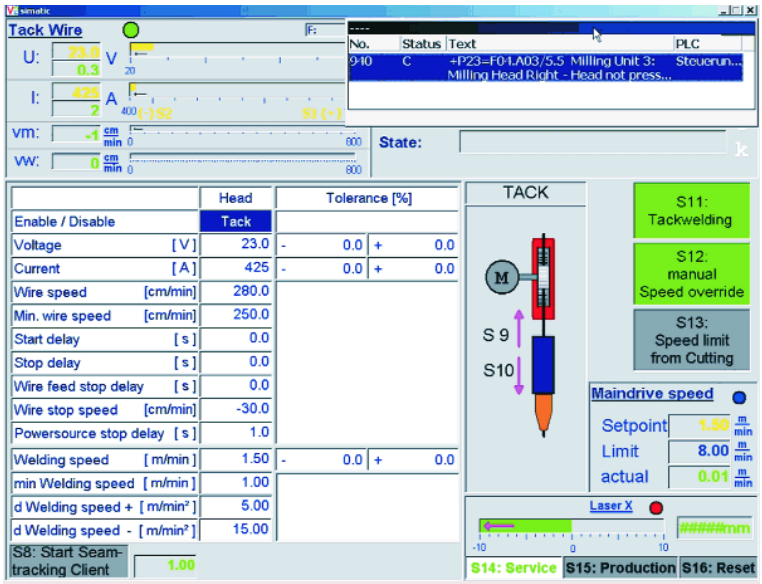


Fig. 8: First digital arc controller for multi-wire submerged arc welding (SAW) at Europipe

variable speeds to support the helical two-step (HTS) pipe process. Today, all operating two-step helical pipe mills use isam control equipment and, thus, the company has become the preferred automation supplier for new spiral pipe mills, such as Corinth Pipe Works, Greece and PSL's new facility in Varsana, India.

The first entirely digital joint tracking sensor was developed as part of the pipe welding automation systems. It is based on advanced laser scan technology and features sophisticated image processing which, nowadays, is state-of-the-art in pipe manufacturing, see e.g. Europipe´s longitudinally welded pipes and Salzgitter´s spirally welded pipes.

Quality assurance. Another project on pipe welding affects the quality assurance of large diameter pipes. Here, the contractor, then MFI, research institute of Mannesmannröhren-Werke AG (today SZMF, Duisburg) even left the design of the necessary hardware to isam. The software for the complete system created based on a VME bus system was integrated into the existing data processing system.

Combination of image processing and welding. In the steel processing and manufacturing branch, much experience has been gained with control systems for arc welding, no matter whether these employed shielded or submerged arc, with automatic detection of the optimum welding path (see already fig. 10b) seam tracking systems for different weld geometries, as well as handling of image data for quality assurance. Thus, it is not surprising that image processing and welding were key factors for isam's step into the aerospace business. This industry branch is synonym for the highest quality requirements at all. Including high-profile programs like the A380 large passenger aircraft and the European Fighter Aircraft EFA 2000, **fig. 9**, isam has been involved in the development of production processes employing laser beam and electron beam welding as well as in the processing of new composite materials. For one thing, automatic guidance of the laser beam, **fig. 10a,** ensures the high precision required in welding air intakes simultaneously allowing the automatic detection of the optimum welding path for the joint, **fig. 10b.** Image processing for the detection of workpiece and laser focus has thus proven indispensable for achieving sound and reproducible results.

Fig. 9: Eurofighter

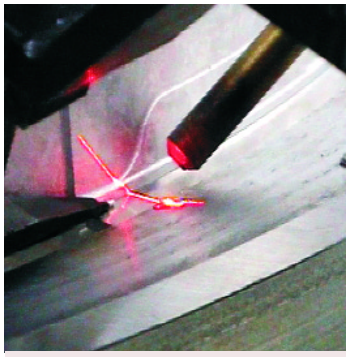


Fig. 10a: Automatic guidance of the laser beam in welding components, such as air intakes

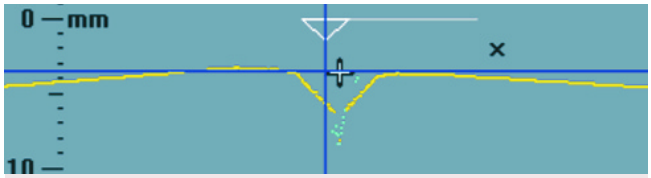


Fig. 10b: Image processing for automatic detection of the welding path

Conclusion

With all these applications and different customers isam has always stuck to the basic principle which allowed the company to grow so far: keeping up with quality. To our experience, this ultimate ambition can be obtained by recognizing own key competence *and* understanding the processes of our customers. All this must be supported by continuous innovation based on feedback from operational production. As far as the latter is concerned, one more aspect may tip the scales: with isam, no Chinese Wall separates development from commissioning. Customers all over the world appreciate that whoever developed a system at isam´s is on the customer´s site to implement it, wherever this application may be.

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