Computer Iron Casting Process Control System for Blast Furnaces

Florin Hartescu and Carmen Oana

Real Time Systems Laboratory
Research Institute for Informatics
8-10 Averescu Avenue,
71316 Bucharest
ROMANIA

Abstract: The paper presents an integrated plant system designed for blast-furnace charging and iron casting process control in a blast-furnace. The system is based on a RT-ARCH (Real Time ARCHitecture), an architecture comprising software tools to be used in process control.
Keywords: Industrial application, technological process, process control, real-time system, process computer.

Florin Hartescu was born in Bucharest, Romania in 1950. He received his M.Sc. in Computer Science from the Polytechnical Institute of Bucharest. He also graduated the Faculty of Mathematics, the University of Bucharest. He works as senior researcher at the Research Institute for Informatics in Bucharest. He is preparing a doctoral thesis in the field of real-time systems.
His research interests include real-time systems, process control systems, databases, parallel architectures, CAD tools for automation, networks.
He published numerous papers and he is a member of DECUS.
Carmen Oana was born in 1967. She received her diploma in Control Engineering from the Polytechnical Institute of Bucharest in 1991. She joined the staff of the Research Institute for Informatics in Bucharest in 1992. Her main research work is carried out in the field of real-time systems and process control.

1. Introduction

The paper presents a computer control system for an iron casting process which benefits the latest research results of temporal semantics. The created system optimizes the cowper thermic processes and controls the blast furnace charging and iron casting processes. The control system optimizes the cowper thermic process in terms of high thermic efficiency and economical combustion. In order to attain such objectives, researches aimed at developing a wide range of algorithms capable of simulating the processing environment, by computing heat level for cowper heating, and the gas mixture caloric power and by computing air flow necessary for a complete burning.

2. Blast Furnace Control System

The blast furnace control system moderates material prescription and material furnace laying, and computes any necessary remedies. The iron casting blast furnace control system compares the observed data with those predicted using a mathematical model to generate correction settings. Both control systems make extensive use of temporal semantics.

The application model consists of the following component models:

- charging computing model
- charging distribution model
- thermic regime model and weighing balance
- anticipation silicon model and silicon reduction
- hearth control model
- metal and slag evaluation quantity model
- wear hearth and lateral wall model
- blast furnace temperature and gas circulation model
- melting zone temperature model

Such researches resulted in:

1. A set of modelling techniques, which integrates data structures and functions for active temporal data.

2. A representative model for multiple dimensioning of temporal information in a process control environment.

3. A control system based on the integration of historical information and of current active temporal data.

4. Higher system performance by using real-time and parallel processing techniques.

3. Software and Control Components

1. A Sun's based temporal database system(TDM), provides a context for modelling and simulation.

2. Real-time Database Management Subsystem for industrial application-RTDO - provides access to the process database, similarly as to accessing indexed files but at a speed comparable to the access time for data stored in internal memory, in COMMON regions. The RTDO data structure corresponds to the relational model. RTDO utility programs provide the data structure definition and data loading into the relations. RTDO provides the independence of data against the application programs.

3. Computer Process Supervisory and Control subsystem- DD-Master-, based on continuous and/or batch weighing equipments, is a program package enabling the communication between minicomputer- and microprocessor-controlled weighing/dosage equipments, updating the process values and states controlled by the weighing equipments , and the communication between process operator and computer system. The microprocessor- controlled weighing equipment allows an automatic weighing and dosage operation of raw- materials, according to programmed receipts (certain quantities and proportions of different raw- materials), and can be used with or without computer supervision. The DD-Master software supervises maximum 32 microprocessor- controlled weighing equipments, which are interconnected to the supervisor computer through twisted pair lines, the transmission being serially asynchronous by the speed of 9,600 bauds. The DD-Master provides the process operator with several predefined screens on a display terminal, with current information about the states of the weighing/dosage equipment, the process parameters as well as the quality of the serially asynchronous transmission between the supervisor computer and the existing weighing/dosage equipment.

4. Process Operator and Computer System Communication Software/ Output Reports Generation Software gives the possibility of defining and using a large variety of reports and forms to be displayed on video terminals or hardcopy printers, as well as an interactive communication between the process operator and the computer control system. The program package includes the following main components : video forms editor, video forms translate program, forms library management utility program, a set of routines for accessing the video forms from user program.

5. Industrial Process Graphical Representations Definition, Manipulation and Editing Software is a support for the creation and manipulation of process synoptical graphic representations on video terminals, for supervision and control purposes. The subsystem has two major components: a) a graphic editor for synoptical representations and graphic diagrams; b) a set of routines for on- line updating of synoptical graphic representations from user programs. The users are offered graphic editor facilities for the creation and maintenance of synoptical representations by means of some graphic primitives such as LINE, CIRCLE, ARC etc., as well as by means of standard graphic symbols libraries, symbols manipulated by graphical primitives like MOVE, ROTATE, TYPE, FIX, ZOOM. The graphical symbols are also created by editing operations and are to be stored in an appropriate library. The set of routines for the on-line updating of synoptical representations, is implemented as an "image" code sharable between several processes using this subsystem on- line.

6. Process Control Computers Reservation software, is dedicated to uninterrupted operation of a computer configuration consisting of two computers and a special BUS-SWITCH device. The subsystem
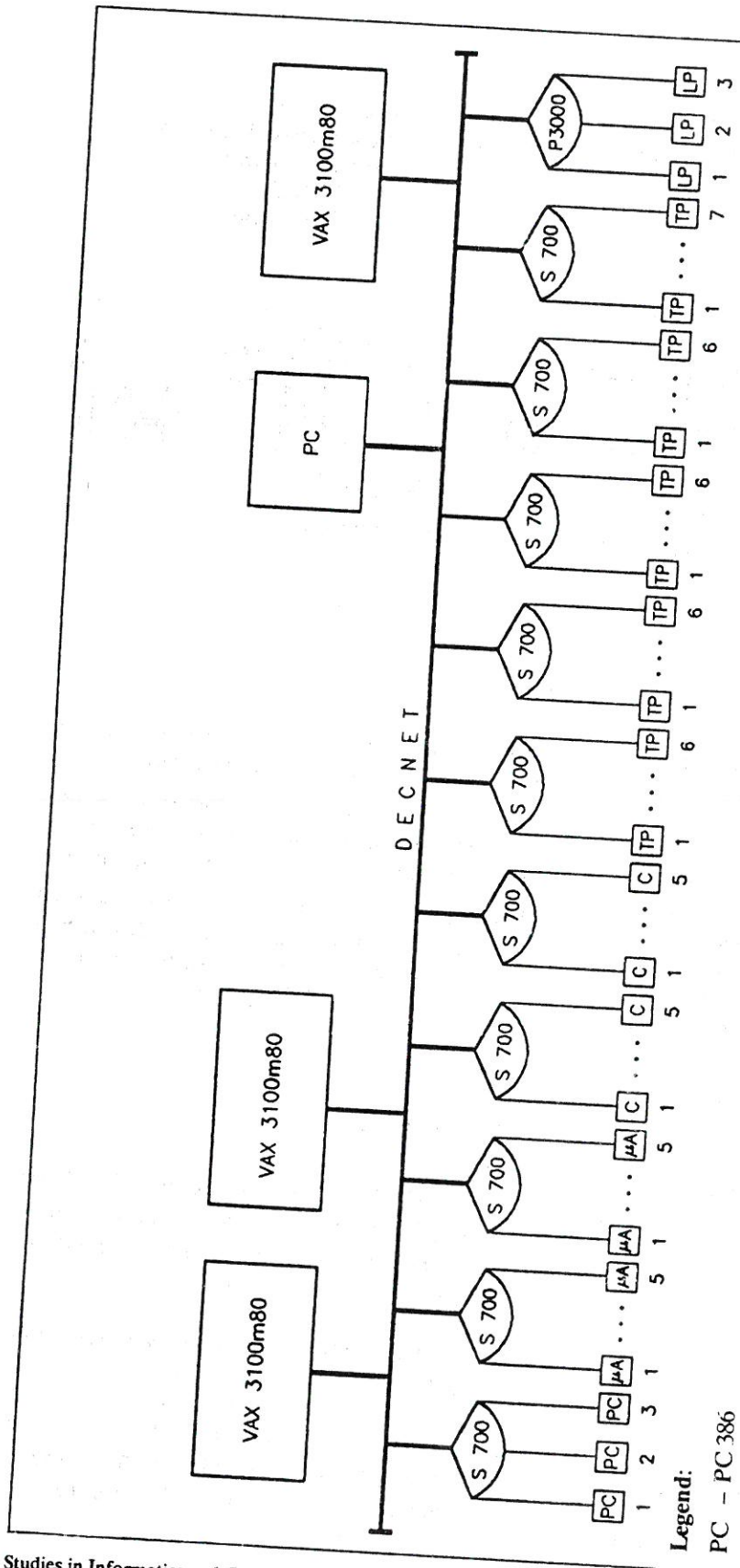
Figure 1.

Legend:

PC – PC 386

μA – μArgus Interface

C – APMaster CORAL

TP – VDT 240 Terminals (22 pcs.) or Matricial Printers (9 pcs.)

LP – Parallel Printer

VAX
ALPHA

MicroVAX
PDP 11 – compatible CORAL
UNIX Machines

Process Interface PC
Programmable Automata
Automated Chargers
Micro ARGUS
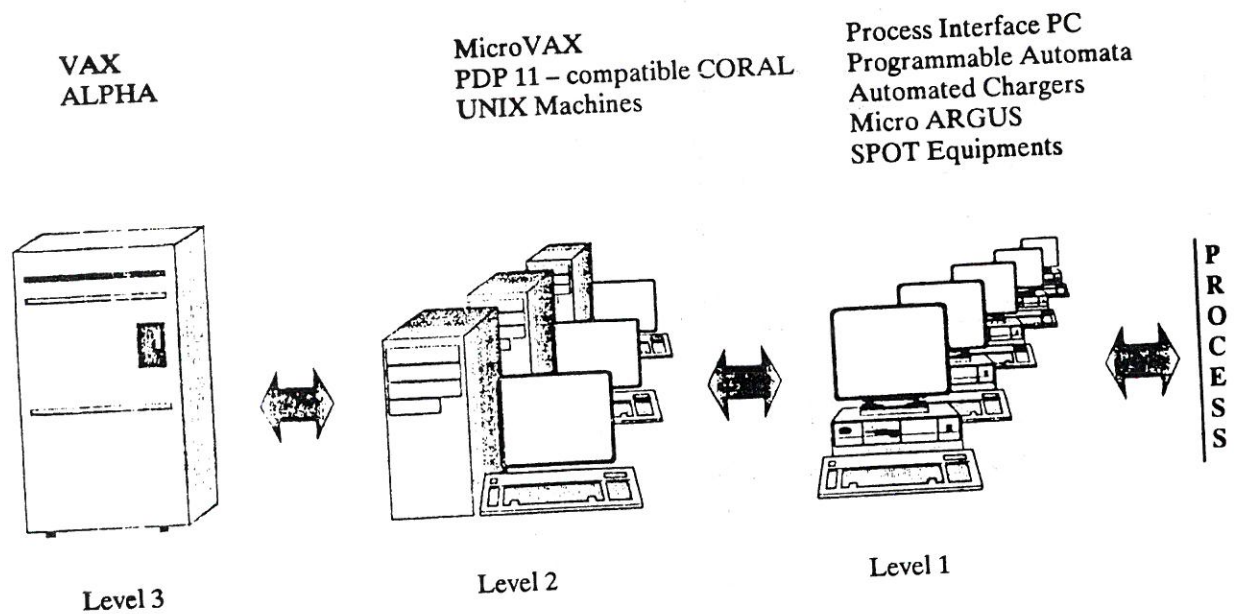SPOT Equipments

Level 3

Level 2

Level 1

P
R
O
C
E
S
S

Figure 2.

considers one of the computers as MASTER and the other one as SLAVE (under operation) or "switched-off", for maintenance purpose, for instance. MASTER or SLAVE attribute is not fixed in time to one computer or another, but it is assigned according to momentous functioning states of each computer. The two computers also have a high speed communication connection, which helps update the process database, pertaining to the SLAVE computer.

7. Networking computers in complex industrial processes control systems, consisting of several computers, needs a program support not only for their physical interconnection but also for enabling transparent functional communication among the different application program entities which are distributed on these equipments.

4. Conclusions

Implementation of this system at steel works in Romania accounts for its advantages: limited efforts for developing new applications in a short

period of time, and high efficiency of the system in solving the demands of the applications.

The system is suitable for a large variety of real-time applications, of which configuration covers computers and various process control equipments.

Flexibility and modularity associated with efficient data acquisition and management and with a built-in support for the main functions of such applications, are the main features of the system.

REFERENCES

1. RT-ARCH - A New Approach in Real-Time Application Design. Mini and Microcomputers and Their Application, Lugano, 18-21 June 1990.

2. ESPRIT - Information Process Systems and Software.

3. LAPRIE, J.C., Dependability: A Unifying Concept for Reliable, Safe, Secure Computing, IFIP Congress, Madrid, 1992

4. **Algorithms, Software, Architecture, Information Processing,** IFIP Congress, Madrid, 1992.

5. CALIN, S., **Digital Tuning of Technological Processes.**

6. CALIN, S., **Numerical Control Systems,** Technical Publishing House, Bucharest.

7. DUMITRACHE, I. et al, **Automatic Control Techniques,** Technical Publishing House, Bucharest.

8. NONSTOP-32, **A Fault- Tolerant System Used in Metallurgical Plants,** STUDIES IN INFORMATICS AND CONTROL, Vol. 2, No. 1, 1993, pp. 61-64.