Kaiserslautern October 2005

MoMAS® **The Mobile Measurement and Automation System ....**

.... has been created to achieve the main goal of automation of an extruder, viz. to

Achieve highest possible productivity and simultaneously ensure top product quality, without trespassing limits on variables by employing instrumentation and information processing. Productivity and product quality in metal extrusions are not mutually independent. The dependencies are:

Productivity • Extrusion rate

Quality: • Extrusion rate • Billet temperature • Extrusion temperature

Limiting factors: • Maximum extrusion force of press / die • Maximum billet temperature
• Prescribed ranges of Process parameters

MoMAS®offers optimal *iso-thermal extrusion*; with a furnace or quenching system which can control billet temperature taper, you can get optimal *iso-thermal and iso-speed* extrusion. **MoMAS®** fulfils tasks. It

1. ..... *measures and displays*
   profile temperature, extrusion force, ram velocity etc. during every cycle and the time per billet, standard deviation and the mean temperature over the cycles
2. ..... *optimises extrusion*
   by calculating optimal process inputs between successive cycles and transferring these to the PLC
3. ..... *archives and retrieves best process inputs*
   for an order; it automatically retrieves and uses the best inputs if the order repeats. This feature makes it possible to optimise extrusion, even with short orders (three to five billets billets)

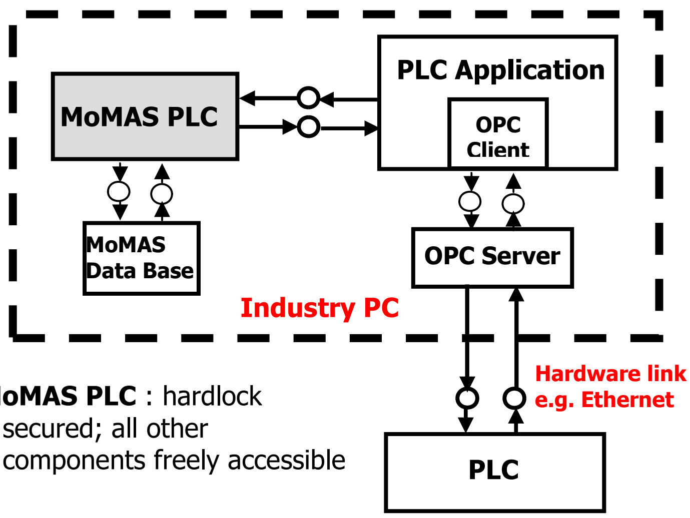
Furthermore:

MoMAS®provides the extruder managers and engineers with a versatile data base for logging and analysing the process data and keeping a watch over the *extruder* (machine and man) and *product*

Presses which use **MoMAS®** *:*

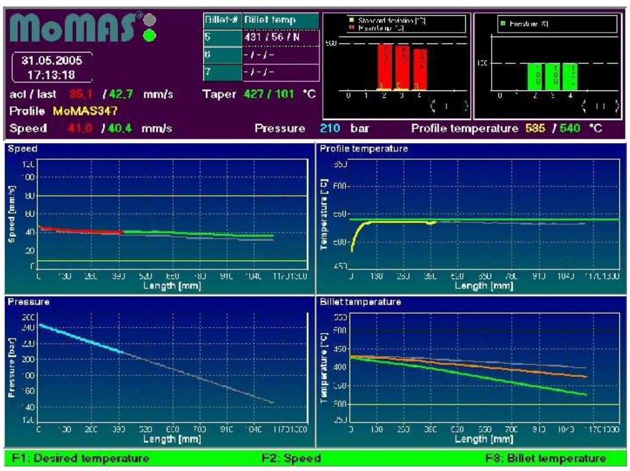
3 presses in Germany (SAPA , ALCAN and Research Centre for Extrusions, Berlin)
1 press in Sweden (SAPA)
2 presses in Italy (ALEX and COMETAL)
2 presses in USA (SAPA)
4 presses in Australia (CAPRAL)
2 presses in Russia

Production statistics in an industrial press comprising over 50 000 extrusions showed that the mean extrusion rate with **MoMAS®** *was 6% higher than without.*



MoMAS PLC : hardlock secured; all other components freely accessible

MoMAS® software configuration



MoMAS ® display as the operator sees it

Prof. Dr.-Ing. Habil. M. Pandit **Kaiserslautern, Sep. 2005**

ISSUES TO BE CONSIDERED DURING PLANNING of AUTOMATION SYSTEMS

It is not seldom that a company acquires an automation system, and the operators use it for a few days or weeks but gradually revert to the old scheme of things, i.e. operate the extruder manually. This is unsatisfactory and should be pre-empted.
In order to do this it would be advisable to take a look at the following points.

Commercial viability

Is the extruder plant working at its full capacity ?

Is there a demand for increased product output?

Is a new market sector being envisaged?

Is a customer to be catered to, who asks for proof of the ranges of process parameters which have been adhered to during production?

Technical feasibility

1. Are the hydraulics and ram position / speed control adequate?
   Extruders not older that 20 years are equipped with PLC and velocity control. Best performance is obtained if the ram speed is controlled and the profile speed just measured and displayed. Profile speed display is often necessary, because operators almost always observe and adjust only the profile speed. Some extruders have profile speed control which is not suited for operating the extruder with varying speed which is mandatory for iso-thermal extrusion. Generally an extruder is designed to be operated at a constant speed. Iso-thermal extrusion demands a speed which generally varies with the ram position. Check whether the actual ram speed follows changes of the set point with negligible error, if the set point is varied during an extrusion cycle.
2. Is the billet furnace temperature control in order?
   For a constant reference input to the billet temperature control loop, the billets coming out of the furnace should have the same temperature after the steady state has been reached. If the reference input is changed, a few bars pass before the new steady state is reached, i.e. before the bars have the temperature equal to the reference input temperature. The transition should not comprise more than 2 or 3 billets.
3. Is the puller control adequate?
   When the ram speed changes with the reference input, the puller motion control should be adequate so that the profile speed varies correspondingly.
4. Is the PLC capable of handling the data traffic to the PC? Is an OPC server available for the data transfer?
   This is a vital requirement. MoMAS receives measurement data sent by the PLC during extrusion and the process data and the measured billet temperature during the idle time between 2 cycles. It transmits the optimised data (reference inputs for the billet temperature control and ram speed) to the PLC also during idle times between two cycles.

Expertise of and acceptance by the crew

1. Installation and maintenance
   MoMAS depicts an open system whose functions can be integrated into the overall working of the plant data processing system to gain maximum advantage. In order to exploit the capabilities fully, technicians capable of programming the PLC and configure the data transfer and PLC set-up to operate in concert with the plant data base would be very useful. Is such expertise available?
2. Process engineering
   MoMAS helps operate the extruder under prescribed conditions, viz. limits of process parameters. In order to exercise this possibility, the expertise of a process engineer is needed who can prescribe the limits and / or evaluate the data acquired and supplied by MoMAS to find the optimal parameters and

limits. Underlying this expertise is the knowledge of the relationship between material parameters such as Young´s modulus, hardness, tensile strength etc. on the one hand and the process parameters such as billet temperature, extrusion speed, profile temperature etc. on the other.

Are the services of such a process engineer available, who can specify the extrusion parameters / ranges/ limits of extrusion parameters to the operators and interact with the process?

3. Enthusiasm of the operating crew

   The success of any system which is added to the extruder depends upon the will of the operator to make it work and his competence. Is the crew capable of operating a new system and does it have the spirit to exploit the capabilities of the new system. Would it have difficulty to look at both temperature and speed instead of concentrating only on the speed?

The Checklist is to summarise relevant data for assessing whether and how **MoMAS**® is to be installed

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MoMAS® MoMAS - Mobile Measurement and Automation System for Extruders

- **Check List** (Information to be provided by the extruder crew) –

I Extruder, Furnace, Puller

Project: ....

Firm: ....

Place: .... **Date**:.........................

Product types ....

No. of shifts / per week .... **Annual tonnage** ....

No. of extrusions per die change .... (typical)

Extruder: Manufacturer and year of installation........................

Type:	direct / indirect	Extrusion force:	.... tonnes
Alloy:		Hydraulic control/actuation:	....
Block length:	.... mm	Control electronics:	Relay / PLC Type: ....
Block-Ø:	.... mm	Velocity control:	Yes / no
Extrusion time / billet	.... s (typical)	Idle time between extrusion cycles	.... s (typical)

Variable which is controlled and which the operator gives as input	**Ram speed**	**Oil flow**	**Valve position** ....

Billet furnace:

Type: Gas / Oil/ Induction

Taper heating: yes / no No. of zones ....

Puller: Details of puller and control of puller motion: ....

....

II Process variables and sensors

Sensors available and sensor signals which can be tapped at PLC:

Variable	Sensor installed: yes / no; Sensor type	Signal at PLC
Extrusion speed (Ram velocity)		
Ram position		
Profile exit temperature		
Hydraulic pressure		
Billet temperature		
Container temperature		

III Programmable Logic Control (PLC)

Make, Type and Date of installation of PLC ....

....

OPC available ☐ yes ☐ no

Availability of links between PC – PLC (e.g. ETHERNET) …………………

Provision to access process parameters and batch data from PLC ☐ yes ☐ no

Contact person for PLC:

Name... Designation/Position ....

Tel. No. .... Telefax...

Email...

IV Data Base (if in use) ……………………………………………………………………………

Contact person for project:

Name... Designation/Position ....

Tel. No. .... Telefax...

Email...

Date............................... *Signature...*

Some hints and needs for setting up hardware for MoMAS®.

First of all, a state of the art standard office PC should be sufficient for **MoMAS®** (>1.5Ghz, >512MB RAM, >40GB HDD). Then, an OPC server running on the MoMAS PC for the connection of **MoMAS®** to the PLC is needed. Due to past experience we recommend RSLinx.

A monitor for visualisation should be installed at te operator console.

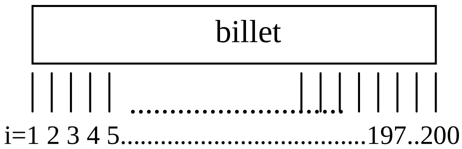
As online measurement data, **MoMAS®** needs

- Elapsed time since extrusion start
- Absolute ram position
- Pressure
- ram speed
- Profile temperature
- Measurement pointer

from the PLC.

The Measurement Pointer is a number which represents the index of the measured data.

The measurement pointer is very important, because **MoMAS®** expects 200 equidistant measurement points spread over the billet length according to the absolute ram position. It can be a simple counter that increments after each "delta extrusion length" according to the current billet. This helps us to normalize the data for optimization of billets with different billet lengths.



The online measurement data have to have an update rate of at least:

((Minimum billet length[mm]) / (maximum ram speed[mm/s])) / 200

that brings us to 150 ms, if we assume a minimum billet length of 600mm with a maximum ram speed of 20mm/s. Of course you can adapt these values according to your situation.

As mentioned above, these values are expected to be located at 200 "measurement points" over the billet length, addressed by the measurement pointer (just an increasing counter from up to 200).

Thus with Δ = billet length/200,

at each location $i \cdot \Delta$, i = 0, 1, 2, ..., 199 of the ram the data set

[$t_e(i\Delta)$, $l(i\Delta)$, $p(i\Delta)$, $v_R(i\Delta)$, $\vartheta(i\Delta)$ i] has to be sent by the PLC to **MoMAS®**.

There is a small pit fall with this "200 values". Because one sends to **MoMAS®** as 'current billet length' the length of the uncompressed billet, one has to correct the absolute ram position you send to **MoMAS®** during extrusion by a factor such as (length uncompressed / length compressed) to get the uncompressed billet length which is used by **MoMAS®** for display and optimization.

MoMAS® writes an optimized ram speed to the PLC as 20 values spread equidistantly over the billet length and an optimized billet temperature as 4 values over the billet length. Therefore float memory is needed in the PLC.

There are two parameters in **MoMAS®** which have to be adapted to the press, viz. the distance between the die exit and profile pyrometer and the press rest at the end of an extrusion cycle.

Appropriate register addresses should be assigned in the PLC for

Handshake Signals,

Measurement Data and

Process Data

Optimised inputs