
Jožef Stefan Institute
DEPARTMENT OF SYSTEMS AND CONTROL
Developments and applications
1985–2010

Jožef Stefan Institute
Department of Systems and Control
DEVELOPMENTS AND APPLICATIONS

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Foreword

The earliest roots of the ***Department of Systems and Control*** *date back to the late 1950s and early 1960s, a period marked by intensive developments at the Jožef Stefan Institute in the area of electronics design for nuclear-reactor technologies. The initiator and leader of the activities was Professor France Bremšak, known for his important contributions to analogue computing and simulation. Professor Bremšak is credited with being the first person in the Slovenian scientific community to recognise the relevance and need for systematic research on control theory and its practical applications. With this in mind he founded the Department of Analogue Technique and Servo-Mechanisms, which evolved in the early 1970s into the Department of Automatic Control, Biocybernetics and Robotics. With the expansion of the field of control in the years that followed, the Automatic Control Group, which made up part of the former department, expanded into the new Department of Computer Automation and Control being established in 1986 by Professor Stanko Strmčnik who also had been its head for more than 25 years. As the range of activities continued to increase, the current title of the Department of Systems and Control was adopted.*

*Since its very beginnings our department has been focused on the transfer and exchange of knowledge with industry, in accordance with the department's mission statement "****to bridge the gap between theory and practice****". To achieve this goal a broad spectrum of activities has been developed, ranging from basic and applied research, to development, industrial applications and teaching. As a result, the activities of the department can be divided into several areas.*

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In the area of basic research, the aim is to contribute knowledge, methods and algorithms for a better analysis of systems' behaviour, the design of control actions and the optimisation of performance. The results from these various activities have been summarised in numerous journal publications, books and conference proceedings.

Our contribution in the area of education falls into three main categories. First, the department has been providing opportunities for postgraduate study, and as a result of this many PhD and MSc theses have been completed over the years. Second, a number of our staff are lecturers and assistants in regular graduate and postgraduate programmes at the University of Ljubljana, the University of Nova Gorica, the University of Maribor and the Jožef Stefan International Postgraduate School. Third, our staff have been organizing and contributing regular curricula for the continuing education of engineers from industry.

One of our most important areas of activity is the development of new tools, devices, systems and technologies based on results achieved through applied research and development. The aim of this booklet is to provide a summary of the key results from the past 25 years. Two types of results are described: results from our own development that were later implemented in commercial applications, and results from our work with partners from industry. Several smaller projects are also presented, because they are very interesting from the technological point of view, even though their results have not yet found their way to the market.

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What the presented achievements have in common is the fact that at the time they came into being they represented either a technological breakthrough or an innovation, not only locally but also in the wider sense, and have, as such, influenced technological development.

This review is intended to draw attention to the tradition and continuity of our department in the area of technological advancement as well as to stress our ability to extend these ambitions to our future work.

In what follows is a review of our most important application and development achievements, placed in the context of the time when they occurred or the application they were intended for. At the end we have provided a complete list of projects carried out by our staff for industrial and other partners.

Let me stress that some of the achievements below have resulted from joint endeavours with other research and development teams. In particular, it is my pleasure to acknowledge a long and fruitful cooperation with the Laboratory of Modelling, Simulation and Control and the Laboratory of Autonomous Mobile Systems at the Faculty of Electrical Engineering in Ljubljana as well as the INEA company from Ljubljana.

Head of the Department: dr. Vladimir Jovan

The system for real-time analysis of operating characteristics of the family of electronically commutated electric motors

CUSTOMER • Domel, d. o. o.

OBJECTIVES • the diagnostic system enables semiautomatic end quality assessment of electronically commutated (EC) electric motors as well as diagnostics of manufacturing faults and detection of deviations of the quality of the components.

DESCRIPTION • the diagnostic system measures the characteristic features of each produced electric motor based on the information from two accelerometers' signals, input power, voltage between phases and phase currents. After an advanced signal processing and diagnostic algorithms are carried out, 'birth certificate' of each complete motor is produced. For faulty motors, the most likely cause of quality deviation is indicated. Data on the diagnostic findings are stored in the company's information database.

INNOVATION • the system consists of an innovative test set-up, which allows simultaneous measurement of rotor unbalance and defects in the bearings. The application of Hilbert's transformation in signal processing enables a very effective detection and evaluation of defects in the bearings. Monitoring of the induced voltage is used for the diagnostics of irregular magnetisation of permanent magnets.

BENEFITS • the diagnostic system allows 100-percent quality control of EC-motors without operator intervention. The operator provides only for the proper location of the motor on a test stand and sticking labels onto the corresponding motor. This way "human factor" is eliminated from the diagnostic process and only fault-free products go to the market. Using this diagnostic system has enabled the company Domel, d. o. o. to gain trust of new customers in the global market.

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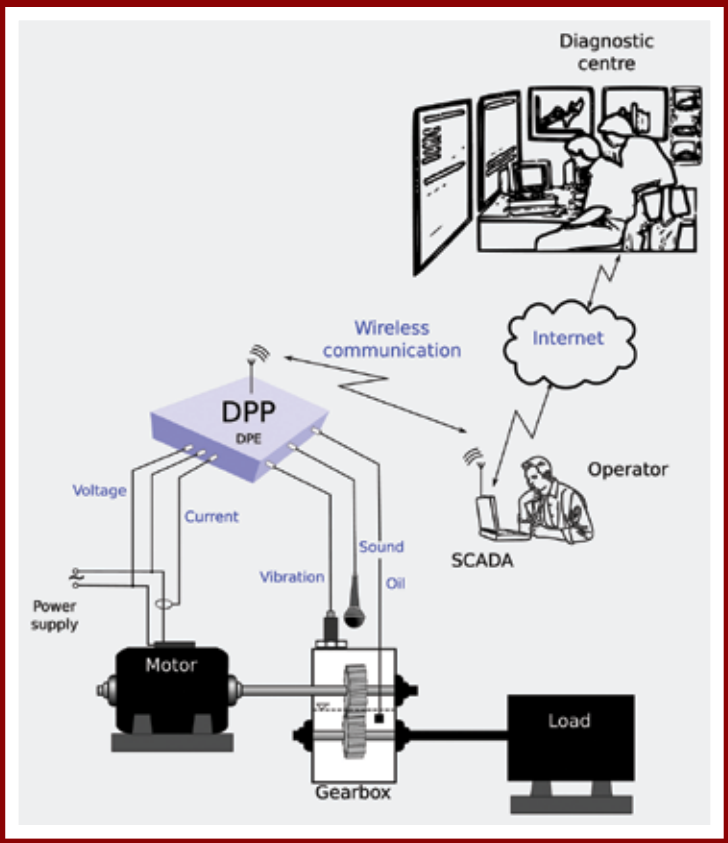
DPP 822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DPE
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Voltage
Current
Sound
Vibration
Oil
SCADA
Power supply
Motor
Load
Gearbox

DPP 822 – a prototype system for real-time detection and localization of faults in mechanical drives

CUSTOMER • an internal project within the research programme

OBJECTIVES • DPP 822 is a prototype device that allows real-time non-invasive condition monitoring of the rotational machinery and mechanical drives, automatic detection and localization of faults and prediction of the remaining useful life.

DESCRIPTION • the device is based on a digital signal processor (DSP) that performs real-time acquisition and processing of signals and allows communication with the operator and maintenance centre. The device can be connected with a wide range of sensors, such as vibration, sound, rotational speed sensors, sensors for electrical parameters, real-time oil analyzers etc. The sensor fusion procedures are available to reach high diagnostic requirements in industry. The design and the system configuration are carried out in Matlab/Simulink environment.

INNOVATION • DPP 822 enables the use of advanced diagnostic algorithms. The inexpensive equipment and versatile configuration environment guarantee low cost implementation. The latter is particularly easy since thanks to the radio frequency communication minimal local wiring is needed.

BENEFITS • reliable equipment monitoring (predictive maintenance), reduced maintenance costs, reduced breakdowns and increased availability of equipment. Since it is relatively cheap, the system is accessible to a wide range of users in industry, transport and power engineering.

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Communication module - GSM RTU 2200MB SIBA

CUSTOMER • Inea d. o. o.

OBJECTIVES • an industrial module for remote control and diagnostics of geographically remote processes.

DESCRIPTION • GSM RTU 2200MB SIBA module serves as a communication gateway between a remote control centre and a local communication network. Remote connection is relayed over a GPRS/GSM connection. On the other hand, the local communication is supported by Modbus TCP protocol via Ethernet connection. The module allows an integration of an additional universal communication module which enables a substantial increase of the range of supported industrial buses (Bluetooth, CANopen, CC-Link, DeviceNET, Ethernet, EtherCAT, GSM, Profibus, Wifi ...). Furthermore, the module can perform the function of programmable logic controller with two dedicated digital inputs and outputs.

INNOVATION • cost effective and compact industrial communication module, based on ARM Cortex-M3 microcontroller. The GSM RTU 2200MB module supports over 25 standard industrial buses. In addition to providing versatile communication hub functionality, it also serves as a basic programmable logic controller.

BENEFITS • as a key element of the company Inea, d.o.o., this module has enabled realization of new projects in the field of remote monitoring and control.

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Fuel-cell stack freezing prevention system

CUSTOMER • Inea d. o. o.

OBJECTIVES • the system for prevention of fuel-cell stack freezing allows the use of systems with PEM fuel-cells even at ambient temperatures below the freezing point of water. Power systems with fuel-cells can be thus kept at temperatures to about –20 °C. Also immediate startup of these devices is possible at subzero ambient temperatures.

DESCRIPTION • a system for freezing prevention with regulated re-heating of the coolant in the primary cooling loop replaces the heat loss caused by radiation and convection. Temperature drops of the fuel-cell stack below 0 °C cause water freezing in the cooling loop and on the cell membranes. This might cause permanent damage to the stack or to the cooling components. When the system detects a drop in temperature below +2 °C, it turns on the circulation pumps and compensates for the loss of heat with the battery power.

INNOVATION • the system allows real-time replacement of heat losses and, unlike the systems that perform preheating, it ensures non-problematic conservation of fuel cells in stand-by mode and allows instant startup. Moreover, the requirements of the battery current capacity are considerably lower. Reliable and efficient regulated heaters provide only as much heat as required to maintain the system above the freezing point. Precise thermostats turn on the circulation pumps or alert the user in time.

BENEFITS • the system for prevention of fuel-cell stack freezing is integrated in two different systems of auxiliary power units in military vehicles. At external temperatures down to -18 °C during winter time the system ensured survival of power units with fuel-cells and allowed their immediate startup. This solution is suitable for all similar power units which must operate in conditions with low temperatures.

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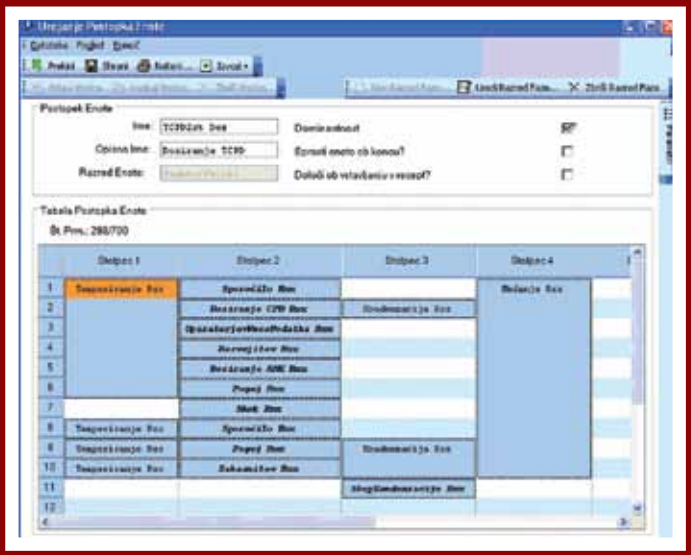
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Resin synthesis batch process control system

CUSTOMER
- Inea d. o. o.
- Color, d. d.

OBJECTIVES
- modernization of the resin synthesis batch process control system, aimed at increasing the reliability, safety, flexibility, repeatability, traceability end efficiency of the process control.

DESCRIPTION
- resin synthesis batch process control, consisting of basic control, procedural control, coordinative control and recipe control of six batch resin synthesis lines.

INNOVATION
- the first application of the PLCbatch tool for recipe control of batch processes on industrial controllers platform. The tool is a result of a common development effort of IJS and Inea, which, together with consistent performing of all the needed life-cycle activities, has resulted in high quality of the control system.

BENEFITS
- shorter batch cycles
- high process repeatability and stable product quality
- flexibility of control
- more accurate dosing of materials
- reduced risk of operator errors
- increased safety and improved work conditions
- reduced environmental impact
- reduced energy consumption per product unit
- traceability and possibility of process operation analysis

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The AVTQ testing line control system, Danfoss Trata

CUSTOMER
- Danfoss Trata, d. o. o.

OBJECTIVES
- a control system for the AVTQ testing line for testing the components used in district-heating systems

DESCRIPTION
- simulation of conditions in district heating;
- repeatable autonomous execution of experiments;
- possible testing of different components, standard valves, control valves and substation for district heating;
- supervision system for configuration of the testing line and automatic generation of reports.

INNOVATION
- specially developed control schemes, allowing time monitoring of temperatures, pressures and flows which are defined by the user;
- control schemes are automatically adapted to the configuration of testing lines;
- a special-purpose developed supervision system with emphasis on extremely fast and responsive communication with the controller;

BENEFITS
- the possibility of testing various components of district heating,
- demonstration to customers and users,
- education.

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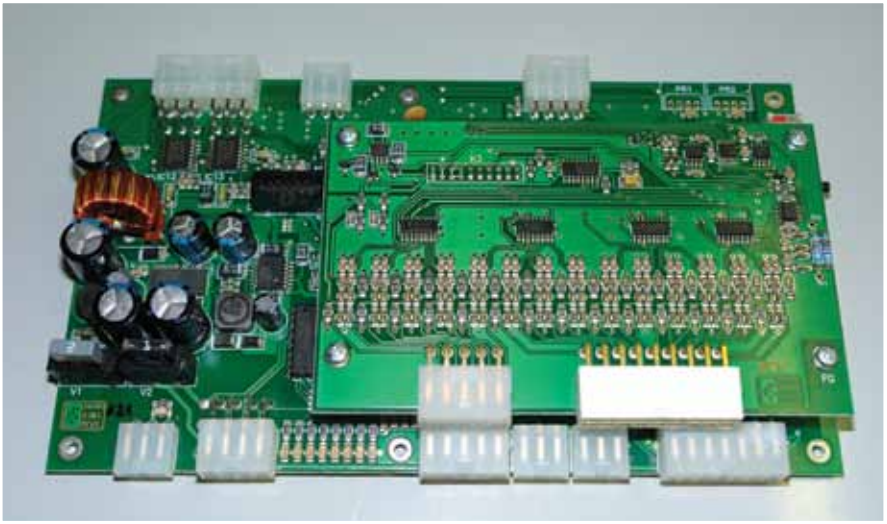

SmartModule - a control and supervisory module for the fuel-cell- based cogeneration power unit for combined production of electric and heat energy

CUSTOMER • Domel, d. o. o., PlugPower Inc.

OBJECTIVES • SmartModule control and supervisory module for the fuel-cell- based cogeneration power unit is a special-purpose electronic module for the control of the reformer and other sub-units of the cogeneration power system. The reformer is designed to extract hydrogen from natural gas. Hydrogen is used to power fuel-cells, while the generated heat is used for heating of sanitary water or central heating system.

DESCRIPTION • SmartModule control and supervisory module measures signals from sensors in the power system and based on the integrated algorithms and remote commands through CAN-bus adjusts the position of two stepper motors. SmartModule can measure signals from two air mass flow meters, two pressure sensors, 12 thermocouples, 4 standard sensors with voltage output and three digital sensors. It influences the operation of the reformer by two outputs for stepper motor actuators, by two voltage outputs 0-10 V, by a PWM output and by 10 digital outputs.

INNOVATION • SmartModule is a compact solution to control and monitor the process of reforming. In addition to the required functions, the integrated ARM Microcontroller also performs automated real-time calibration of temperature inputs, where stability of temperature readout is crucial for managing the process of the autothermal reforming.

BENEFITS • SmartModule modules are manufactured by Domel, d. o. o. and then supplied to the American company PlugPower Inc. The end client uses the modules to equip the latest systems for the PEM fuel-cell-based cogeneration power systems. These power systems equipped with our control modules have been presented on the world's most prestigious technology trade fairs.

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TESTLAB – Mobile test laboratory with fuel-cell power unit

CUSTOMER • Ministry of Defence of Republic of Slovenia

OBJECTIVES • mobile test laboratory with in-built fuel-cell-based generator set for testing and validation of various sub-systems used in hydrogen technologies.

DESCRIPTION • installed subsystems (electrolyser, photovoltaic panels, methanol reformer, metalhydrid storage, fuel cells, electric and thermal storages) enable the production of electric and heat energy from hydrogen. Installed measuring equipment makes possible on line testing and analysis of newly developed subsystems and devices.

INNOVATION • demonstration object for electrical and thermal energy production from hydrogen; experimental environment for the design, testing and validation of various newly developed special purpose components for fuel-cell-based applications.

BENEFITS • on-line testing of newly developed .subsystems and devices
• on-line validation of fuel-cell-based applications

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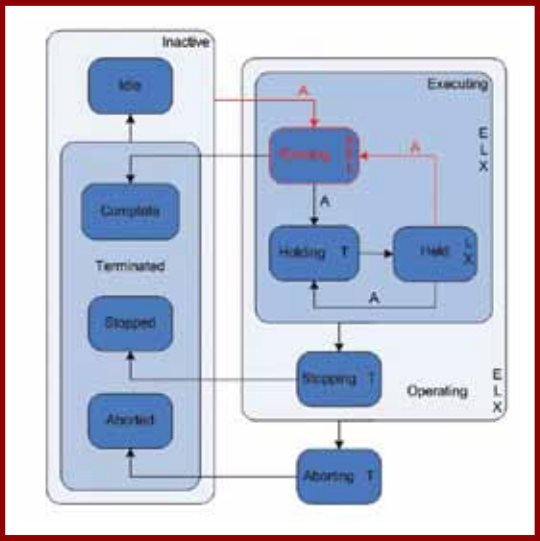
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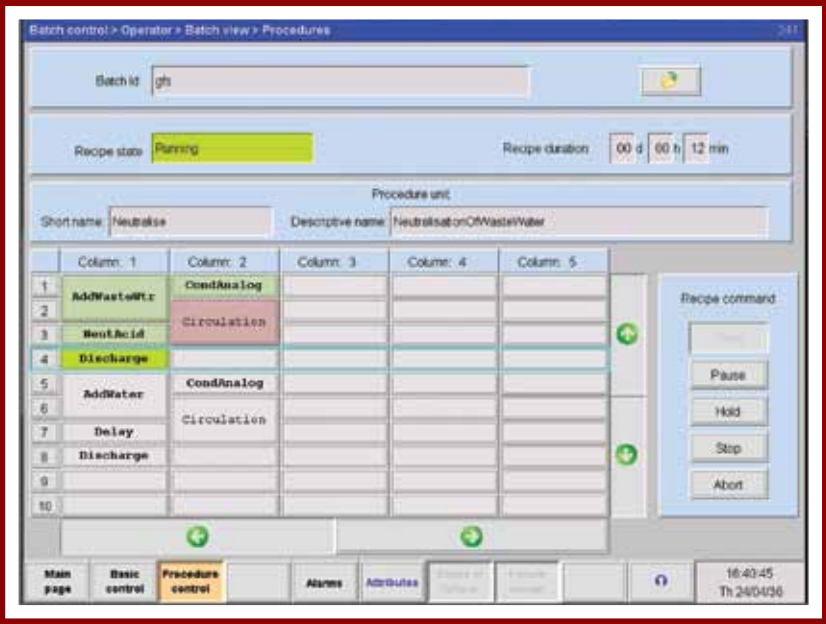
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Batch id gh
Recipe state Running
Recipe duration 00 d 00 h 12 min
Procedure unit
Short name Neutralise
Descriptive name NeutralisationOfWasteWater
Column: 1
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Column: 3
Column: 4
Column: 5
1 AddWasteWtr CondAnalog
2
3 NeutAcid Circulation
4 Discharge
5 AddWater CondAnalog
6
7 Delay Circulation
8 Discharge
9
10
Recipe command
Pause
Hold
Stop
Abort
Main page
Basic control
Procedure control
Alarms
Attributes
16:40:45
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PLCbatch – a S88.01 compliant batch process control tool for controller platform

CUSTOMER
- Inea d. o. o.

OBJECTIVES
- simplify batch process control systems without loss of expressive power and transfer the execution of recipes from the PC platform to the more reliable industrial controllers platform.

DESCRIPTION
- two-level tabular recipes
- general unit-class based recipes
- execution of an extended and adaptable state machine of individual phases

INNOVATION
- two-level tabular representation of SFC diagrams
- phases behavior model based on the concept of extended state machines on a high abstraction level
- object model of equipment and recipes based on overlapping equipment classes, conceived for minimizing repetition of information in recipes and maximizing recipe reuse

BENEFITS
- a simple yet efficient batch process control tool for industrial controllers platform has been developed, which enables a better mastering of batch process control systems development and assures considerably higher reliability of these systems.

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Development of intelligent valve

CUSTOMER • Danfoss Trata, d. o. o.

OBJECTIVES • design of electronics for the new generation of valve positioners and development of the function for automatic reduction of oscillations in the system

DESCRIPTION • we have developed three types of valve positioners, where we have met the requirements of constant speed and the end force of the valve. We have also developed a feature for automatic reduction of the dynamic valve gain in case of oscillations in the system.

INNOVATION • our developed speed control system with the system for achieving repeatable end force on the shaft for BLDC motors is one of the most innovative solutions in the field of control systems. Automatic elimination of oscillations in the system is the only system of this kind, implemented on the valves.

BENEFITS • reduction of the necessary electrical power drive due to the use of BLDC motors and reduction of the valve's wear due to the anti-oscillation function.

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Implementation of fuel-cell-based cogeneration system in mobile dwelling container

CUSTOMER
- Domel, d. o. o.
- Inea d. o. o.
- Ministry of Defence of Republic of Slovenia

OBJECTIVES
- implementation of fuel-cell based cogeneration system in mobile dwelling container in accordance with military standards

DESCRIPTION
- in addition to meeting the basic needs for heating/cooling/lighting, the cogeneration system also meets the energy needs of the installed special-purpose military communication and computer equipment in a residential unit - container.

INNOVATION
- the use of PEM fuel cell system as the power source for the cogeneration system;
- the use of hydrogen as an energy source.

BENEFITS
- no-carbon exhaust;
- low noise and thermal profile levels;
- a successful test of fuel cell technology as an energy source.

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Electronic assembly 3D LANC MASTER

CUSTOMER
- School Centre Šentjur
- VLS Computers d. o. o.

OBJECTIVES
- synchronization of two photographic or video cameras for stereoscopic shooting. Stereoscopic image/video allows the positioning of an object in space.

DESCRIPTION
- the device synchronizes the photographic or video cameras with LANC or ACC inputs and allows for the simultaneous capture of two images or video clips. Synchronization is enabled by simultaneous activation of two cameras and in some cases also by a permanent maintenance of synchronization. The device shows the difference in synchronization of both cameras and allows for synchronous use of certain camera functions (e.g. zoom, sharpness, access of menu functions, etc.).

INNOVATION
- the device is unique in the world, allowing continuous synchronization on some older non-professional Sony cameras. This is achieved by changing the frequency of the internal oscillator.

BENEFITS
- the developed device can be used for effective synchronization of two video cameras and to capture a stereoscopic image.

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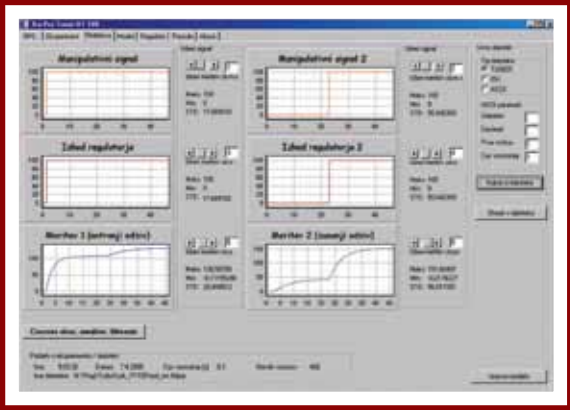
Manipulativni signal
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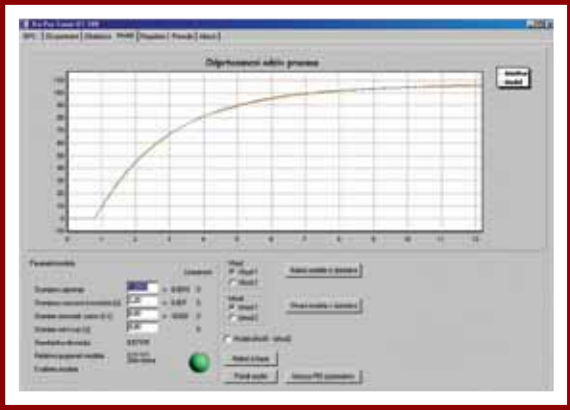
Izhod regulatorja 2
Meritev 1 (notranji odziv)
Meritev 2 (zunanji odziv)


Odprtozančni odziv procesa


Prikaz signala
Meritev 2

Rapid testing of advanced control algorithms in industrial environment

CUSTOMER • Slovenian Research Agency
co-financers: Technology centre ARI , Inea d.o.o., Mitol, d. d., Liko Pris, d. o. o.

OBJECTIVES • helping the user tune the parameters of advanced control algorithms, such as predictive controllers, multivariable regulators and regulators with feed-forward control

DESCRIPTION • selection of appropriate OPC signals, performing the experiment on the process (manual and automatic), the calculation of the process model and controller parameters, performing the closed-loop experiment on the process and automatic report generation in Microsoft Word format

INNOVATION • the calculation of the process model and parameters for advanced control algorithms is based on new methods which have been developed within the research work of our research group

BENEFITS • new procedures for setting the controller parameters allow the user to work more efficiently, save energy and enable a cleaner production. The developed tool can directly show the efficiency of advanced control methods compared with PID controllers.

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Fuel-cells system as an auxiliary power supply to extend the autonomy of military vehicles

CUSTOMER • Ministry of Defence of Republic of Slovenia

OBJECTIVES • fuel-cells-based auxiliary power supply for electronic equipment of special military vehicles.

DESCRIPTION • the auxiliary power source operates on the basis of the PEM fuel-cells stack which converts the electrochemical energy of hydrogen in the electrical energy. The integrated system allows power supply to DC loads with rated voltage of 28 V and AC loads with rated voltage at 230 V, 50 Hz. Direct current provides power up to 6.5 kW, whereas alternating current power output reaches 2 kW.

INNOVATION • the power supply for electronic equipment is enabled by PEM fuel-cells based system which operates at low operating temperature and with negligible noise emission. It provides low thermal footprint and near-silent operation. The innovative solutions include anti-freezing cooling system, alarm system for hydrogen leakage, connection to the uninterruptible power supply system and auxiliary diagnostic system.

BENEFITS • the auxiliary fuel-cells based generator setis a novelty of the Slovenian Armed Forces equipment. It is also an innovation in comparison with the neighbouring armies of NATO. The system has been tested in daily activities of the Slovenian Armed Forces and during military exercises. It is capable of regular functioning also at very low outer temperatures.

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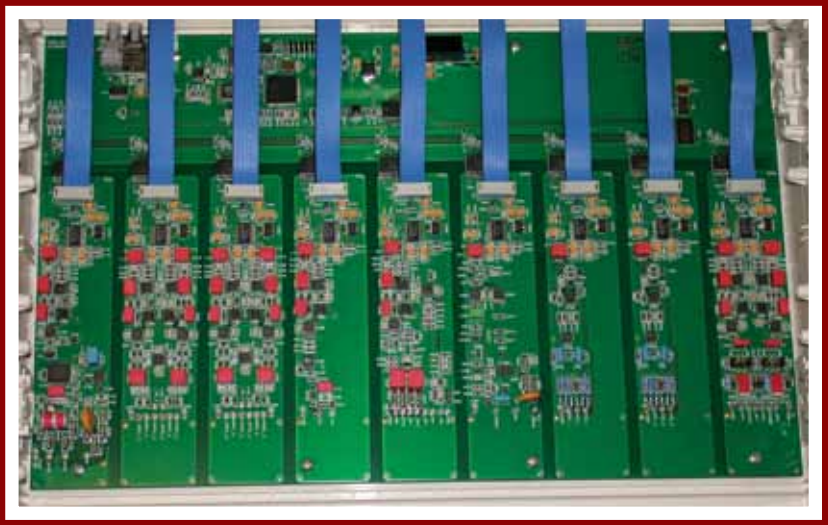

Cardio&Brain Signals Measurement System

CUSTOMER
- Lancaster University, Department of Physics, Great Britain,
- Royal Lancaster Infirmary, Great Britain,
- Ulleval University Hospital, Oslo, Norway,
- Institute of Pathophysiology, Faculty of Medicine, University of Ljubljana, Slovenia
- Neurology Clinic, University Medical Centre in Ljubljana, Slovenia
- Department of Endocrinology, University Medical Centre in Ljubljana, Slovenia

OBJECTIVES
- the measuring system Cardio & Brain signals allows non-invasive measurement and monitoring of various physiological functions.

DESCRIPTION
- the system allows simultaneous monitoring of electrical activity of the heart and brain, the dynamics of blood pressure, breathing patterns, skin conductance and temperature variation. It is also possible to connect other measuring equipment for monitoring physiological signals over two auxiliary channels, which are intended for general use. The Cardio&Brain measurement system digitizes captured signals and sends them via the USB connection to a personal computer. The personal computer is equipped with a dedicated software for storing, analysing and evaluating the signals.

INNOVATION
- a dedicated instrument for the analysis of coupling between brain waves and cardio-respiratory system;

BENEFITS
- it enables the in-depth studies of the interactions between brain waves and cardiovascular system with possible applications in many areas of medicine, especially in monitoring the depth of anaesthesia. Simple use and possibility of connecting additional equipment make the system attractive for multi-disciplinary studies.

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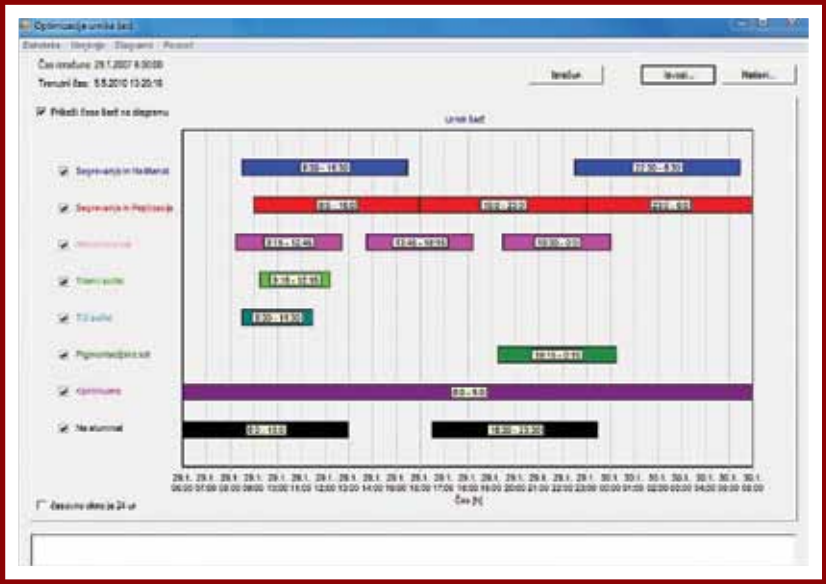
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Datoteka Urejanje Diagrami Pomoč
Čas izračuna: 29.1.2007 8:00:00
Trenutni čas: 5.5.2010 13:20:16
Izračun
Izvozi...
Nalaži...
Prikaži fose šoli na diagramu
Urnik šol
Segregacija in Hidrolat
Segregacija in Pepitacija
Hidrosol in hidrat
Tilenti sulfat
TiO sulfat
Pigmentacija in sol
Kondenzira
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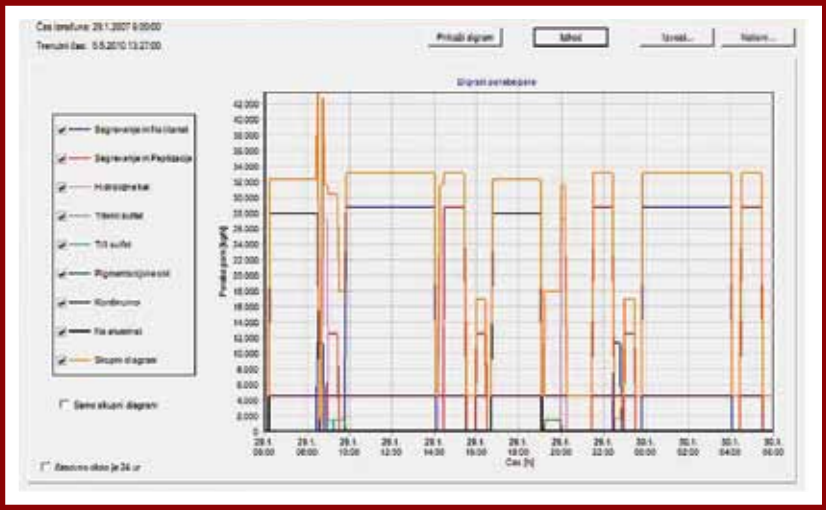
Čas [h]
Časovno okno je 24 ur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Trenutni čas: 5.5.2010 13:27:00
Prikaži diagram
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Izvozi...
Nalaži...
Diagram porabe pare
Segregacija in Na-Hidrat
Segregacija in Pepitacija
Hidrosol in hidrat
Tilenti sulfat
TiO sulfat
Pigmentacija in sol
Kondenzira
Na skupnost
Skupni diagram
Poraba pare [kg/h]
Čas [h]
Samo skupni diagram
Časovno okno je 24 ur

The algorithm for smoothing of the steam consumption in Cinkarna Celje

CUSTOMER • Cinkarna Celje, d. d.

OBJECTIVES • reduced oscillations in steam consumption in the process of preparation of raw materials

DESCRIPTION • batch scheduling for the next 24 hours considering the number and duration of batches and steam consumption per batch

INNOVATION • the algorithm for optimal selection of the batch schedule, where the fluctuations of steam consumption are minimum, taking into account all the limitations.

BENEFITS • support to operators at triggering batches in the preparation of raw materials, lower investment compared to buying a steam accumulator, pressure reduction in the steam boiler and reduction of excess steam releases.

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A control system for magnetically concentrated plasma wire processing machine

CUSTOMER • PlasmaBull GmbH, Lebring, Austria

OBJECTIVES • development and implementation of a system for automatic control of the new series of wire processing machines based on induction-generated plasma

DESCRIPTION • the new series of machines is based on two types of the source of plasma, i.e. induction and electric field. A control system to stabilize the power of induction-generated plasma and to control other electrical parameters has been developed especially for this series of machines. The control system also manages all peripheral plants (pre-heating, cooling, preparation and maintenance of the atmosphere in the electrodes).

INNOVATION • the process of plasma generation with induction has specific dynamic features that can not be controlled with standard control principles. Based on the analysis, we have developed a completely new control scheme which allows the stabilization of power and is essential for the proper functioning of the machine.

BENEFITS • the developed control system is one of the necessary subsystems of the new series of wire processing machines. The new series of machines represent a new market product for the customer.

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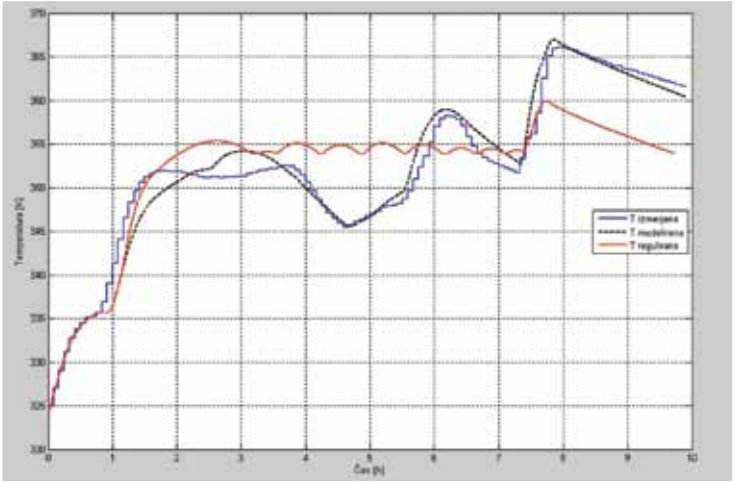
T izmerjena
T modelirana
T regulirana
Temperature [K]
Čas [h]

Model-based control of semi-batch process

CUSTOMER
- Mitol, d. d.
  Project within 6th Framework Programme

OBJECTIVES
- development of a mathematical model and its implementation in the simulation environment gPROMS for the optimization and improvement of the control process of polymerization in the company Mitol, d. d., Sežana

DESCRIPTION
- model-based control of the semi-batch polymerization process in an industrial reactor

INNOVATION
- development of a complex mathematical model of chemical reactions, the energy balance model, adjusting the model to real data, implementation in the simulation environment;
- development of algorithms for dynamic dosing of reagents.

BENEFITS
- lower temperature variations in the reactor
- lower variations of quality parameters.

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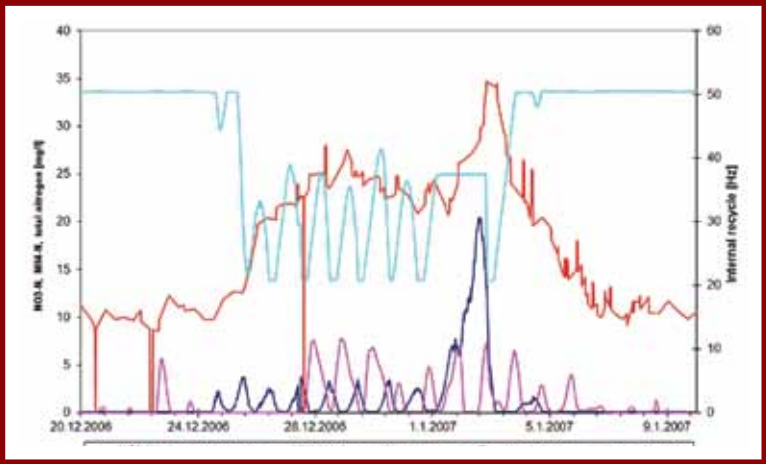
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9.1.2007
Internal recycle [Hz]


TreeCon

Control of the nitrogen removal process in wastewater treatment

CUSTOMER
- Domžale-Kamnik Wastewater Treatment Plant, co-financer: European Regional Development Fund

OBJECTIVES
- improvement of the nitrification and denitrification processes in wastewater treatment plant and consequently lower concentration of total nitrogen in the wastewater treatment plant effluent

DESCRIPTION
- control of the nitrate nitrogen concentration in anoxic reactors of wastewater treatment plant by dynamically adjusting the internal recycle flow;
- control of the ammonium nitrogen concentration in aerobic reactors of wastewater treatment plant by dynamically adjusting the set-point of dissolved oxygen concentration.

INNOVATION
- control of nitrification and denitrification processes using on-line measurements of ammonium and nitrate nitrogen in wastewater;
- dynamic adjustment of the internal recycle flow in the wastewater treatment plant.

BENEFITS
- optimum utilization of the carbon source in the influent wastewater for the denitrification process;
- adjustment of the dissolved oxygen concentration in aerobic reactors according to variable input load;
- lower concentrations of total nitrogen in the wastewater treatment plant effluent;
- lower aeration costs due to optimum utilization of carbon in anoxic reactors and consequently lower transfer of carbon to aerobic reactors, where oxygen is needed for their biodegradation.

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System for the automatic end-quality assessment of vacuum-cleaner motors

CUSTOMER • Domel, d. o. o.

OBJECTIVES • to provide a complete quality assessment of every vacuum-cleaner motor at the end of the assembly line and to isolate any faults and find their root causes.

DESCRIPTION • the system consists of three test cells that operate in sequence. Each test cell performs a different set of performance tests (basic characteristics, commutation, vibrations and acoustical tests). The set of measured signals is used to calculate a vector of features for each motor. If some of the features exceed the prescribed thresholds, the underlying motor is recognized as having faults and the root cause for the reduced quality is identified.

INNOVATION • an innovative design of clamping system that isolates the motor under test from environmental disturbances. Use of a servo system to scan the vibration profile along the motor body using a laser vibrometer. A patented system for acquiring the histogram of the commutator's sparking. Application of the acoustical noise measurement in a noisy industrial environment.

BENEFITS • the fully automatic quality assessment of the electrical motors precludes any need for additional manual checks. From the measurement point of view, the subjective "human factor" is entirely eliminated. Only motors that fully comply with the quality standards are delivered to the market. Better working conditions result in a healthier environment for operators. In particular, there are fewer hearing- and back-related problems.

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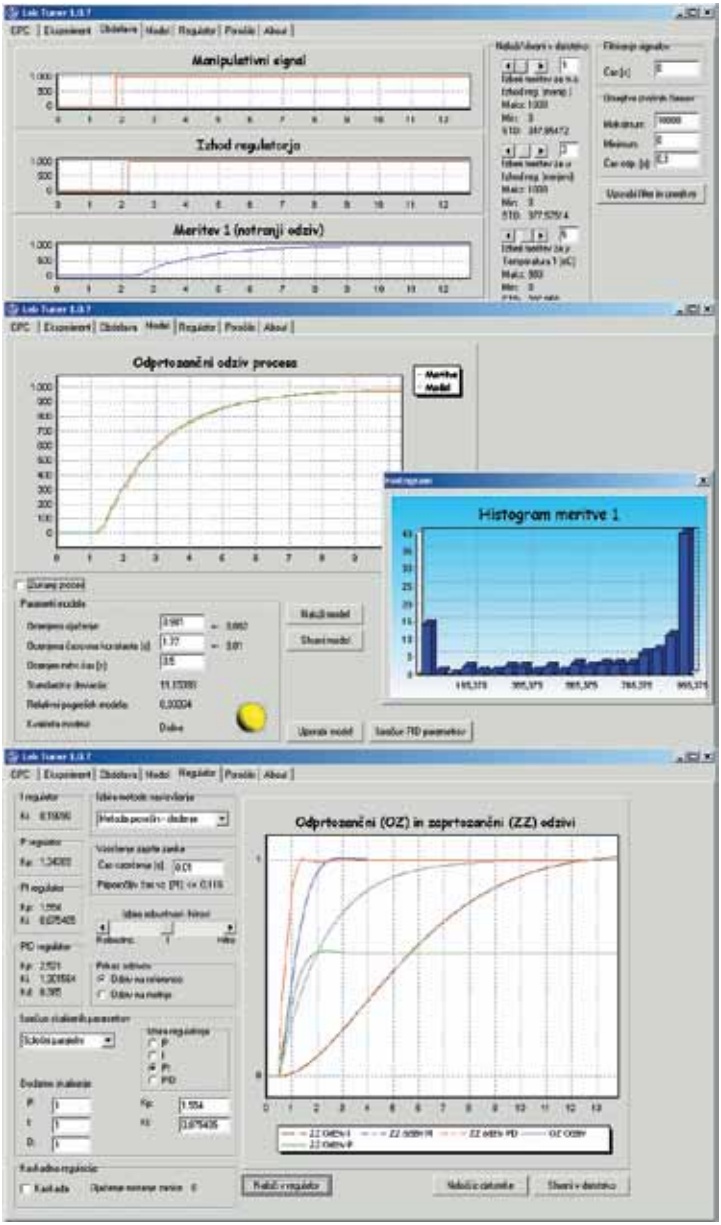
Manipulativni signal
Izhod regulatorja
Meritev 1 (notranji odziv)
Odprtozančni odziv procesa
Histogram meritve 1
Odprtozančni (OZ) in zaprtozančni (ZZ) odzivi

Programme package for automatic controller tuning

CUSTOMER • Lek d. d.

OBJECTIVES • to help industrial customers with the efficient tuning of PID and cascade controllers.

DESCRIPTION • selection of the OPC signals, fully autonomous design of the experiment and its realisation directly on the process, identification of the process model and calculation of the optimum parameters of the PID controller, automatic report generation in Microsoft Word files.

INNOVATION • model identification and controller design rely on original methods developed in the department during the past ten years.

BENEFITS • highly increased efficiency of the control-loop tuning (e.g., in the commissioning phase) as well as maintenance. Better tuned controllers result in energy savings and reduced waste.

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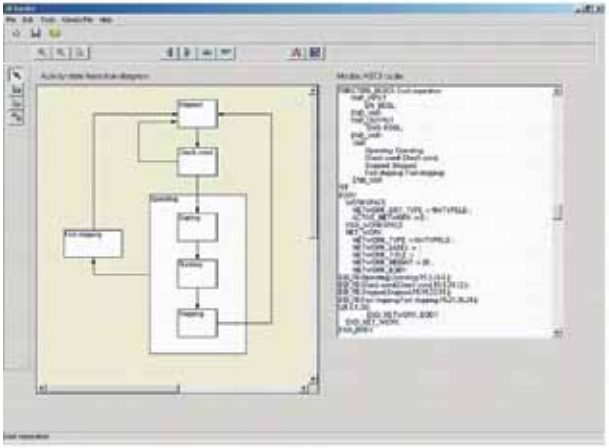
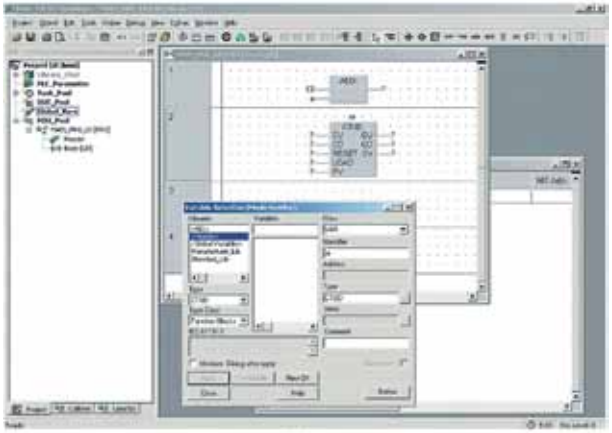
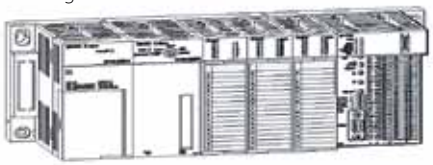
Modelling tool with automatic code and documentation generation



Programmable logic controller software code



Programmable logic controller



Prototype of a tool for automatic code generation for programmable logic controllers (PLCs)

CUSTOMER • internal project in the framework of a research programme

OBJECTIVES • to simplify and speed up the process of software development, while ensuring higher quality of the resulting code for controllers.

DESCRIPTION • automatic mapping of specifications into PLC code.

INNOVATION • development and application of domain-specific software tools for setting up specifications and the generation of programme code together with the documentation.

BENEFITS • compared to the classical conversion of specifications into programme code "by hand", which is often time consuming and prone to errors, code generation takes almost no time and is error free. This results in a better quality of the code, reduced development costs and, consequently, increased efficiency of the development process.

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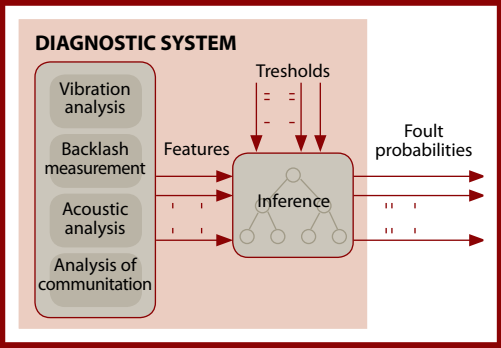
DIAGNOSTIC SYSTEM
Vibration analysis
Backlash measurement
Acoustic analysis
Analysis of communitation
Features
Tresholds
Inference
Foult probabilities

A prototype of a system for the quality assessment of electrical motors

CUSTOMER • Domel, d. o. o.

OBJECTIVES • to determine the quality of electrical motors as well as to detect and isolate any faults.

DESCRIPTION • a dedicated diagnostic algorithm calculates the features of the motor on the basis of measurements of electrical quantities, vibrations, sound, sparking and axial backlash. If all the features are within the prescribed limits, the motor is considered to be of appropriate quality. Otherwise, it is marked as defective and the algorithm reveals the location of the fault.

INNOVATION • several original algorithms have been designed, i.e., assessment of the sparking intensity, non-invasive isolation of the mechanical faults on the basis of acoustic measurements and a procedure for an extremely precise determination of the axial backlash of the rotor.

BENEFITS • the fracion of defective motors delivered to the market is expected to be reduced by an order of magnitude
- reduced production costs
- better image of the manufacturer
- better working environment

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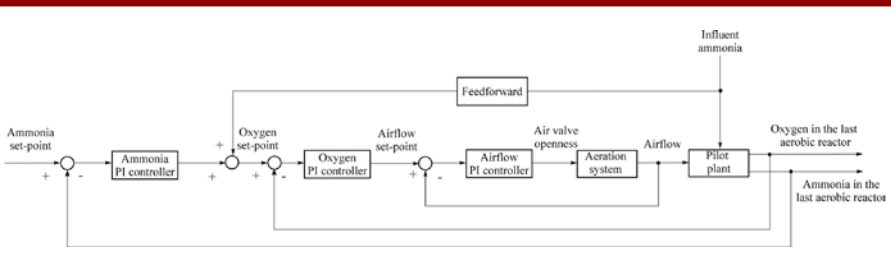
Influent ammonia
Feedforward
Ammonia set-point
Ammonia PI controller
Oxygen set-point
Oxygen PI controller
Airflow set-point
Airflow PI controller
Air valve openness
Aeration system
Airflow
Pilot plant
Oxygen in the last aerobic reactor
Ammonia in the last aerobic reactor
+
-

SMArt Control of wastewater systems

CUSTOMER
- Domžale-Kamnik Wastewater Treatment Plant
  Project within 5th Framework Programme

OBJECTIVES
- improvement of the nitrification process in wastewater treatment plant and consequently lower concentration of ammonium nitrogen in the wastewater treatment plant effluent as well as consumption of electrical energy for aerobic tanks aeration

DESCRIPTION
- control of aerobic tanks aeration by implementing ammonium nitrogen control

INNOVATION
- upgrading of the dissolved oxygen control by ammonia nitrogen control using on-line measurement of ammonium nitrogen in wastewater
- dynamic adjustment of the dissolved oxygen control set-point in aerobic tanks
- measurement of the concentration of ammonium nitrogen in the influent wastewater and in the aerobic tanks
- application of feedforward and feedback control
- application of predictive control

BENEFITS
- more stable concentrations of ammonium nitrogen in the aerobic tanks and consequently also in the wastewater treatment plant effluent (lower average values and lower peaks)
- significantly lower electrical energy consumption for aerobic tanks aeration (up to 45%)

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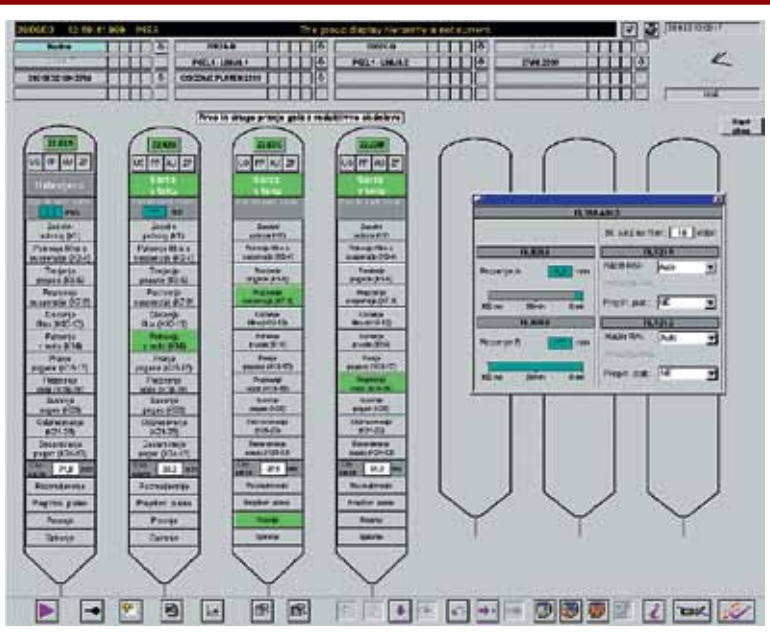

A prototype of a system for batch scheduling in the process of gel washing in Cinkarna

CUSTOMER • Cinkarna Celje, d. d.

OBJECTIVES • to ensure uniform production and the required capacity of the two-stage gel-washing process.

DESCRIPTION • determination of the starting times for individual batches by taking into account the current process states, technological constraints and required capacity.

INNOVATION • an online batch-scheduling algorithm for predicting the appropriate starting time for a single new batch, which takes into account the shared resources, blocking and no-wait constraints of the two-stage gel-washing process.

BENEFITS
- more uniform production
- more stable product quality
- decision support for the process operators

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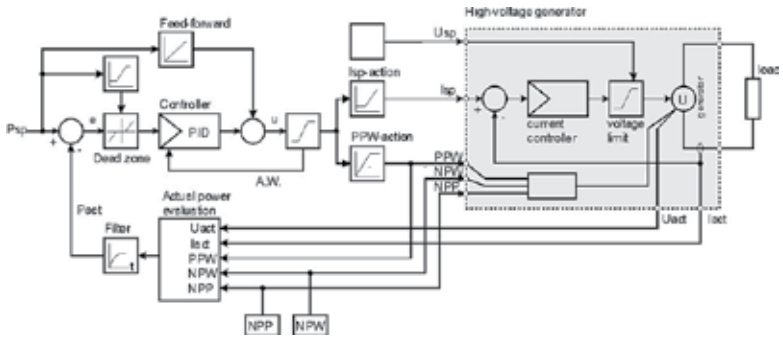
Feed-forward
Controller
PID
Dead zone
A.W.
Psp
Pact
Filter
Actual power evaluation
Uact
Iact
PPW
NPW
NPP
Isp-action
PPW-action
Usp
Isp
High-voltage generator
current controller
voltage limit
U
I
Uact
Iact
load

A system for the control of a plasma wire-treatment machine

CUSTOMER
- Niedermair&Sackl GmbH, Deutschlandsberg, Austria
- PlasmaIt GmbH, Lebring, Austria

OBJECTIVES
- design and implementation of a control system for a wire-treatment machine based on a new technology of magnetically focused plasma.

DESCRIPTION
- complete electrode power management, including the control and monitoring of all the electrical parameters of the electrodes. Control of additional units (pre-heating, cooling, preparation and maintenance of the atmosphere inside the electrodes, gas-pressure control, etc.).

INNOVATION
- new algorithms for power control meeting various demands (robustness at high wire speed, accuracy at low speed, fast control response during wire acceleration/deceleration to prevent wire from underheating/overheating, taking into account the variation of the process conditions within the electrodes).

BENEFITS
- mastering difficult processes related to the plasma and the entirely automated control of the machine.

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A system for the control of the pressure difference at the LAV testing line in Danfoss Trata

CUSTOMER • Danfoss Trata, d. o. o.

OBJECTIVES • design and implementation of a control system to control the line for testing and assessment of various types of control valves used in district-heating systems.

DESCRIPTION • the control of the pressure difference on the valve under test by adjusting the speed of the pumps.

INNOVATION • model-based self-tuning control of the pressure difference, taking into account the nonlinearity of the valve characteristics, which varies with different types of valves.

BENEFITS • simple, fully autonomous testing of different types of valves under different configurations of the testing line.

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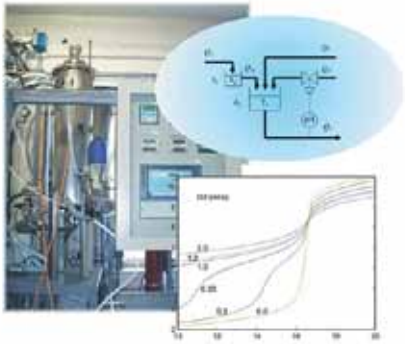
Programmable Logic Controller
Mitsubishi A1S with coprocessor INEA SPAC20

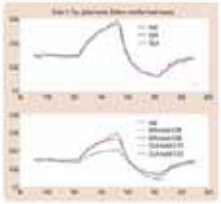
User interface
Beijers E700

Test process
Neutralisation, pH control



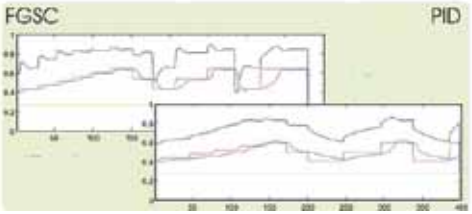
Extremely non-linear static characteristic
(titration curve)

Online Learning
Non-linear model



Automatic tuning

Advanced control algorithms



ASPECT - Advanced control algorithmS for ProgrammablE logiC conTrollers (PLCs)

CUSTOMER
- Inea d. o. o.
- Start, Indelec Europe S.A., Athens, Greece
- Start Engineering JSCo., Sofia, Bulgaria
- European Commission (5th Frame-work Programme - CRAFT)

OBJECTIVES
- implementation of advanced control algorithms for demanding nonlinear and time-varying processes using programmable logic controllers.

DESCRIPTION
- nonlinear control algorithm
- online learning of a nonlinear model from process measurements
- control-loop performance monitoring
- self-tuning procedures

INNOVATION
- artificial intelligence methods and pattern recognition are used to improve the accuracy and reliability of online experimental modelling and to enable autonomous operation.

BENEFITS
- new opportunities for the application of controllers with parameter scheduling in industrial practice.

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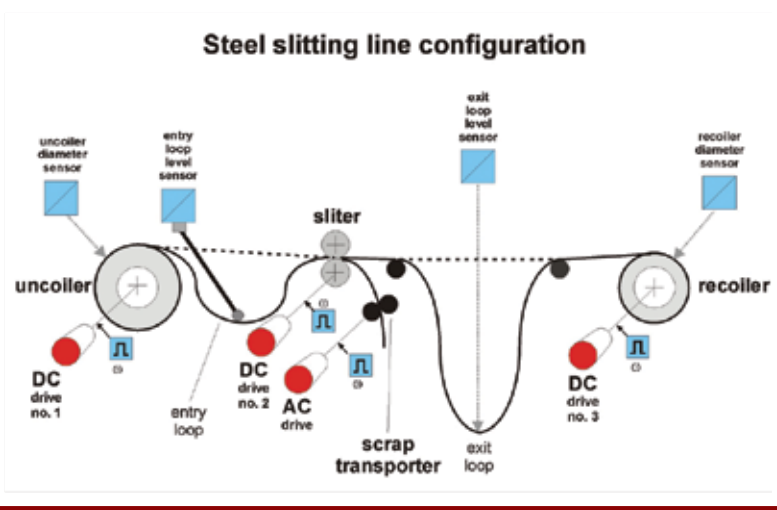
Steel slitting line configuration
uncoiler diameter sensor
entry loop level sensor
exit loop level sensor
recoiler diameter sensor
sliter
uncoiler
recoiler
DC drive no. 1
entry loop
DC drive no. 2
AC drive
scrap transporter
exit loop
DC drive no. 3

A system for the control of a steel-strip slitting line

CUSTOMER
- Sip Mobil, Šempeter
- Acroni d. o. o.

OBJECTIVES
- design and implementation of an advanced control system allowing for extended functionality of the steel-strip slitting line and operation under various conditions.

DESCRIPTION
- basic control of DC drives: armature and field voltage/current control. Advanced DC drive functionality: linear speed control, jog speed control, tension control, dynamic compensation of accelerating/decelerating torque, field current reference calculation, variable coil-diameter compensation, loop level control.

INNOVATION
- the first microcomputer control of DC drives at the Cold Rolling Mill in Acroni. Replacement of the input relieving loop with specially tailored control, which ensures minimum, i.e., zero force between the uncoiler roll and the slitter roll, not only in the stationary condition but also during acceleration and deceleration, compensating the variable uncoiler roll diameter.

BENEFITS
- extension of the production process to a new type of thin metal strips, thus resulting in increased production at Acroni.

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SPAC20 - a coprocessor module for PLCs

CUSTOMER • Mitsubishi Electric Europe BV

OBJECTIVES • the SPAC20 is a coprocessor module that makes possible the control of demanding industrial processes using standard industrial PLCs from the MITSUBISHI AnS and QnA series of modular programmable controllers.

DESCRIPTION • the SPAC20 coprocessor module and the related SW package IDR BLOK transforms the standard PLC into a highly efficient system for the control and monitoring of industrial processes.

INNOVATION • allows the utilisation of relatively low-cost industrial controllers for the control of fast and/or problematic continuous processes, where fast sampling and extensive signal processing are often required. The SPAC20 operates as a "controller within a controller".

BENEFITS • the SPAC20 coprocessor has already been applied in a number of applications that demand sophisticated control, such as blow-moulding plastic extruders, energy consumption smoothing, a wire annealing machine using magneto-focused plasma, a machine for the production of rubber strips, a steel slitting machine, etc.

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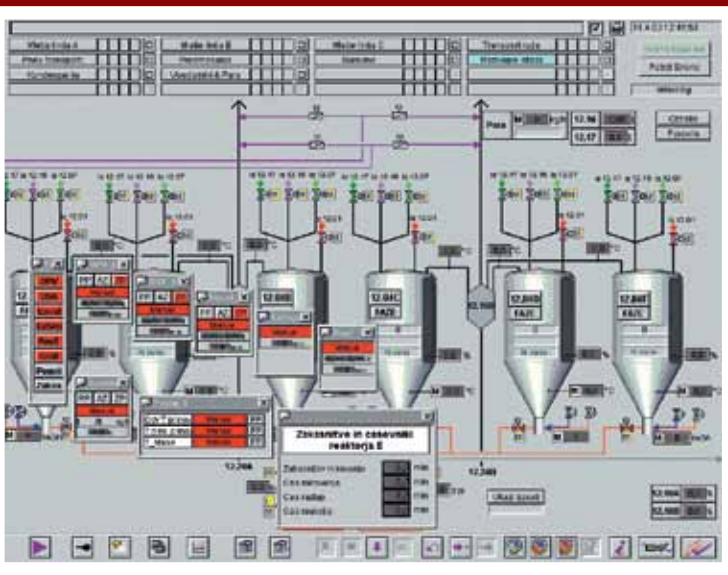
Zaustavitve in ceseviski
reaktorja E

Control system for titanium dioxide production

CUSTOMER • Cinkarna Celje, d. d.

OBJECTIVES • improved handling of a complex process using the automation of continuous and batch sub-processes (ore digestion, hydrolysis, gel washing, chemical treatments, etc).

DESCRIPTION • large-scale technological process control according to the S88.01 standard, including:
– basic control
– advanced control solutions
– continuous procedural control
– batch-recipe control
– coordination control

INNOVATION • consistent use of the lifecycle concept in control systems' design, the development and employment of advanced control algorithms, innovative recipe notation making possible the handling of simultaneous phases.

BENEFITS • increased capacity, higher yield of the raw materials (savings of approximately € 380.000 per year), possible savings related to environmental taxes (due to a decreased quantity of waste gypsum) of approximately € 750.000 per year, improved quality of most of the sub-processes, some of the sub-processes can be controlled only by means of a computer.

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CARDIOSIGNALS - Signal-conditioning system for physiological signals

CUSTOMER
- Lancaster University, Department of Physics, UK
- Department of Endocrinology and Department of Intensive Internal Medicine, Clinical Centre, Ljubljana
- Institute of Pathophysiology, Faculty of Medicine, Ljubljana
- Faculty of Electrical Engineering, Ljubljana.

OBJECTIVES
- CARDIOSIGNALS makes possible non-invasive measurements and monitoring of various physiological functions in the human body.

DESCRIPTION
- CARDIOSIGNALS enables safe and efficient signal conditioning and the simultaneous acquisition of basic physiological signals, e.g., ECG, respiratory effort, dynamic blood pressure (plethysmograph) and minute variations in body temperature. The signal-conditioning system is connected to a personal computer, where the analysis of the acquired signals is proceeded by the use of standard data-processing SW tools.

INNOVATION
- CARDIOSIGNALS has a very intuitive user interface and can detect changes of less than 1/1000°C in body temperature.

BENEFITS
- the system is intended for in-depth research of the dynamics of the cardio-vascular system. It can be used for research in many fields of medicine, especially for research on procedures for controlling the depth of anaesthesia.

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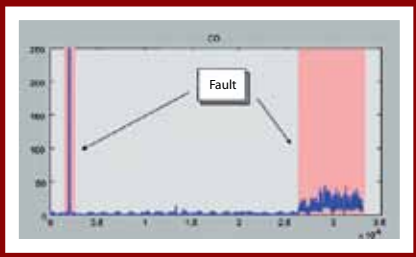
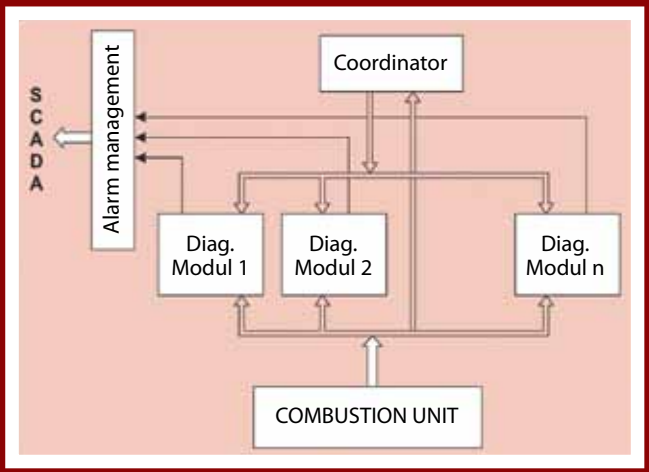
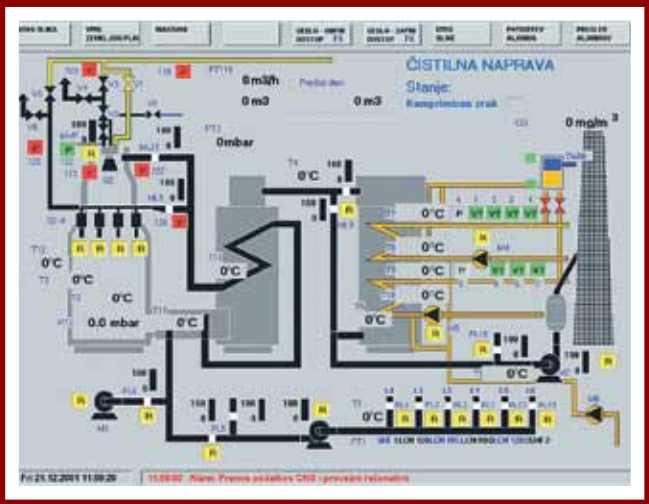

Fault


SCADA
Alarm management
Coordinator
Diag. Modul 1
Diag. Modul 2
Diag. Modul n
COMBUSTION UNIT


ČISTILNA NAPRAVA
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0 m3
0 mg/m 3
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0.0 mbar

System for the condition monitoring of sensors and control loops in a process for incinerating vulcanisation gases

CUSTOMER • Sava d. d.

OBJECTIVES • online detection and localisation of faults in vital control loops as well as in sensors and actuators (bias, drift, precision loss).

DESCRIPTION • the diagnostic system classifies sampled signals into characteristic patterns and then provides fault localisation by means of pattern matching.

INNOVATION • the classification of signal patterns is based on a robust estimation of the basic statistical parameters of the signals (first two moments) and an analysis of the oscillations. Detection and localisation are performed by means of simple logical rules and approximate reasoning.

BENEFITS • automatic detection of malfunctions in sensors and actuators results in:
- decreased maintenance costs
- fewer emergency shutdowns
- reduced load on the operator
- improved monitoring of critical emission sensors (e.g., CO concentrations)

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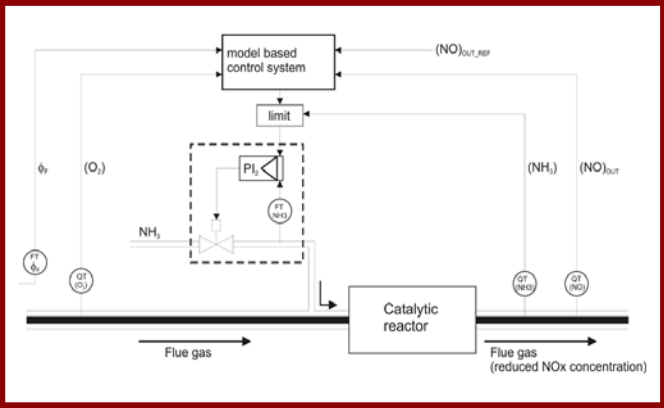
model based
control system
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(O_2)
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NH_3
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ϕ_F
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$(NH3)$
QT
(NO)
Catalytic
reactor
Flue gas
Flue gas
(reduced NOx concentration)

A system for the control of the selective catalytic reduction of NOx

CUSTOMER • internal research project

OBJECTIVES • design and implementation of a control system for the process of the selective catalytic reduction (SCR) of nitrogen oxides (NOx) from flue gases after combustion.

DESCRIPTION • combination of feedback and feedforward control of ammonia flow rate, with the aim to maintain a minimal NOx concentration in the flue gases at the output from the SCR reactor. Feedforward control predicts the required ammonia flow rate on the basis of two signals: input NOx concentration and flue-gas flow rate. These two signals are not measured, rather they are estimated using software sensors based on the measured fuel flow rate and excess oxygen concentration in the combustion process. Thus, a significant part of the expensive measuring equipment is omitted. The prediction error of the feedforward control is corrected by the feedback control, which is based on the measured NOx concentration at the output of the SCR reactor.

INNOVATION • software sensors contain a mathematical model of the combustion. They estimate the concentration of NOx in the flue gases during combustion and the flow rate of the flue gases. The estimation is based on the existing measurements of the excess oxygen concentration and fuel flow rate, which are included in standard combustion control systems.

BENEFITS • efficient control of the output NOx concentration in both stationary and dynamic conditions, omitting the expensive measurement equipment that is normally required to achieve a comparable control performance.

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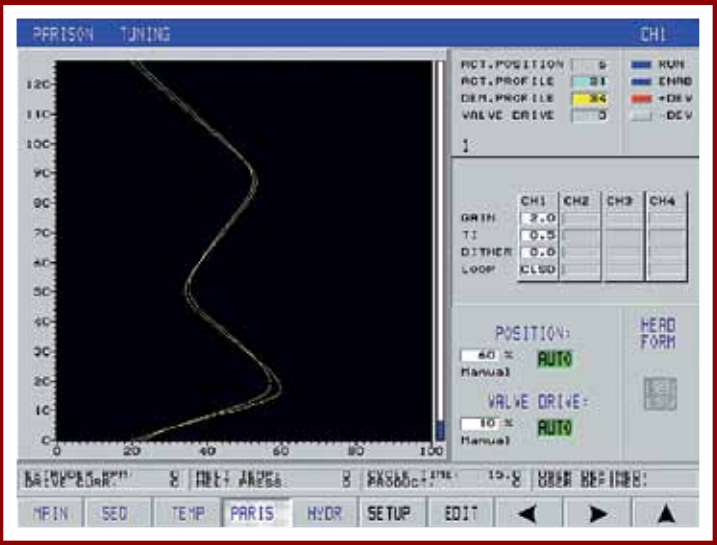
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ACT.PROFILE
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CH1 CH2 CH3 CH4
GAIN 2.0
TI 0.5
DITHER 0.0
LOOP CLSD
POSITION:
60 %
Manual
AUTO
VALVE DRIVE:
10 %
Manual
AUTO
HEAD FORM
MAIN SEQ TEMP PARIS HYDR SETUP EDIT

PECS - Control system for plastic extruders

CUSTOMER
- Mitsubishi Electric Europe
- Techne Spa
- Inea d. o. o.

OBJECTIVES
- complete automatic control of the operation of plastic extruders, particularly blow-moulding machines.

DESCRIPTION
- self-tuning and adaptive temperature control of heating zones
- parison control
- hydraulic positioning
- sequential control
- man-machine interface

INNOVATION
- new approach to the self-tuning of the temperature controllers of heating zones
- cost-effective implementation using standard modular programmable controllers from the Mitsubishi Electric and the SPAC20 coprocessor module

BENEFITS
- open control system, successfully used by a number of manufacturers of plastic extruders and blow-moulding machines, like Techne Spa, Italy, Picoplast GmbH, Germany, BBM GmbH, Germany.

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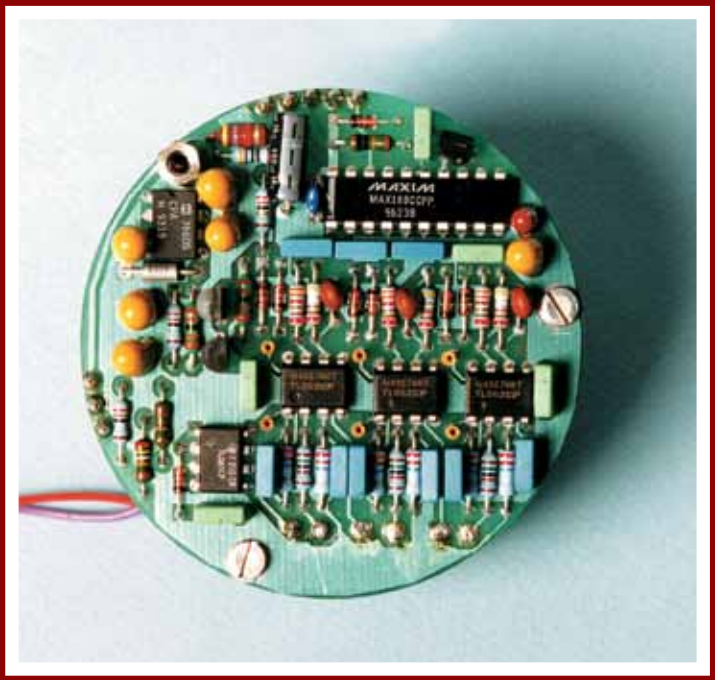
MAXIM
MAX180CPP

Measuring sphere for the characterisation of the dynamics and forces affecting particles in the natural environment

CUSTOMER • Faculty of Civil Engineering and Geodesy, Ljubljana

OBJECTIVES • design of a device for measuring the characteristic parameters of the dynamics of rocks in water streams.

DESCRIPTION • with the use of in-built accelerometers, the device is able to register the intensity and position of erosive forces; moreover, by means of additional offline signal processing it is possible to calculate the trajectory of the motion of pebble-stones.

INNOVATION • the measuring sphere is an autonomous measurement device that simulates the motion of the pebble-stones in water channels. At the end of the experiment the acquired data are transferred to the computer for further signal processing. The device is very robust to mechanical disturbances and shocks and is easy to operate. The device is triggered by means of an external magnetic field.

BENEFITS • new perspectives in the research of water-stream dynamics.

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A system for control of a sintering process

CUSTOMER • Jozef Stefan Institute, Electronic Ceramics Department

OBJECTIVES • design and implementation of a control system for the process of sintering ferrite products (cores and beds).

DESCRIPTION • automatic and very precise control of oxygen concentration and temperature during the sintering process. Also included is a system for monitoring and report generation.

INNOVATION • during the sintering process oxygen concentration must follow the prescribed time profile. This is achieved by a special model-based controller, which adjusts the oxygen and nitrogen flow rates, taking into account the dynamics of the gas mixing. In addition, a special combination of solenoid valves and mass-flow control valves is used to provide a smooth switchover between the mass-flow control valves with different ranges, which are needed to achieve the very high required control ratio.

BENEFITS • very precise control of oxygen concentration and high control ratio (from 100 vol% to 0.001 vol%).

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DP2
Vnos opombe

Production control system for PVA glues

CUSTOMER • Mitol d. d.

OBJECTIVES • holistic, highly automated, reliable and safe batch control

DESCRIPTION • control of the physical and production level complying with the S88.01 standard for batch control including:
- basic control
- procedural control
- coordination control
- transfer of recipes and work orders from the production level to the physical level
- transfer of information
- information about production events and the consumption of raw materials from the physical level to the production level

INNOVATION • the control system is designed to encourage the operator to be creative during his/her work, while ensuring reliability and safety in the case of operator error. This results from consistent implementation of the activities of quality assurance and product assessment at the end of particular phases of the lifecycle.

BENEFITS • improved quality of products, reduced waste, better repeatability, flexibility, safety and reliability (the system has been in continuous operation since the spring of 1999, with no reports of failure).

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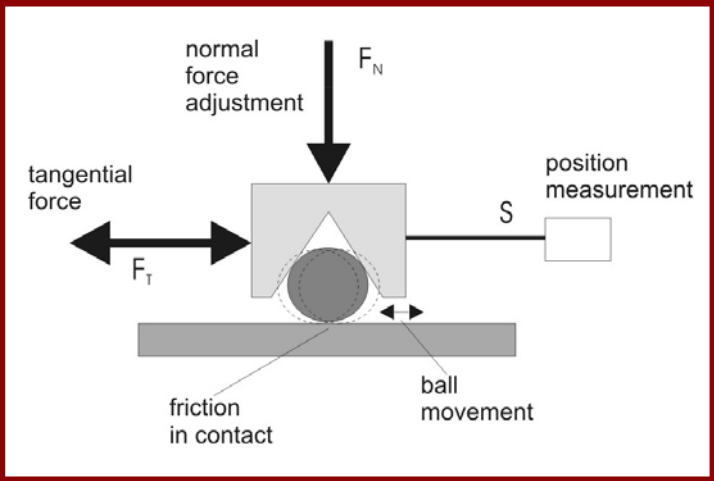
normal
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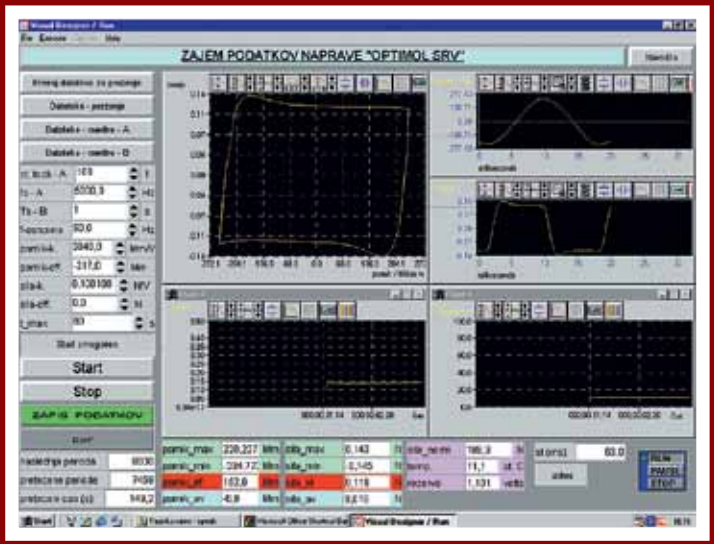
movement


ZAJEM PODATKOV NAPRAVE "OPTIMOL SRV"
Start
Stop

A system for the automatic analysis of friction phenomena

CUSTOMER • Faculty of Mechanical Engineering, Centre for Tribology and Technical Diagnostics

OBJECTIVES • design and implementation of a computer-based system for observation, analysis and data acquisition for an existing friction testing device. The device is used for on- and offline observation of the friction phenomena within the standard contacts (ball, cylinder or ring-on-flat).

DESCRIPTION • the system is connected to the existing friction-testing device. The main function is fast data acquisition of the tangential friction force and ball displacement, along with other signals, the automatic calculation of various indexes, and the online graphical display of results.

INNOVATION • the particular method of design allows pre-programmed quick sampling and data storage, exceeding the limits of standard data-acquisition equipment.

BENEFITS • simple experimentation and documentation of experiments, online graphical display of the friction curve (i.e., force/displacement relation).

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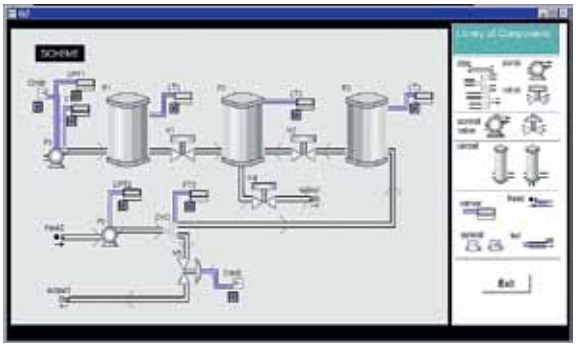
SCHEME
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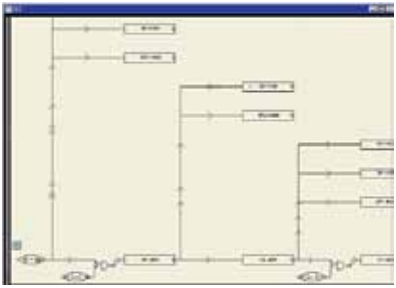
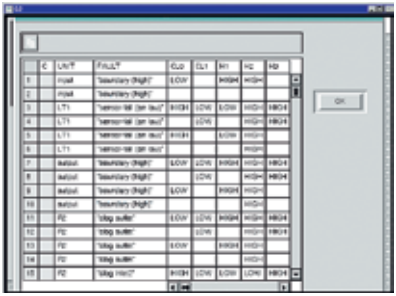
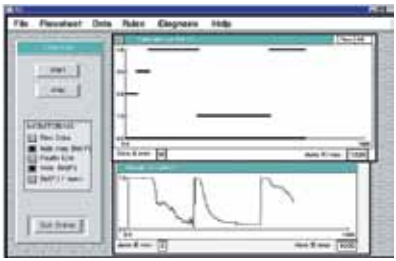



OK


File
Flowsheet
Data
Rules
Diagnosis
Help

Program package for diagnostic rules synthesis in G2

CUSTOMER
- realised in the frame of an EU Copernicus project

OBJECTIVES
- diagnostic systems design for process engineering based on a user-friendly graphical interface (GUI).

DESCRIPTION
- the system relies on a library of diagnostic models related to various items of equipment (valves, reservoirs, etc.). Each component is associated with a model in terms of directed graph. The user has to provide a process flowsheet via a graphical environment, while an automatic procedure derives event trees and fault trees and diagnostic rules for the entire process. Rules can be applied online to the measured signals acquired from the process.

INNOVATION
- automatic procedure for the synthesis of diagnostic rules
- modern reasoning mechanism based on a transferable belief model
- graphical user interface that allows simple data entry and interaction with the design procedures (e.g., manual rules setting in the rule base)

BENEFITS
- shorter design times
- the package is suitable for educational purposes

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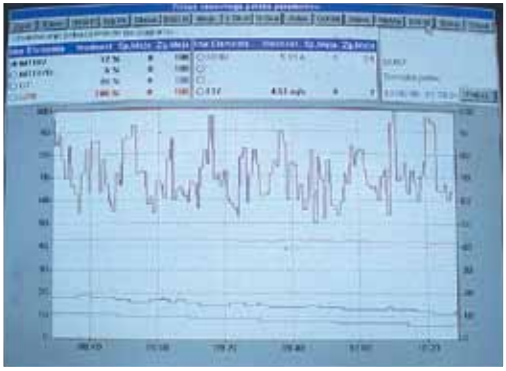

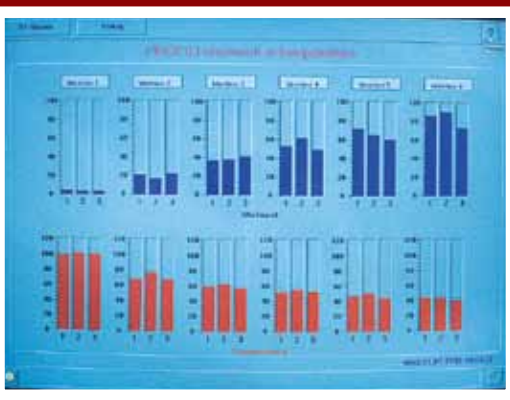

Control system for a tile-drying process

CUSTOMER
- Goriške opekarne d. d.
- Wienerberger Opekarna Ormož d. d.

OBJECTIVES
- optimised control of the drying process for tile products in chambers and tunnel driers.

DESCRIPTION
- automatic control of drying rooms with respect to the prescribed technological parameters (following the time profiles of temperature, moisture, pressure, recipe control, etc.).

INNOVATION
- the control system makes it possible to achieve the optimum technological conditions in the drying rooms with regard to the type of product and the required capacity.

BENEFITS
- high and evenly distributed product quality
- significantly reduced amount of waste
- reduced energy consumption

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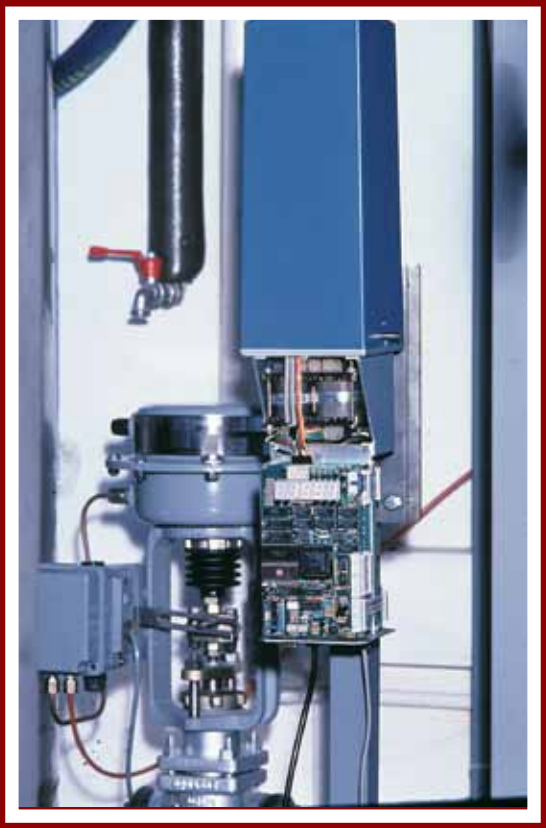


02
2093

MK300
Oxygen analyzer

CUSTOMER
- RACI d. o. o.
- Magneti d. o. o
- Altex d. o. o.

OBJECTIVES
- the MK300 oxygen analyzer is primarily intended for measuring the oxygen concentration in the exhaust lines of industrial boilers. It is used for optimum control of the fuel/air ratio, so that accurate and economic operation of industrial power systems can be achieved. Because of its very wide measuring range it is also possible to measure trace amounts of oxygen in certain other gases.

DESCRIPTION
- the MK300 oxygen analyzer performs continuous measurements of oxygen concentration across a very wide range, i.e., from 1ppm to 99.9%. The analyzer measures the electrochemical potential of a solid cell made of doped ZrO_2 ceramic. The microprocessor-based instrument provides accurate cell-temperature control and signal processing, while direct fuel/air ratio control is also possible.

INNOVATION
- the microprocessor-based analyzer also allows some additional online measurements, e.g., temperature of the flue gases (by means of additional sensors) as well as calculation and display of the losses caused by an excess of oxygen in the flue gases. Fuel/air ratio control is also possible.

BENEFITS
- improved control of industrial heating systems
- control of the purity of some industrial gases, e.g., nitrogen and argon

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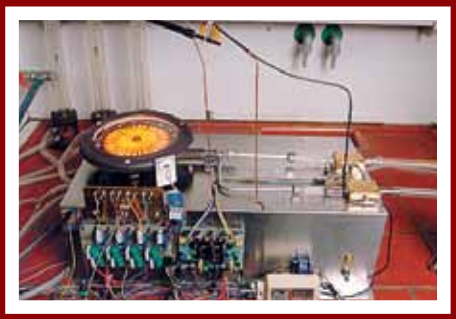

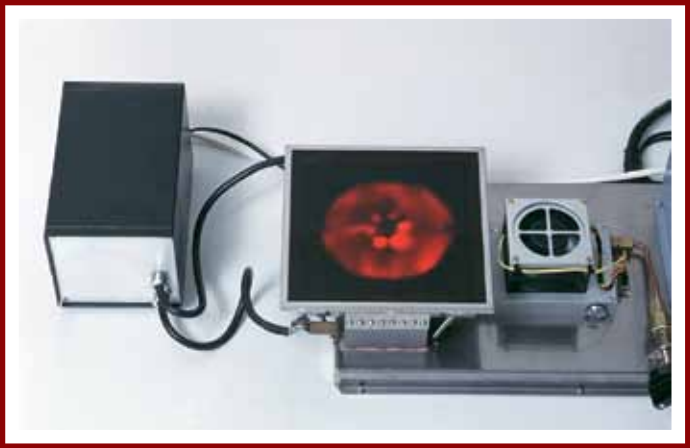

A prototype of a catalytic gas burner for domestic applications

CUSTOMER
- Zeltron Spa
- Electrolux Group

OBJECTIVES
- to design a prototype for a cooking hob based on catalytic gas burners and a ceramic-glass top plate.

DESCRIPTION
- the prototype makes possible the catalytic burning of gas (without a flame), resulting in radiation from the catalytic mesh. The heat is radiated through the ceramic-glass plate to the cooking pot on the hob. By constructing an operating prototype the process was shown to be feasible and safe, and good control of the fuel-to-air ratio was ensured.

INNOVATION
- first introduction of a ceramic-glass-based hob for domestic application using catalytic burning. The glass plate has no opening at the top, so providing for easy cleaning. Innovative ignition of the burner by means of an electrical pre-heat of the catalytic mesh.

BENEFITS
- a kitchen technology of the future
- a domestic hob for countries with extensive gas distribution systems or countries with a low capacity for electricity distribution
- easy cleaning of the gas hob

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Institut
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Ljubljana
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COMM
BATT 1
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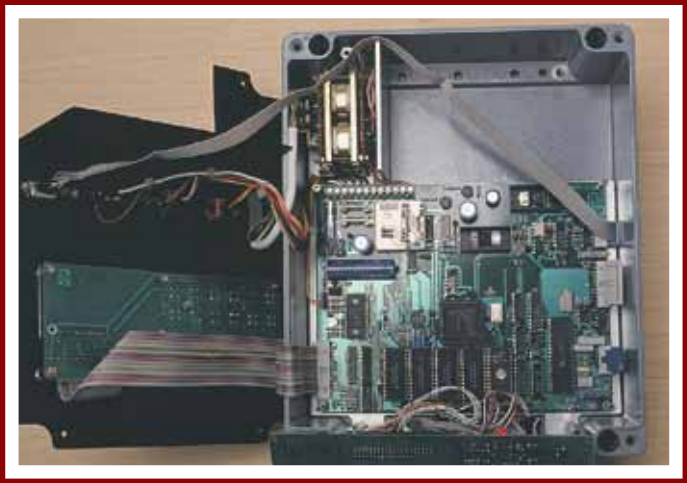
RESET



CRA2000
Corrosion analyzer

CUSTOMER • ZAG – Zavod za gradbeništvo, Ljubljana (Slovenian National Building and Civil Engineering Institute)

OBJECTIVES • short-term as well as long-term monitoring of the corrosion in reinforced concrete constructions, buildings, industrial plants, etc.

DESCRIPTION • cumulative corrosion monitoring by means of a resistance-measuring method or online prediction of the corrosion thread by means of a noise-measuring method.

INNOVATION • the device is able to collect data autonomously for several months.

BENEFITS • based on the long-term data acquisition the device is able to evaluate the progress of the corrosion, thus enabling early corrective actions.

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α [°] = 31.000000
Mg [kg/s] = .500000
O2 [x] = 5.394551

A system for the combustion control of industrial boilers

CUSTOMER
- Cinkarna Celje, d. d.
- Sugar Factory Ormož
- TAM Maribor d. d.

OBJECTIVES
- computer control of the combustion in industrial boilers.

DESCRIPTION
- temperature control, control of pressure, flow, level, O_2% in exhaust gases, etc.
- alarm system
- data display

INNOVATION
- the control system takes into account the dynamically varying load of the boiler in order to achieve the optimum air/fuel ratio. The control algorithms are based on a mathematical model of the process.

BENEFITS
- decreased consumption of reagents
- increased reliability of operation
- established a spin-off company, RACI, based on the developed technology, at the Technology Park Ljubljana

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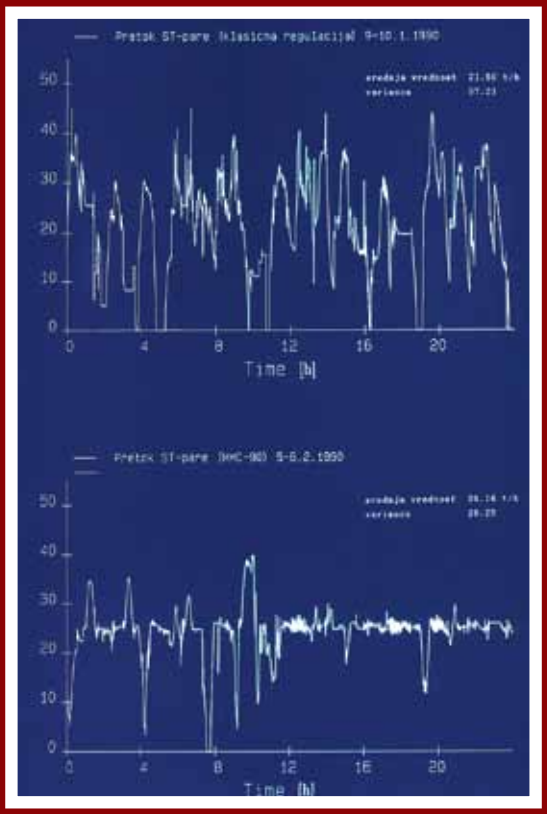
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Pretok ST-pare DMC-90 5-6.2.1990
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Time [h]

A computer-control system for a pulp cooking process

CUSTOMER • Pulp and paper mill "Đuro Salaj", Krško

OBJECTIVES • to maximize yield, increase product quality and reduce the oscillations in steam consumption.

DESCRIPTION • process monitoring, batch sequencing, temperature and pressure control, online estimation of the Kappa number, smoothing steam consumption, etc.

INNOVATION • model-based approach to the estimation of the Kappa number, algorithms for control of the steam consumption implemented on a network of multiloop microcomputer controllers developed in our laboratory.

BENEFITS • savings of approximately € 200,000 per year, just on the basis of reduced energy consumption.

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MMC-90 Microprocessor-based multiloop controller

CUSTOMER • several Slovenian industrial companies: Vipap Videm (pulp and paper production), Cinkarna Celje, d. d. (TiO_2 production), TAM (hot-water boiler), Tovarna sladkorja Ormož (sugar production)

OBJECTIVES • advanced process control of processes with multiple interacting control loops.

DESCRIPTION • signal processing; data visualization; control; sequencing; alarm systems, etc.

INNOVATION • six control loops can be handled at the same time; advanced and computationally demanding control algorithms can be freely programmed and performed; data can be graphically displayed on a PC; manual control possible even in the case of a loss of power.

BENEFITS • significant technological leap forward for the department in terms of HW and SW development.

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MK100 and MK200 oxygen analyzers

CUSTOMER • about 40 units have been delivered to various customers in ex-Yugoslavia.

OBJECTIVES • the instruments are intended mainly for the optimization of the combustion processes in industrial power plants, testing the purity of technical gases, assessing the appropriateness of nitrogen and other inert protective atmospheres.

DESCRIPTION • continuous sampling of the oxygen concentration in incombustible gases, from1 ppm to 99.9 vol %. The measurement procedure relies on measuring the electrochemical potential of a solid-state cell made of doped ZrO_2 ceramic, heated up to 820°C.

INNOVATION • robust electronic design resulting in high reliability and ease of maintenance.

BENEFITS • reduced energy consumption and pollution when using the instrument for combustion control
- increased product quality when using the analyzer to test for traces of oxygen in pure gases
- increased product quality and production safety when using the analyzer to test for the presence of oxygen in inert protective atmospheres.

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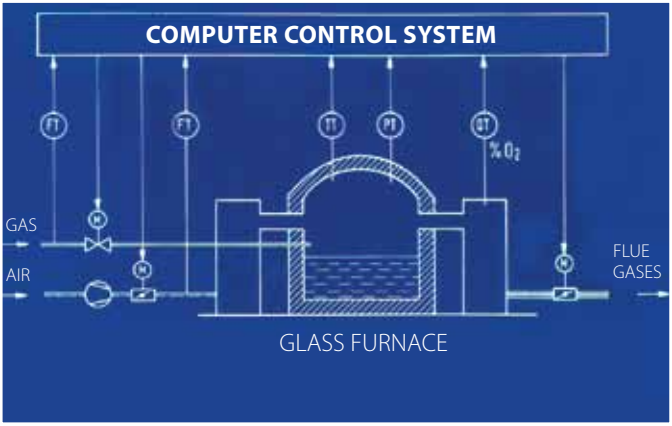
COMPUTER CONTROL SYSTEM
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GASES
GLASS FURNACE

Combustion control of glass furnace

CUSTOMER • Glass Factory Hrastnik

OBJECTIVES • to reduce energy consumption and improve the precision of glass-temperature control.

DESCRIPTION • temperature control, pressure control, oxygen control in flue gases.

INNOVATION • the control system design was realised with the ANA CAD package and was fully based on the mathematical modelling, simulation and synthesis of advanced controller structures.

BENEFITS • energy saving of approximately 20%
• increased quality of glass

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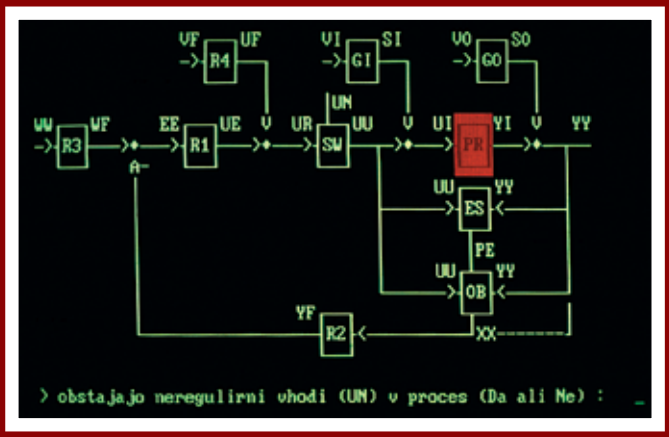
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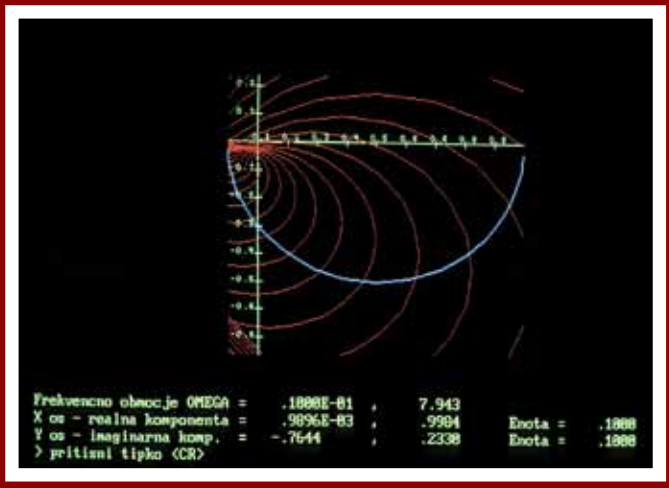
> obstajajo neregulirni vhodi (UN) v proces (Da ali Ne) :


Frekvencno obmocje OMEGA = .1000E-01 , 7.943
X os - realna komponenta = .9896E-03 , .9904 Enota = .1000
Y os - imaginarna komp. = -.7644 , .2338 Enota = .1000
> pritisni tipko <CR>

ANA - Programme package for the analysis and design of control systems

CUSTOMER • delivered to a number of companies, schools and universities in ex-Yugoslavia and Germany, including IBM (Germany) and Schenk (Germany).

OBJECTIVES • to improve the efficiency of control systems' design.

DESCRIPTION • analysis of measured data, development of mathematical models, design of control loops, analysis of control systems.

INNOVATION • ability to deal with either continuous or discrete univariable, as well as multivariable, systems, interactive and batch processing.

BENEFITS • new and improved control solutions for systems and processes in industry
• important educational aid in schools and universities

INFO • stanko.strmcnik@ijs.si

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Computer control of elevators

CUSTOMER • IMP Dvigalo

OBJECTIVES • computer control of a cluster of elevators.

DESCRIPTION • optimised assignment of calls; priority assignment to various operational modes; accommodation of operational modes to the current situation; handling of exceptional situations.

INNOVATION • hierarchical multi-computer control system equipped with software that makes it possible to take advantage of a cluster of elevators in an optimised way.

BENEFITS • reduced waiting times
• uniform loading of a cluster of elevators
• reduced consumption of electrical energy

INFO • vladimir.jovan@ijs.si

Jožef Stefan Institute

DEPARTMENT OF SYSTEMS AND CONTROL

Application and development projects for various customers

1985–2010

1985

1. **Software for an elevator control system**
   Customer: IMP – DO EMOND, TOZD Dvigalo, Ljubljana
   Type of project: development of application software
2. **Improvement of combustion control in a leach boiler**
   Customer: Pulp and paper mill "Đuro Salaj", Krško
   Type of project: measurements, conceptual design
3. **Computer automation of pulp cooking**
   Customer: Pulp and paper mill "Đuro Salaj", Krško
   Type of project: conceptual design

1986

4. **Computer automation of pulp cooking (phase 1)**
   Customer: Pulp and paper mill "Đuro Salaj", Krško
   Type of project: computer-control system design and implementation
5. **Glass furnace control system**
   Customer: Glass Factory Hrastnik
   Type of project: development of a model-based control system
6. **Software package ANA for analysis and design of control systems**
   Customer: Iskra Electrooptics Centre, Ljubljana
   Type of project: customization of a general-purpose SW package
7. **Analysis of the combustion control in a leach boiler (phase 2)**
   Customer: Pulp and paper mill "Đuro Salaj", Krško
   Type of project: upgrade of the computer-control system
8. **Analysis of the combustion control in the glass factory Straža - Hum**
   Customer: Glass Factory Straža, Hum
   Type of project: measurements and conceptual design
9. **SIMCOS - language for continuous system simulation**
   Customers: – Belinka, Ljubljana
   – Energoinvest, Sarajevo
   Type of project: customization of a general-purpose SW package

1987

10. **Computer automation of pulp cooking (phase 3)**
    Customer: Pulp and paper mill "Đuro Salaj", Krško
    Type of project: upgrade of the computer-control system

11. **Computer automation of titanium dioxide production process**
    Customer: Cinkarna Celje
    Type of project: conceptual design

12. **ANA - software package for analysis and control design**
    Customer:
    – Steelworks Ravne
    – Iskra Electrooptics Centre, Ljubljana
    Type of project: customization of a general-purpose SW package

1988

13. **Computer automation of titanium dioxide production: the crystallization sub-process**
    Customer: Cinkarna Celje
    Type of project: specification of the control system

14. **Computer automation of pulp cooking (phase 4)**
    Customer: Pulp and paper mill VIDEM, Krško
    Type of project: design and implementation of a system for smoothing steam consumption

15. **ANA - software package for analysis and control design**
    Customers:
    – Centre of Navy High Schools ˝Maršal Tito˝, Split
    – Faculty of Electrical, Machine Enginee-ring and Ship-building, Split
    Type of project: customization of a general-purpose SW package

1989

16. **Computer automation of titanium dioxide production: the reduction sub-process**
    Customer: Cinkarna Celje
    Type of project: specification of the control system

17. ANA - software package for analysis and control design
Customers: – Cinkarna Celje
– Faculty of Process Engineering – Institute of Petrochemistry, Gas, Oil and Chemical Engineering, Novi Sad
– Industrial Energetics, Domžale
Type of project: customization of a general-purpose SW package

18. Steam boiler control in Cinkarna Celje
Customer: Cinkarna Celje
Type of project: Mathematical modelling of a steam boiler

19. Computer automation of pulp cooking (phase 5)
Customer: Pulp and paper mill VIDEM, Krško
Type of project: upgrade of the computer-control system

20. MK-100 oxygen-concentration sensor
Customer: various customers
Type of project: small-series production, 25 pieces in the period 1986–1989

1990

21. MMC-90 microcomputer controller
Customer: Faculty of Electrical Engineering and Computer Science, Ljubljana
Type of project: development of a powerful multi-loop controller

22. Control of 40MW steam boiler
Customer: Cinkarna Celje
Type of project: control-system design and implementation

1991

23. SIMCOS - continuous system simulation language
Customers: – Korona, Ljubljana
– Fachhochschule, FB Maschinenbau, Konstanz
– Hartmannn & Braun, Frankfurt (3 licences)
Type of project: customization of the simulation package

24. Hydraulic test rig
Customer: Basic Computer Systems, Klagenfurt
Type of project: construction of the test rig and control design

25. **Information system application and automation of production**
Customer: Brest, Cerknica
Type of project: conceptual design

26. **ANA - software package for analysis and control design**
Customer:
- Faculty of Mechanical Engineering, Ljubljana
- Gesamthochschule, Paderborn
- IBM Deutschland GmbH, Mainz
- H. Kuhnke GmbH, Malente
- Carl Schenck AG, Darmstadt

Type of project: customization of a general-purpose simulation package

27. **Rationalization of combustion processes in Krka**
Customer: Krka, Division of Technical Support and Energy Supply, Novo mesto
Type of project: conceptual design

28. **Rationalization of combustion processes**
Customer: Ministry of Energy, Ljubljana
Type of project: creation of a database of industrial combustion chambers and power plants

29. **Steam-boiler control**
Customer: TAM, Maribor
Type of project: Design and implementation of a control system

30. **Control system for the sub-process of precipitation**
Customer: Cinkarna Celje
Type of project: specifications of the control system

31. **Automatic production of mineral plates**
Customer: Mineralka, Cerknica
Type of project: conceptual design

1992

32. **Improved control of the production of mineral plates**
Customer: Brest, Cerknica
Type of project: development of a system for glue mixing

33. **Improvement of filter press control**
Customer: Cinkarna Celje
Type of project: specification of the control system

34. Contribution to the conceptual design of the Central Wastewater Treatment Plant in Ljubljana
Customer: Hidroinžinering, Ljubljana
T*ype of project:* conceptual design

35. Steam boiler control system
Customer: Sugar factory Ormož, Ormož
Type of project: conceptual design

36. Computer control of the production of wainscot plates
Customer: Javor - Management, marketing, finances and development, Pivka
Type of project: conceptual design

37. Control of the batch chemical treatment
Customer: Cinkarna Celje
Type of project: design of the density control

38. Computer control of the pigmentation sub-process
Customer: Cinkarna Celje
Type of project: specification of the control system

39. Professional support and consulting
Customer: Cinkarna Celje
Type of project: evaluation of realized projects over a 5-year period

40. Control of the process of titanium puddle preparation
Customer: Cinkarna Celje
Type of project: specifications for the control system

41. Control of 80MW steam boiler
Customer: Sugar factory Ormož
Type of project: realization of a control system for a steam boiler

1993

42. Development of special-purpose instruments
Customer: Faculty of Electrical Engineering and Information Science, Ljubljana
Type of project: construction of electronic modules (amplifiers)

43. Catalytic combustion in a gas burner
Customer: Zeltron S.p.A., Udine
Type of project: development of an industrial prototype for a new generation of burners for domestic cookers

44. Computer-aided control of wastewater treatment plant
Customer: Central wastewater treatment plant Domžale –Kamnik
Type of project: conceptual design

45. Optimization and computer control of spray dryer
Customer: Pliva, Zagreb
Type of project: conceptual design

46. Control of titanium puddle preparation process
Customer: Cinkarna Celje
Type of project: cooperation in control system design, implementation and commissioning

47. Computer-aided plant-wide control of Central Wastewater Treatment Plant Ljubljana
Customer: Hidroinženiring, Ljubljana
Type of project: development project

48. Determination of the optimal operating parameters for waste-water treatment plants
Customer: Central Wastewater Treatment Plant Domžale–Kamnik, Domžale
Type of project: measurements, conceptual design

49. Upgrade of the batch chemical treatment
Customer: Cinkarna Celje
Type of project: control-system upgrade

50. Computer-aided plant-wide control of wastewater treatment plants - phase 1
Customer: Ministry of the Environment and Spatial Planning, Institute of Environmental Protection and Water Management, Ljubljana
Type of project: requirements analysis for a computer-control system

51. Preparation of the guidelines, precepts and ordinances
Customer: Ministry of the Environment and Spatial Planning, Institute of Environmental Protection and Water Management, Ljubljana
Type of project: preparation of the materials for legislation purposes

52. Computer control of an SBR reactor
Customer: National Chemical Institute, Ljubljana
Type of project: design and implementation of the control system

53. Application of modern control procedures in lift construction
Customer: Lift Inženiring, Ljubljana
Type of project: feasibility study

54. Computer control of hydrolysis
Customer: Cinkarna Celje
Type of project: preparation of the system specifications

55. Control of the SiO_2 precipitation process
Customer: National Chemical Institute, Ljubljana
Type of project: design and implementation of the control system

56. Aeration control in wastewater treatment plants
Customer: Wastewater Treatment Plant Domžale–Kamnik, Domžale
Type of project: measurements, realisation of the oxygen control in reactors

57. CRA-2000 corrosion analyser
Customer: Jožef Stefan Institute, Department of Physical and Organic Chemistry, Ljubljana
Type of project: realisation of a special-purpose sensor

1994

58. Catalytic burner
Customer: Zeltron S.p.A., Udine
Type of project: realisation of a prototype of the catalytic burner

59. Modernization of steam-boiler control
Customer: Javor-Koncern, Pivka
Type of project: measurements and conceptual design

60. Control of a cascade heat exchanger
Customer: RC Pivka - Information Engineering, Pivka, Javor-Belsko
Type of project: control-system design and implementation

61. Computer control of TiO_2 final processing, technology update and improvement of the surface-treatment capacity
Customer: Cinkarna Celje
Type of project: specifications for the upgrade of three sub-processes

62. **Update of the production process by means of computer automation**
Customer: Goriške opekarne, Renče-Bilje
Type of project: feasibility study

63. **Plant-wide control of wastewater treatment plants - phase 2**
Customer: Ministry of the Environment and Spatial Planning, Institute of Environmental Protection and Water Management, Ljubljana
Type of project: preparation of the materials for legislation purposes

64. **Linking technology and organization in computer-aided production**
Customer: Javor–Koncern, Pivka
Type of project: modelling of business processes

65. **Linking technology and organization in computer-aided production**
Customer: Cinkarna Celje
Type of project: modelling of the business processes

66. **System analysis for a database design**
Customer: Ministry of the Economy, Ljubljana
Type of project: preparation of the documentation

1995

67. **Stirring system for adhesive in the production of mineral plates**
Customer: Mineralka, Cerknica
Type of project: realisation of a system for glue preparation

68. **Development of electronic modules for the MK200 oxygen sensor**
Customer: Raci, Ljubljana
Type of project: realisation of special-purpose hardware

69. **AFI2000 gas-flow indicator**
Customer: Inea, Domžale
Type of project: instrumentation design

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70. Construction of three R/I converter units
Customer: Raci, Ljubljana
Type of project: construction of special-purpose converters

71. Computer-aided control of three sub-processes in Cinkarna Celje
Customer: Cinkarna Celje
Type of project: control system specifications

72. Cutting system for Al profiles
Customer: Inea, Domžale
Type of project: design of a procedure for cutting during movement

73. MK-200 oxygen-concentration sensor
Customer: various
Type of project: small-series production, 15 pieces in the period 1990–1995

1996

74. Control system for an SBR reactor
Customer: National Chemical Institute, Ljubljana
Type of project: requirements analysis and design of an SBR pilot bed

75. Automation and informatization of the glue production
Customer: Mitol, Sežana
Type of project: conceptual design

76. Informatization of the production of polyurethane products
Customer: Poliuretani - Plama, Podgrad
Type of project: conceptual design

77. Update of a tunnel furnace by means of computer automation
Customer: Goriške opekarne, Renče-Bilje
Type of project: conceptual design

78. Re-engineering of the plastic extruder machine
Customer: Inea, Domžale
Type of project: design and implementation of the adaptive control of temperature profiles

1997

79. Re-engineering of a control system for a blow-moulding plastic extruder using standard control-system components
Customer: Inea, Domžale
Type of project: system development

80. Integration of the computer-based control of the production level and physical level
Customer: Inea, Domžale
Type of project: system conceptual design

81. Update of a polyvinyl acetate glue production (phase I)
Customer: Mitol, Sežana
Type of project: system design and implementation

82. Modelling and simulation of wastewater treatment plant Domžale-Kamnik
Customer: Central Wastewater Treatment Plant Domžale-Kamnik
Type of project: synthesis of the mathematical model of the plant designed for plant simulation and an analysis of the root causes of limited nitrification

83. Update of the tunnel dryer in brick production
Customer: Brickworks Ormož
Type of project: conceptual design

84. Automation of melting-glue production in the MITOL company
Customer: Mitol, Sežana
Type of project: implementation of a control system

85. Automation of a dryer chamber in Goriške opekarne, plant Renče III
Customer: Goriške opekarne, Renče-Bilje
Type of project: realisation of the temperature and moisture control

86. Automation of PVA glue production in the MITOL company (phase 2)
Customer: Mitol, Sežana
Type of project: upgrade of the control system

87. Development of a hydraulic test rig
Customer: Faculty of Electrical Engineering, Ljubljana
Type of project: design and construction

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88. **Information system for Central Wastewater Treatment Plant Domžale-Kamnik**
Customer: Central Wastewater Treatment Plant Domžale-Kamnik
Type of project: realisation of the project documentation

89. **Modernization of the drying process in tunnel dryers**
Customer: Opekarna Ormož
Type of project: conceptual design

90. **Control of a furnace for sintering ferrite cores**
Customer: Jožef Stefan Institute, Department of Ceramics
Type of project: realisation of the furnace control including temperature and oxygen control

1998

91. **Improving the efficiency of production by applying automation and optimization**
Customer: Krka, Novo mesto
Type of project: conceptual design

92. **Automation of the tunnel dryers in the brickworks Opekarna Ormož, 1997-98**
Customer: Opekarna Ormož
Type of project: realisation of the temperature and moisture control

93. **Automation of melting-glue production in the MITOL company II**
Customer: Mitol, Sežana
Type of project: system analysis, control-system upgrade

94. **Control of a plastic extruder machine**
Customer: Inea, Domžale; Techne Spa, Italija
Type of project: system design and implementation

95. **Update of a tunnel dryer's performance**
Customer: Opekarna Ormož
Type of project: conceptual design

96. **Online measurements of phenol pitch viscosity**
Customer: Fenolit, Borovnica
Type of project: measurements, selection of equipment

97. **Measurement of pebble-stones dynamics in streams**
Customer: Faculty of Civil Engineering, Ljubljana
Type of project: realisation of a special-purpose accelerometer

98. **Design optimization and operation of wastewater treatment plants**
Customer: Central Wastewater Treatment Plant Domžale-Kamnik
Type of project: design of mathematical models for conventional and MBBR technologies; comparative study of performance by means of simulation

99. **Efficient control and management of biological waste-water treatment plants**
Customer: National Chemical Institute, Ljubljana
Type of project: review of the technologies for information support in wastewater treatment plants

100. **Auto-tuning temperature controller**
Customer: Inea, Domžale, Techne Udine
Type of project: development of a control system for plastic extruders

101. **IDR-10F diagnostic module**
Customer: Mitsubishi Electric Europe; Inea, Domžale
Type of project: development of a new functional module for the Mitsubishi family of programmable logic controllers

1999

102. **Parison control**
Customer: Inea, Domžale, Techne Udine
Type of project: development of a control system for thickness control in production of blown plastic products

103. **Automated measurement system for analysing friction mechanisms**
Customer: Faculty of Mechanical Engineering, Ljubljana
Type of project: development of a special-purpose control system

104. **Requirements analysis and specifications for PIS production information system at Gorenje, the new Division of Cooling Technology**
Customer: Gorenje, Velenje
Type of project: conceptual design

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105. Requirements analysis for production control in the MITOL company
Customer: Mitol, Sežana
Type of project: conceptual design

106. System for oxygen concentration and temperature control in the sintering process of ferromagnetic products
Customer: Jožef Stefan Institute, Department of Ceramics
Type of project: development of a special-purpose control system

107. Update of titanium dioxide production
Customer: Cinkarna Celje
Type of project: system specifications and quality assurance for five sub-processes

2000

108. Requirements analysis and specifications for the production-management information system
Customer: Polycom, Škofja Loka
Type of project: conceptual design

109. Module IDR20SPAC for Mitsubishi AnS and AnQ controllers
Customer: Mitsubishi Electric Europe, Inea, Domžale
Type of project: development of a special-purpose module for PLC

110. Integrated information system for production management
Customer: Salonit Anhovo
Type of project: conceptual design

111. Interface for a mass spectrometer
Customer: Eotvos Lorand University, Budapest
Type of project: realisation of special-purpose electronic equipment

112. Automation of a reactor for the production of glues and pitches
Customer: Lesonit, Ilirska Bistrica
Type of project: conceptual design

113. PECS software toolset for the SPAC20 coprocessor
Customer: Inea, Domžale
Type of project: development of special-purpose application SW

2001

114. Cardiosignals: measurement system for physiological parameters
Customer: Clinical Centre, Ljubljana
Type of project: development of special-purpose measurement equipment

115. Feasibility study regarding replacement of mechanical commutation with electronic commutation
Customer: Kolektor, Idrija
Type of project: feasibility study

116. Automatic control of motor quality based on vibration analysis
Customer: Domel, Železniki
Type of project: development of a prototype for the quality assessment of electrical motors

117. Control of a a steel-strip slitting line
Customer: SIP Mobil Šempeter – Acroni, Jesenice
Type of project: realisation of the control system for a demanding cutting process

118. Conceptual design for using a modern information system in leather production
Customer: IUV, Vrhnika
Type of project: conceptual design

119. Production information system
Customer: Metal Ravne
Type of project: conceptual design

120. A supervision system for sensors and control loops in the process in an incineration plant
Customer: Sava, Kranj
Type of project: design and implementation of a rule-based diagnostic system

2002

121. Upgrade of the computer-control system in PVA glue production
Customer: Mitol, Sežana
Type of project: control-system upgrade

122. Application of modern algorithms in industrial practice
Customer: Inea, Ljubljana
Type of project: development of advanced control algorithms for industrial use

123. Upgrade of sub-processes in TiO_2 production: gel washing and calcinate cooling
Customer: Cinkarna Celje
Type of project: quality assurance

124. Information support to production planning
Customer: Liv Postojna
Type of project: conceptual design

125. Information monitoring and production management in wood manufacturing
Customer: RCL Pivka, wood processing group,
Type of project: feasibility study

126. Computer subsystem for the end-quality assessment of a vacuum-cleaner motor based on vibration analysis
Customer: Domel, Železniki
Type of project: prototype development

127. Optimal control of biological wastewater treatment plants
Customer: Central Wastewater Treatment Plant Domžale-Kamnik
Type of project: modelling and simulation of MBBR pilot plant and controller design for aeration process

128. Flexible technological line for the production of special emulsions
Customer: Mitol, Sežana
Type of project: control-system specifications

129. Assessment of investments in the rationalization of energy consumption
Customer: Mitol, Sežana
Type of project: expert opinion

2003

130. Integrated computer-based production management
Customer: Kovinoplastika, Lož
Type of project: development project

131. Information system for production monitoring in a plywood plant
Customer: Bohor
Type of project: conceptual design

132. Application of an information system to a wood manufacturing plant
Customer: Svea
Type of project: conceptual design

133. Requirements analysis and conceptual design of information system for scheduling support
Customer: Kovinoplastika, Lož
Type of project: conceptual design

134. Control of a valve-testing line
Customer: Danfoss Trata, Ljubljana
Type of project: realisation of a special-purpose control system

135. Design of a pilot process for chemical synthesis
Customer: Krka, Novo mesto
Type of project: participation in the development of the production process for a new product

136. Flexible technological line for the production of dispersions with special properties
Customer: Mitol, Sežana
Type of project: development project

137. MK-300 oxygen-concentration sensor
Customer: Altex, Ljubljana
Type of project: realisation of a measurement unit

138. Upgrade of sub-processes in TiO_2 production: calcinate cooling
Customer: Cinkarna Celje
Type of project: quality assurance

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139. Automatic tuner for air-conditioning control systems
Customer: Lek, Ljubljana
Type of project: special-purpose application SW

140. System for end-assessment of electrical motors
Customer: Domel, Železniki
Type of project: development project

141. HMI interface for control of a blow-moulding extruder machine
Customer: Inea, Ljubljana, Mitsubishi Electric Europe
Type of project: design and implementation of a communication link between command panel, controller and SPAC20 coprocessor in extruder machine

142. Use of OLAP tools for production supervision
Customer: Eta Cerkno, Cerkno
Type of project: feasibility study

143. Control of a wire treatment device using plasma
Customer: Niedermair Sackl, Austria
Type of project: realisation of a special-purpose control system

144. Batch-production scheduling in a two-stage gel-washing process
Customer: Cinkarna Celje
Type of project: development of the control algorithms

2004

145. Functional verification of diagnostic cells
Customer: Domel, Železniki
Type of project: realisation of a prototype for testing the axial gap in electrical motors

146. Monomer flow control in a polymerization plant
Customer: Mitol, Sežana
Type of project: design and implementation of the control algorithms

147. Development of a programme package for tuning, optimisation and documentation of control loops
Customer: Lek, Ljubljana
Type of project: development of special-purpose application SW

148. **Design and implementation of pH control in the batch chemical treatment of TiO2**
Customer: Cinkarna Celje
Type of project: realisation of pH control

149. **Specifications for a process in drug production (Krka)**
Customer: Metronik, Ljubljana
Type of project: participation in preparation of FDS specifications for the control system

150. **Control and supervision system for a hydraulic testing line HWS**
Customer: Danfoss Trata, Ljubljana
Type of project: realisation of a special-purpose control system

151. **Control of the nitrogen removal process in wastewater treatment**
Customer: Domžale-Kamnik Wastewater Treatment Plant; co-financer European Regional Development Fund
Type of project: realisation of a special-purpose control system

152. **Model-based control of semi-batch process**
Customer: Mitol, Sežana, project within 6th Framework Programme
Type of project: development of a mathematical model and its implementation

2005

153. **A control system for magnetically concentrated plasma wire processing machine**
Customer: PlasmaBull GmbH, Lebring, Austria
Type of project: control system implementation

154. **The algorithm for smoothing of the steam consumption in Cinkarna Celje**
Customer: Cinkarna Celje
Type of project: implementation of special-purpose software

2006

155. Cardio & Brain Signals Measurement System

Customer:
- Department of Physics, Lancaster University, Great Britain
- Royal Lancaster Infirmary, Great Britain
- Ulleval University Hospital, Oslo, Norway
- Institute of Pathophysiology, Faculty of Medicine, University of Ljubljana, Slovenia
- Neurology Clinic, University Medical Centre in Ljubljana, Slovenia
- Department of Endocrinology, University Medical Centre in Ljubljana, Slovenia

Type of project: implementation of a special-purpose device

156. Fuel-cells system as an auxiliary power supply to extend the autonomy of military vehicles

Customer: Ministry of Defence of Republic of Slovenia
Type of project: design and implementation project

157. Production of a prototype of integrated self-adaptive system

Customer: Danfoss Trata, Ljubljana
Type of project: prototype development

2007

158. Rapid testing of advanced control algorithms in industrial environment

Customer:
- Slovenian Research Agency
- Technology centre ARI, Ljubljana
- Mitol, Sežana
- Inea, Ljubljana
- Liko Pris, Vrhnika

Type of project: applied research project

159. Electronic assembly 3D LANC MASTER

Customer:
- School Centre Šentjur
- VLS Computers, Velenje

Type of project: implementation of a special-purpose module

160. Implementation of fuel-cell-based cogeneration system in mobile dwelling container
Customer: – Domel, Železniki
– Inea, Ljubljana
– Ministry of Defence of Republic of Slovenia
Type of project: design and implementation project

161. Development of intelligent valve
Customer: Danfoss Trata, Ljubljana
Type of project: development project

162. PLCbatch – a S88.01 compliant batch process control tool for controller platform
Customer: Inea, Ljubljana
Type of project: conceptual design and specifications of a special-purpose software

163. KeraPro - Ceramic processor for fuel reforming and cleaning of exhaust gases
Customer: Ministry of Defence of Republic of Slovenia
Type of project: design and implementation project

164. TESTLAB – Mobile test laboratory with fuel-cell power unit
Customer: Ministry of Defence of Republic of Slovenia
Type of project: design and implementation project

165. SmartModule – a control and supervisory module for the fuel-cell-based cogeneration power unit for combined production of electric and heat energy
Customer: – Domel, Železniki
– PlugPower Inc., Latham, New York
Type of project: implementation of a special-purpose module

166. Development of printed circuit boards and software
Customer: Danfoss Trata, Ljubljana
Type of project: prototype development

167. Specifications' production for a procedural control of the Synthesis process
Customer: Inea, Ljubljana
Type of project: specifications of the control system

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168. Education for the GPS-X programme package
Customer: Domžale-Kamnik Wastewater Treatment Plant
Type of project: education

169. Analysis of the opportunities for real-time fault detection
Customer: Technology centre ARI, Ljubljana
Type of project: conceptual design

170. Realization of the course for the software package "LEK Tuner"
Customer: Cinkarna Celje
Type of project: realization of the course

2008

171. The AVTQ testing line control system – Danfoss Trata
Customer: Danfoss Trata, Ljubljana
Type of project: control system implementation

172. Resin-synthesis batch-process control system
Customer: – Inea, Ljubljana
– Color, Medvode
Type of project: specifications for controlling the technology

173. Feasibility study for improved production control
Customer: Technology centre ARI, Ljubljana
Type of project: prospective study

174. Expert opinion on KPTE project
Customer: Inea, Ljubljana
Type of project: expert opinion

175. Feasibility study: Anti-freezing system for fuel-cell cooling circuit of the aggregate
Customer: Technology centre ARI, Ljubljana
Type of project: prospective study

176. Participation in the development of software for the testing line
Customer: Technology centre ARI, Ljubljana
Type of project: production of special-purpose software

2009

177. Fuel-cell stack freezing prevention system
Customer: Inea, Ljubljana
Type of project: implementation of a special-purpose module

178. Communication module - GSM RTU 2200MB SIBA
Customer: Inea Ljubljana
Type of project: implementation of a special-purpose module

179. DPP 822 - a prototype system for real-time detection and localization of faults in mechanical drives
Customer: an internal project within the research programme
Type of project: development project

180. The system for real-time analysis of operating characteristics of the family of electronically commutated electric motors
Customer: Domel, Železniki
Type of project: special-purpose system implementation

181. Specifications of models and control instructions according to S88.01
Customer: Inea, Ljubljana
Type of project: analysis and specifications

182. Participation in the development of the algorithm for determining the distance to objects from the imaging information
Customer: Luka Koper
Type of project: algorithm specification

183. Batch server specifications
Customer: Inea, Ljubljana
Type of project: preparation of specifications

184. Participation in the KIBERNET project
Customer: Inea, Ljubljana
Type of project: production of special-purpose software

185. Feasibility study for EC motors
Customer: Domel, Železniki
Type of project: prospective study

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186. Participation within HyCORE project
Customer: Inea, Ljubljana
Type of project: design and application of the prototype control algorithms in complex industrial processes

187. Service work on the aggregate with fuel cells
Customer: STMMsistemi, Ljubljana
Type of project: service work

2010

188. Specifications of the batch client
Customer: Inea, Ljubljana
Type of project: preparation of specifications

189. Evaluation of the laboratory environment of the batch client
Customer: Inea, Ljubljana
Type of project: verification and validation of the software

190. Development of the module for fuel cell stack heating
Customer: Inea, Ljubljana
Type of project: implementation of a pecial-purpose module

191. Study of coating and agglomeration process control
Customer: Brinox, Medvode
Type of project: prospective study with experimental measurements

192. Functional updates of the diagnostic systems
Customer: Domel, Železniki
Type of project: design and application of the prototype control algorithms in complex industrial processes

193. Specifications of the operator panel interface
Customer: Inea, Ljubljana
Type of project: specifications of the control system

194. Conceptual design for the III. phase of WWTP construction
Customer: JP VodovodKanalizacija, Ljubljana
Type of project: expert opinion

195. Implementation and installation of the diagnostic equipment for the final inspection of the suction units on line ML_7
Customer: Domel, Železniki
Type of project: special-purpose control system implementation

196. Preparation of specifications for the automation of equipment for processing metal plates by plasma
Customer: Plasmalt GmbH, Lebring, Austria
Type of project: specifications of the control system

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