EDUCATION IN ADAPTATIVE ADAPTRONICS - SUPPORT OF ADVANCED RESEARCH ON TELE-MONITORING, TELE-SERVICE, TELE-CONFIGURATION, TELE-MAINTENANCE AND TELE-CONTROL OF INTELLIGENT TECHNICAL AND TECHNOLOGICAL EQUIPMENT FOR INTEGRATED CONTROL

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Abstract: *The scientific paper treats the new concepts on engineering education in intelligent specialized field of Adaptative Adaptronics regarding their integration into advanced research and development activities of new professional skills for the future. Also, the concepts are treated the concepts of tele-monitoring, tele-service, tele-configuration, tele-maintenance and integrated tele-control.*

Keywords: *education; adaptronic engineering; adaptative integrating adaptronic engineering; advanced intelligent research.*

1. INTRODUCTION

Why Education in the Adaptative Adaptronics field?

- What is Adaptronics?
- What is Intelligent Adaptronics?
- What is Adaptative Adaptronics?

What is Adaptronics (Figure 1):

➢ is innovative and multi-disciplinary technological engineering gathering and integrating new fundamental knowledge from Adaptronics & Adaptative Adaptronics, materials science and engineering, actuators and sensors architecture, as well as measurement technology and automatic control and software engineering;

➢ is the advanced science facilitating high performance of Adaptronic systems, and high-tech but also the competitive development of new, innovative products, rediscovering the relevance of multiple efficient business areas;

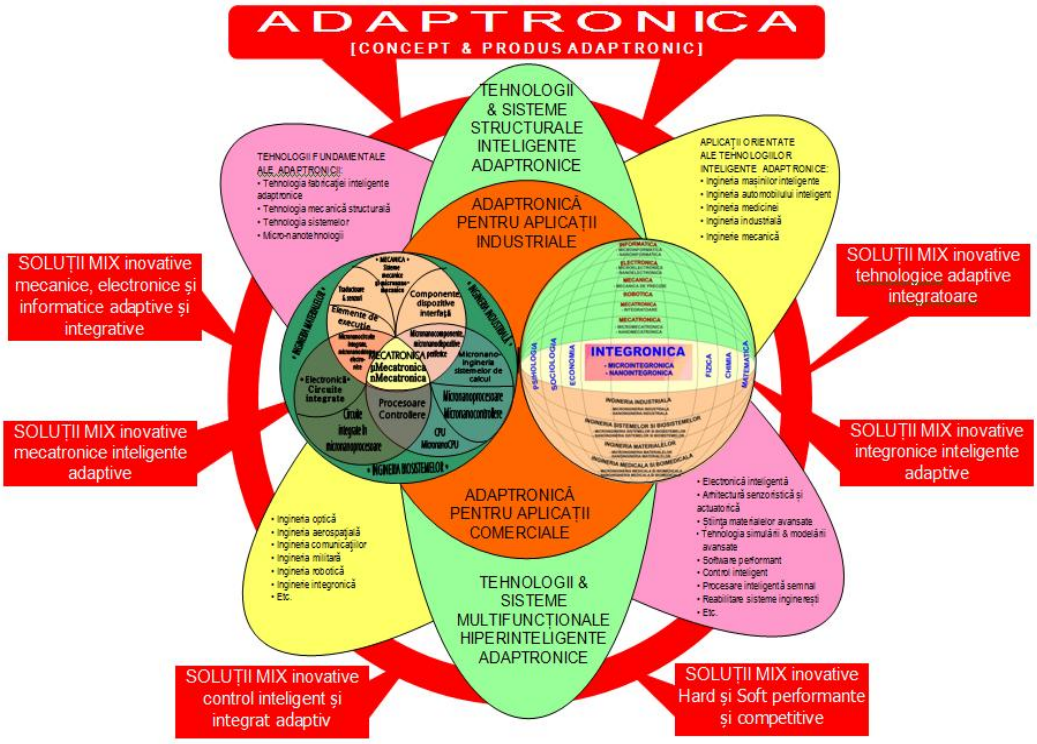


Figure 1.

- is the hyper-advanced field complementing the innovative developments and necessary potentials for modernizations and significant improvements of intelligent technologies suitable and necessary for the national and international markets of the computerized and cybernetic industries;
- is the high-tech integrator vector for strategic industries such as Adaptronic industry, aerospace industry, automotive industry, medical technology, measuring and control technology, intelligent measurement engineering, mechanical and process engineering, handling engineering and automation of production.

Generally, Adaptronics is a key technology for the future, being a fully adaptive, adapted and integrative intelligent science.

Adaptronics includes, in a Holonic systemic assembly, Adaptronic engineering, μn-Adaptronic engineering, Robotic engineering, μnRobotic engineering, Innovative technological engineering, Innovative μn-Tehnological engineering, Multidisciplinary engineering, Hardware and Software engineering / μn-Software and μn-Hardware engineering, Intelligent Measurement Technology engineering / Intelligent Measurement μn-Technology engineering, Computer engineering / μn-Computer engineering, etc.

Intelligent Adaptronic Technology and μnTehnology being considered as the most technical, technological and scientific advanced technologies, now and in the future, especially for the future, have rapid, efficient and competitive effects with performances of the highest on improvement, modernization and development of products, processes, products systems and intelligent systems, regarding promotion of the most innovative technical and technological solutions for industry, generally, and for adaptronic intelligent systems, particularly, concerning the design of other products and new intelligent systems and adapted to new scientific discoveries, the creation of new working techniques for different inter and multidisciplinary areas, on promoting new concepts and intelligent adaptronic creations and extended to the most advanced fields such as aerospace and extraterrestrial domain - as the most interested domain in the planetary life, etc.

Adaptronics and adaptronic technologies, as multi-integrative advanced sciences, versatile and synergistic globalized adopt implementations of systems, structures, materials and substances in new scientific approaches and with new generative/ adaptative algorithms and new multiple neural networks.

Adaptronics and adaptronic technologies further develop new connections, interfaces and total integrations almost like human anatomy and human functions, new intelligent/ computerized/ informational and neuro-informational integrations, and new global/ synthesizer and holonic concepts of technical-scientific sciences/ fundamental theoretical sciences/ economics/ sociological sciences/ pedagogical sciences/ psychological sciences and social and human sciences.

Adaptronics, as a concept for the development of adaptronic structures and systems is at the beginning, is still, a young discipline that applies the research in domains of micro-nanotechnologies, multifunctional materials and multi-structural and multi-functional elements.

Thus, major and redefined and reconfigurable contributions of Adaptronics and Adaptronic Technologies can be found in innovative technological engineering, in innovative polypotential developments of intelligent systems, in innovative and intelligent architecture of high-tech integration vector of industries, in the avant-garde perspective of the new intelligent and hyper-intelligent adaptronic field, in key technology for future in the future, in international platforms of new knowing and new knowledge, in active and hyperactive structural and applicable technologies, in the structures-materials-products & intelligent systems mix and in permanent and future perspective dialogue with research-development-innovation and application or transfer of knowledge and results, all to answer the questions "What is Adaptronics? What is Intelligent Adaptronics? What is Adaptative Adaptronics? What is advanced and applied Adaptative Adaptronics? Generally, Adaptronics is created and then materialized and developed to integrate new scientific fields for complex engineering structures synergies, for combinations and mix-integrations of engineering/ μn-engineering, for intelligent architectural systemic constructions pertain to all industrial assemblies for connecting other new high-tech industries (such as systems and biosystems industry, medical and biomedical industry/ μnmedical and μnbiomedical industry, etc.), for intelligent machines/ μn-machines science for other new fields (such as hydronics/ μn-hydronics, pneutronics/ μn-pneutronics, thermotronics/ μn-thermotronics, actuatorics/ μn-actuatorics, agrotronics/ μn-agrotronics, etc), for intelligent control/ μn-control, for hybrid / μn-hybrid systems, for a new interdisciplinary/ μn-interdisciplinary mix, for a new scientific thesaurus / scientific μn thesaurus, etc.

In this context of defining Adaptative Adaptronics, a good example of "product" or "adaptative adaptronic system" is the "auto structure" consisting of "car body", "sensor architecture", "actuator architecture", "signals processing system", "electronic components system" and "controller system".

- **Why Education in the Adaptative Adaptronics field?**

Education in Adaptative Adaptronics ensures flexibility in action and thinking by approaching Adaptronics principles: development of systemic thinking and teamwork training.

Education in Adaptative Adaptronics includes both education for its integrator assembly, and education for each specialized subdomain, such as: sensoric and micro-nanosensoric, actuatorics and micro-nanoactuatorics, robotics and micro-nanorobotics, MEMS & NEMS, technology and micro-

nanotechnology, manufacturing and intelligent micro-nanomanufacuring, etc.

Adopting "Adaptative Adaptronics" as a new intelligent science complex integrative and a new high-tech advanced engineering, it is based on Adaptronics, Intelligent Adaptronics and Integrated Adaptronic, as new intelligent fields with determinant role, in extending the functionality of an intelligent/ hyper-intelligent system structures by adding new multi-structural and multifunctional components and subsystems, i.e. in "continuous interference" in structure, functionality and information decision, on higher levels, of the assemblies and component parts and always adaptive to mass and space of new designed, developed and manufactured solutions.

As concern, Adaptative Adaptronics is responsible for introducing adaptive and adapted high-tech solutions in engineering fields to optimize and develop new intelligent products, systems and processes, and as commercial vector has the potential of creating added value and stimulating the creation of future markets, and as primarily aim to realize new innovative adaptronic concepts, mainly adaptation to the environment and working conditions.

Currently, Adaptative Adaptronics, as a new concept for the future, is the best science and the best intelligent specialized field for the national and international markets of the industries and, particularly, of strategic industries (aerospace, intelligent car, rail and shipbuilding industry, medical and biomedical technology, measurement technology and integrated intelligent automatic control, manufacturing automation industry, etc.).

Education in Adaptative Adaptronics is currently motivated by:

- the need to develop curricula in all public and private universities in Romania, compared with the international level;
- the need for strategic development of Adaptronics as integrating innovative science and as intelligent specialized field, as a result of the national and international markets requirements for intelligent adaptronic products and technologies;
- the need to develop intelligent specialization as a result of developing specialized adaptronics industry and other industries, which approached adaptronic advanced technologies and adaptative intelligent adaptronic products;
- the need to develop the markets niches and, in the future, commercial markets with intelligent adaptronic products and technologies, having effects and efficiencies, as follows:
  - increasing work productivity;
  - approaching new technologies and products based on the implementation of intelligent products and technologies;
  - improving and developing intelligent industrial processes and products;
  - promoting new technical and technological solutions for new machines and equipment;
  - increasing adaptronization degree of technological processes and new products;
  - increasing consistent and intensive transfer of intelligent adaptronic technologies and products;
- development of applications areas in society/ economy/ industry, with competitive and advanced intelligent technologies and products;
- development of intelligent manufacturing in industry, economy and society;
- developing permanent innovation of products, technologies and intelligent services;
- development of basic, applicative and technological research in adaptronics;
- developing advanced technologies for components and subsystems integration in compact and miniaturized architectures and assemblies;
- development and implementation of intelligent machines oriented towards society by simulating human behavior and functions (architecture perception/ knowledge/ execution/ self-care/ energy conversion, etc.);
- the need to develop some intelligent industries based on adaptronic and adaptive integrating adaptronic hard and soft-ware structures;
- permanent development and improvement of manufacturing intelligent machines

and human-machine interfaces;

- intelligent continuous development and improvement of human operations and skills;
- permanent development and modernization of intelligent integrated control in all intelligent manufacturing processes;
- permanent development and modernization of evaluation, monitoring and remote diagnosis of intelligent manufacturing processes and products through tele-monitoring, tele-configuration, tele-control and tele-maintenance and tele-service;
- developing robotics and industrial, medical and social robot, with performant applications and capabilities and with technical/ technological/ economic/ social/ environmental, etc. impact;
- developing and setting up cyber-adaptronic systems compared to systems theory and cybernetics theory, at higher levels of computerization and information.

1.2.Support of Education in Adaptative Adaptronics

Supporting Education in the Adaptative Adaptronics is done by the following considerations:

√ resizing and reconstitution of the Adaptronics specialty curriculum by completing, adaptation and integration of new knowledge, information and achievements in the field, compared to its European curriculum, including the gradual introduction of new sciences created as a result of its scientific development (e.g. universities in Germany have introduced courses on "Adaptronics" as a result of "VDI" and "VDE" efforts), as follows:

- ➢ modeling of dynamic micro- nanosystems;
- ➢ advanced knowledge on intelligent materials;

- active vibrations attenuation;
- design of advanced and special components;
- nano-concept regarding design, components selection, systems modeling, intelligent control;
- knowing processes "inside", processes models, processes optimization;
- knowing the level of components, actuators, sensors, communication systems, intelligent machine components, command systems, etc.;
- knowing new computational experimental processes, predictive modeling and simulation;
- new extended adaptronization in manufacturing processes of new and intelligent products and materials;
- new physical simulation of the intelligent manufacturing process by advanced experimental simulation;
- new computer's integration in intelligent manufacturing processes by experimental simulation;

√ registration of these courses, in educational stages, starting with the "optional" one and gradually integrating as their acceptance by students;
√ association of specialists and experts in new fields, at the technical faculties of Universities, to support these courses;
√ creation and development of specialized laboratories in Adaptronics filed in technical faculties of Universities;
√ attracting research – development - innovation laboratories from research institutions and innovative SMEs, which have endowments in the exceptional field, in which the students make laboratory works and practice in the field;
√ expansion and development of Adaptronics field also in other universities in Romania, which have not yet validated/ accredited this specialty by the National Association of Academic Accreditation;
√ expansion and development of Doctoral Schools in Universities for the Adaptronics field;
√ developing partnerships and collaborations between different Universities – faculties in the field and different Institutes and SMEs with Adaptronics profile for conducting university practice, collaboration for research projects under National Programs and European/ International Programs, etc.
√ developing common projects (University/ Institute/ SME) under POSDRU Program, developing human resources training in the field of Adaptronics;
√ development and maturation of National Platforms and Networks of Adaptronics in Romania and their inclusion in the European/ international one;
√ contracting Scientific Cooperation Agreements on long period between Specialty Laboratories of Universities (ex: UPB-INCDMTM for laboratories which will develop in 2015 at UPB Research Institute and laboratories existing in INCDMTM: Selective Laser Sintering Technologies/ Biomedical Laboratory/ Lengths Laboratory/ Laser Measurement Techniques Laboratory/ etc.);
√ deployment of European projects in the field, in national consortia in which are found Universities - National Institutes and SMEs;
√ contracting Cooperation Agreements regarding Doctoral Schools of Universities for promoting PhD students from leading universities in institutes and SMEs;
√ attracting graduates from Universities, in Adaptronics specialty, for employment in institutes and SMEs, widening the market for specialization, increasing specialists in the field, etc.;
√ expansion of university practice in summer and study visits at national institutes and innovative SMEs**.**

2. ENGINEERING EDUCATION IN ADAPTATIVE ADAPTRONICS - SUPPORT FOR AN ADVANCED RESEARCH

From those already mentioned, it appeared that engineers education in Adaptronics field holds the support for an advanced research, as intelligent specialized field – Adaptronics is an advanced, high-tech and of future field.
Developing and maturing the field involve activities supported by research - development - innovation, to discover new hard and soft-ware intelligent adaptronic solutions corresponding to new functions required by these, and with characteristics and performances comparable to the European and international one from the similar field.
Thus, by RDI National Programs and European Programs ('Horizon 2020'), the specialized intelligent Adaptronics field occupies a strategic and important (significant) promotion to address research topics in order to develop the new concepts, original solutions for products, technologies and specialized services, for industrial, economic and society strategic areas, representing "the engine of society development", including the development of Romania.

Scientific research in Adaptronics field includes as fields of applications:
(a) the energy, environment and climate change field;
(b) the bio-economic field;
(c) the information and communication technologies, space and security field;
(d) the eco-nanotechnology and advanced materials field;
(e) health field;
and as fields of competitiveness:
(a) the competitive dynamics field;
(b) the innovation, technological development and added value field;
(c) the cyber-adaptronic systems field.

As scientific subjects can be mentioned:
(a) active and automated intelligent measurement technique and computerized control;
(b) adaptronic equipment and systems for integrated multi-parametric control;

(c) non-electric physical control;
(d) advanced tribo-technologies;
(e) adaptronic, intelligent adaptronic biomedical equipment;
(f) robotic, microrobotic and nanorobotic systems;
(g) methodologies, standards, testing and certification;
(h) technological transfer;
(i) development and sustainability strategies;

The aims of applications in research and research of new problems in the Adaptronics and Integrated Adaptative Adaptronics fields set out the following strategy:

- developing the culture of cooperation between science and industry;
- alignment of strategic interests of the industrial and scientific fields;
- accumulation of new knowledge and scientific results for future developments and innovations;
- synergies development by networking the Adaptronic skills and intelligent micro-nanotechnologies in a scientific network;
- development of collaboration in excellence research;
- increase of the national and international attractiveness and of the competitiveness in strategic scientific fields;
- developing human resources in Adaptronics, Adaptative Adaptronics and intelligent integrated adaptronic micro- nanotechnologies;
- developing the transfer of know-how in the intelligent specialized industrial fields;
- developing strategic options for mobilizing skills from research, in science and industry;
- stimulating and developing engineers and specialized researchers education in Adaptronics, Adaptative Adaptronics and intelligent integrated adaptronic micro- nanotechnologies.

Manufacturing processes using research results from Adaptronics and Adaptative Adaptronics are currently observed, as follows:

- in the manufacture of electro-mechanical micro-nano-systems, MEMS & NEMS, intended to carry out industrial processes for carrying out metrological processes, evaluation and diagnostic processes, etc.;
- in the manufacture of integrated technological systems, for various precision machining, ensuring accuracy, precision stability and high level of achieved products quality;
- in the manufacture of new intelligent materials, structured and with new physical, chemical and mechanical properties;
- in the manufacture of new high-tech, intelligent and computerized products;
- in the manufacture of adaptronic and adaptative adaptronic machines, tools and equipment and integrated in manufacturing processes;
- in the manufacture of sensors/ micro-nanosensors, transducers/ micro-nanotransducers and actuators/ micro-nanoactuators;
- in the manufacture of technological/ micro-nanotechnological equipment for micro-nanoprocessing, for micro-nanostructuring, for micro-nanolithography, etc.;
- in the manufacture of micro-nanomechano-electrical bio-micronanosystems, BIOMEMS & BIONEMS designed for carrying biological processes;
- in the manufacture of hardware and software for technical, technological and metrological destinations;
- in the manufacture of systems/ micro-nanosystems for handling/ micro-nanohandling;
- in the manufacture of systems/ micro-nanosystems for assembly/ micro-nanoassembly;
- in the manufacture of systems/ micro-nanosystems for transfer/ micro-nanotransfer;
- in the manufacture of systems/ micro-nanosystems for measurements/ micro – nano-measurements, positioning/ micro-nano-positioning, standardization/ micro-nano-standardization and calibrations/ micro-nano-calibrations.

3. RESULTS OF ADVANCED RESEARCH IN ADAPTRONICS AND INTEGRATIVE ADAPTATIVE ADAPTRONICS

In order to motivate and demonstrate the maturation of intelligent specialized field of Adaptronics in Romania, some results from research-development-innovation activity, at INCDMTM - Bucharest are presented, characterized as follows:

(a) adaptronic systems and equipment for monitoring in real-time intelligent applications of micro-positioning and micro-measuring;
(b) intelligent adaptronic systems and equipment for integrated control of bench-marks and subassemblies finally processed from manufacturing processes of the car;
(c) intelligent adaptronic systems for measurement and integrated control of bench-marks and subassemblies molten from automobile manufacturing processes;
(d) intelligent adaptronic systems and equipment for remote monitoring (measurement & control/ maintenance/ servicing/ configuration, etc.) of intelligent automated equipment in the beneficiary's endowment;
(e) selective laser sintering system and advanced technology (of metallic powders - based on Cr, Ti, Co, Ni, etc.)
(f) cyber-adaptronic systems of laser measuring the distance between satellites/ microsatellites;
(g) adaptronic medical and biomedical systems and equipment;
(h) electromechanical systems and microsystems, components of intelligent adaptronic installations for measuring, regulation and control for the automotive industry;
(i) adaptronic techniques and systems for intelligent measurement of industrial products and processes;
(j) intelligent adaptronic systems for multi-parametric integrated control;

(k) intelligent adaptronic micro-robotic systems;
(l) adaptronic systems for non-electrical measurements;
(m) laser equipment for measurement and control, inductive and photoelectric transducers of high resolution and precision;
(n) adaptronic equipment for multidimensional intelligent control in high-tech manufacturing processes;
(o) intelligent adaptronic concepts and methods for increasing competitiveness and capability of industrial processes;
(p) ultraprecise adaptronic equipment for micro-nano metrological inspection, testing and validation;
(q) intelligent systems to control the parameters and profile of gears in the automobile industry.

Below, intelligent cyber-adaptronic systems and equipment for measurements and integrated control are presented:

(a) **Intelligent cyber-adaptronic equipment for controlling the auto benchmark** "assembled cylinder crankcase" type H4Bt49 & H4Bt (Fig. 2), implemented at SC Renault Dacia SA - Pitesti.

Figure 2.

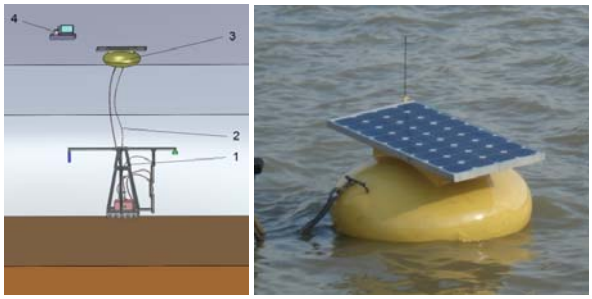
Principal parameters:
- Supply pressure: 6 bar;
- Working pressure: 4,5 bar;
- Acceptable tolerance:
  - > 12 cm^3/min., at low pressure;
  - > 25 cm^3/min., at high pressure;
- Working time: ~83 sec/benchmark;
- Standard room: ATEQF57;
- Programmable automaton: Siemens;
- Operating system: WINCC;

(b) **Intelligent cyber-adaptronic machine for control of auto benchmark** "crankcase gearbox JH3" (fig. 3), transferred and implemented at SC Renault-Dacia SA Pitesti.

Figure 3.

Functional parameters:
- Supply pressure: 6 bar;
- Working pressure: 4,5 bar;
- Acceptable tolerance:
  - > 25 cm^3/min, at low pressure;
  - > accuracy: ± 0,02 cm^3/s;
  - > standard room: ATEQ F 510;
  - > programmable automaton: Siemens;
  - > operating system: WINCC;
  - > working time: ~40 sec/benchmark;

(c) **Cyber-adaptronic ultrasonic measuring system** for sediments deposition in large basins of water (program POSCCE) (fig. 4).



SEDCONTROL system (a) *Floating module (b)*

Figure 4.

Functional parameters:
- Operating depth: 30 m;
- Wireless domains: 1 km;
- Turbidity sensor:
  - > Resolution: 1 µm;
  - > Frequency: 4, for 500 KHz÷5MHz;
- Ultrasonic sensor:
  - > Domain: 0,5÷400 m;
  - > Resolution: 1 cm;

(d) **Cyber-adaptronic system for nanotechnological measurement** (fig. 5).

Figure 5.

Functional parameters:

- Resolution AFM: 0,2 nm;
- Laser measurement resolution: 1 nm;
- Optoelectronic measurement resolution: 10 nm;

(e) **Intelligent cyber-adaptronic system for laser measurement** of the distance between satellites/ microsatellites (STAR European program), (fig. 6).

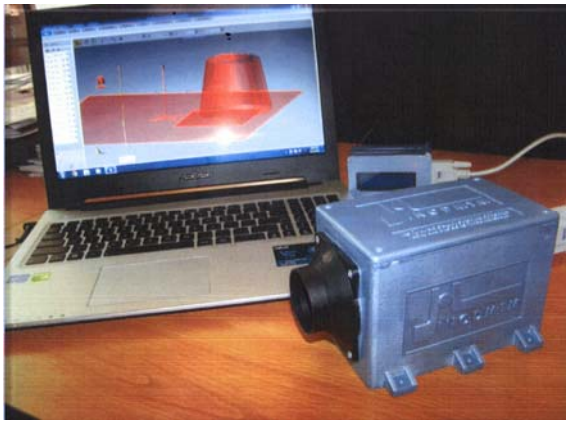


Figure 6.

Functional parameters:

- Measurement domain: 0,5÷1100 m;
- Resolution: 1 mm;
- Accuracy: ÷ 10 mm;
- Laser source: 904 nm, class 1;
- Supply: 20 Vcc;
- Display system: LCD 2x16;
- InterfaceRS-232;
- Mass: <1 kg;

The system was designed and realized by INCDMTM for the STAR space program, aiming to measure the distance between satellites/ microsatellites in order to maintain their lineup.

Cyber-adaptronic system can be connected to a laptop that works independently with the help of a portable display type LCD 2N 6 characters.

(f) **Cyber-adaptronic system for flexible positioning and ultraprecise measurement** with integration in technological platforms (fig. 7);

Figure 7.

Principal performances:

- X: 200 mm;
- Z: 200 mm;
- Positioning accuracy: ± 0,25 μm;
- Clamping force: 50 N;
- Adaptronic measuring devices: with photoelectric displacement transducers;

In figure 8 the screen of application is shown with the visualization of the measuring process.

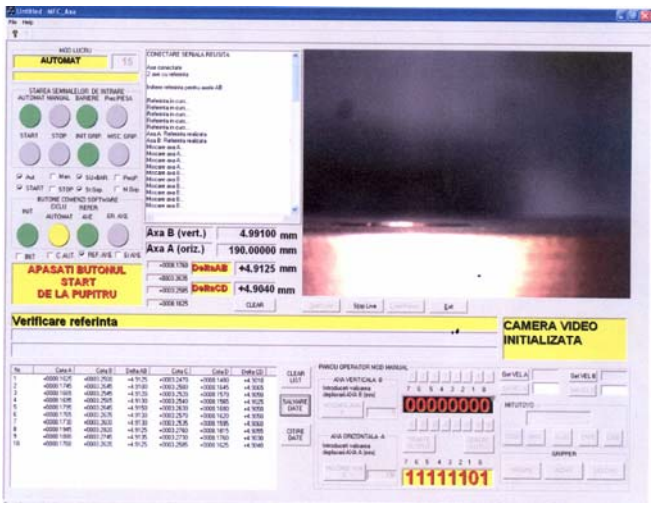


Figure 8.

(g) **Cyber-adaptronic integrated installation for tightness control**, at the auto benchmarker "crankcase oil, S2G crude" (fig. 9), transferred and implemented at SC Renault-Dacia SA - Pitesti.

Figure 9.

(h) **Intelligent cyber-adaptronic installation for tightness control and marking**, at auto benchmark "engine cylinder head" (fig. 10), transferred and implemented at SC Renault-Dacia SA - Pitesti.

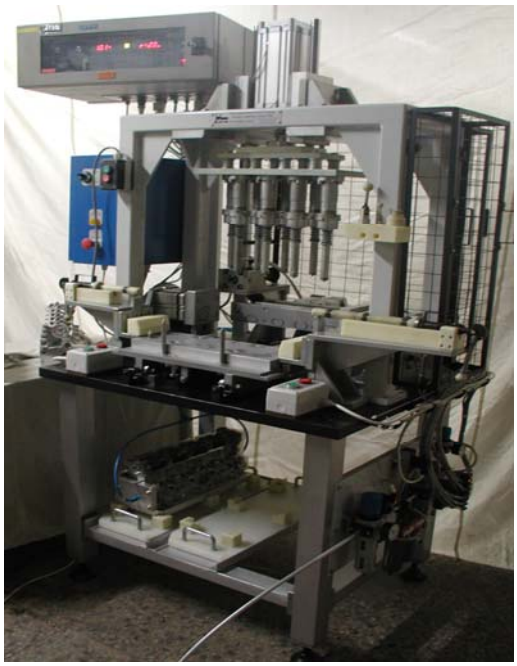


Figure 10.

(i) **Intelligent cyber-adaptronic installation for measuring/ verifying geometry**, at the auto benchmark "pusher" (fig 11), transferred and implemented at SC Renault-Dacia SA - Pitesti.

Figure 11.

(j) **Intelligent cyber-adaptronic installation for tightness control** of the auto benchmark "assembled cylinder head engine" (fig 12), transferred and implemented at SC Renault-Dacia SA – Pitesti.

Figure 12.

(k) **Intelligent cyber-adaptronic installation for measuring/ verifying the tightness** at the auto benchmark "Crankcase distribution H5 (machined)" (fig 13), transferred and implemented at SC Renault-Dacia SA - Pitesti.

Figure 13.

(l) **Intelligent adaptative cyber-adaptronic equipment of tightness verification for the auto benchmark** " Crankcase distribution machined, diversities: H4Bt8°/ H4DA49°/ H4Bt49°/ H4Bt49° Sulev" (fig 14), transferred and implemented at SC Renault-Dacia SA Pitesti.

Figure 14.

Functional performances:

- Supply pressure: 5÷6 bar;
- Control pressure: 1 bar;
- Working pressure: 4,5 bar;
- Measurement type: by pressure difference;
- Measuring time: 40 sec/benchmark
- Acceptable tolerance:
  - » max. 3,6 cm^3/min, on the low pressure circuit;
  - » max. 12 cm^3/min, on the high pressure circuit
- Operating system: WINCC;
- Standard room: ATEQ F 510 cell.

Intelligent equipment verifies four benchmarks with close configurations, but with different sealing, where the work program setting for each piece is automatic with recognition sensors.

(m) Intelligent cyber-adaptronic equipment for measuring and integrated control with remote monitoring:

The equipment (fig. 15–follow page) allows the measurement of two sets of quota for the auto benchmark "returning module" (consisting of three parts: sleeve, body and lid) and its marking when the values obtained enframe in the permissible limits (and according to French rules).

The intelligent adaptronical architecture of measurement and intelligent control equipment is shown in Figure 16.

The process of operating the equipment, initializes both the PC (fig. 17) and PLC (fig. 18), and after the validation of the measured values are automatically done the matrix marking of the three parts forming subassembly "Module of return" (sleeve/ body/ cover).

Figure 17.

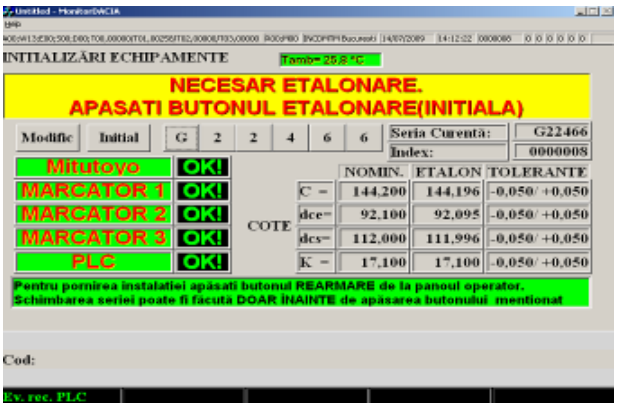


Figure 18.

For achieving the tele-monitoring measurement process and control system or tele-monitoring servicing equipment (devices) are used architectures of Figures 18, 19 and 20.

When the PLC receives the command to measure, it sends it to the industrial PC which through acquisition interface performs measurements, processes and displays of them and sends the results to automatic system of actuation via an adapter of communication.

Figure 15.

Legend:
PC Viewer application (1); optical sensor type protective barrier(2) ; measuring station (3); measuring station (4); station tagging / validation (via matrix code) (5); luminous column PLC enclosure (6); enclosure interface sensors (7); Operator panel with control buttons and signal lamps (8,9).

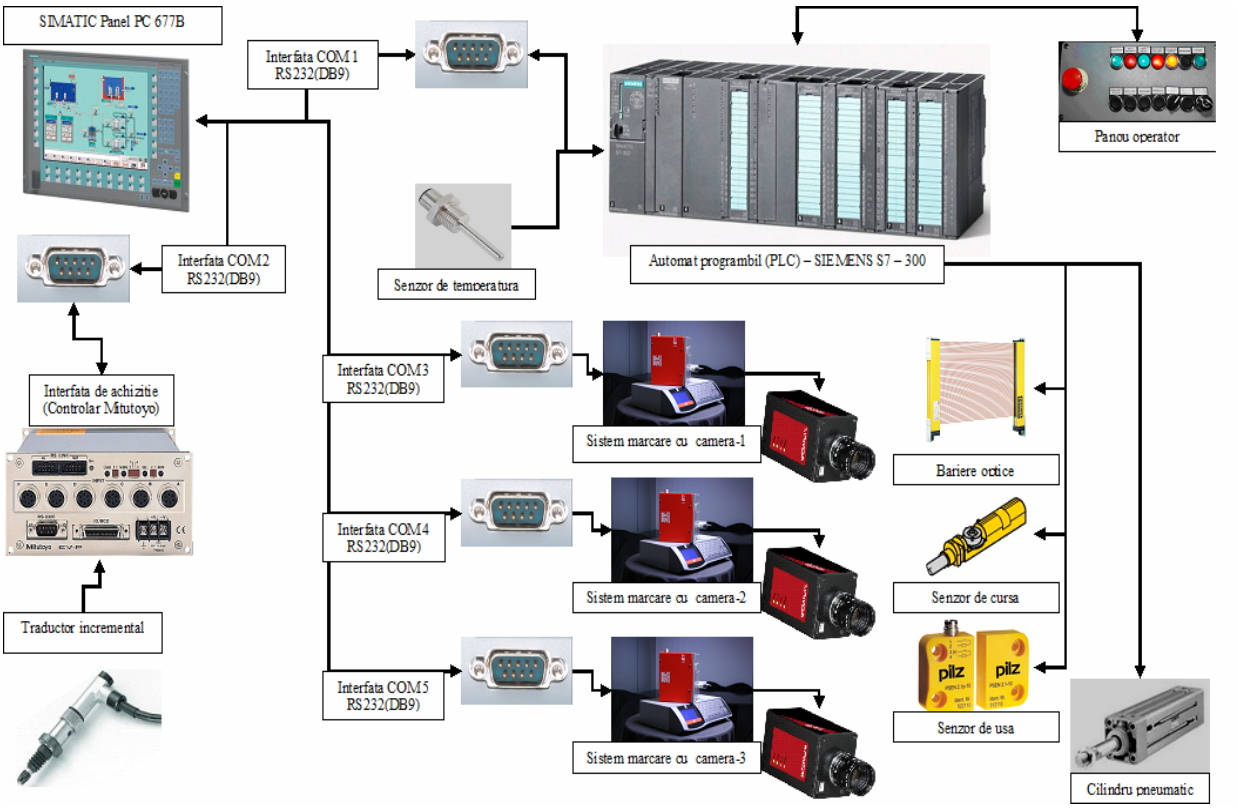


Figure 16

Communication is done by switching the PROFIBUS network to Wireless network in the industrial environment. Figure 19 shows the block diagram of the connection between the internal communication bus MPI (actually 485 Classic with a specific protocol SIEMENS) and Industrial Ethernet network (linking local computers) and another remote automation system using three methods (even simultaneously):

- TCPIP through Internet connection type;
- the mobile phone using a DCF77 module and GPS TIM4;
- through direct connection (to short) when the module TIM4.

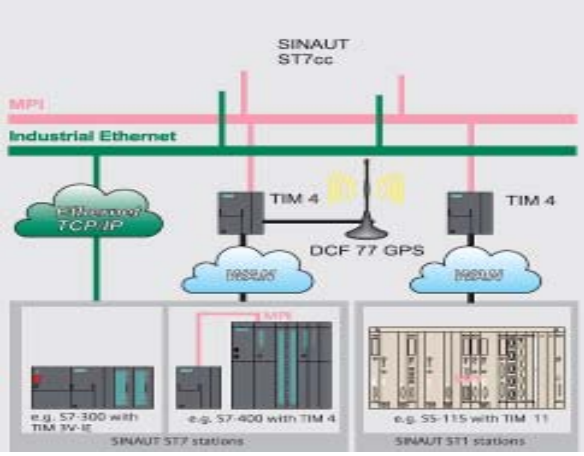


Figure 19.

and where:

- SINOUT S7CC - bus group which links to Command Center where STEP7 software runs;
- ETHERNET TCPIP - external Internet connection;
- TIM 4 - Internet connection module to the bus MPI and at which the module can switch;
- DCF77GPS - connects to the Internet via mobile;
- (in bottom panel) - examples of equipment programmable (PLC) that can be connected remotely using the Command Center S7 family equipment and PIM4.

Figure 20 presents the AS-i bus which is a system connection for transducers and the binary execution elements from lowest level.

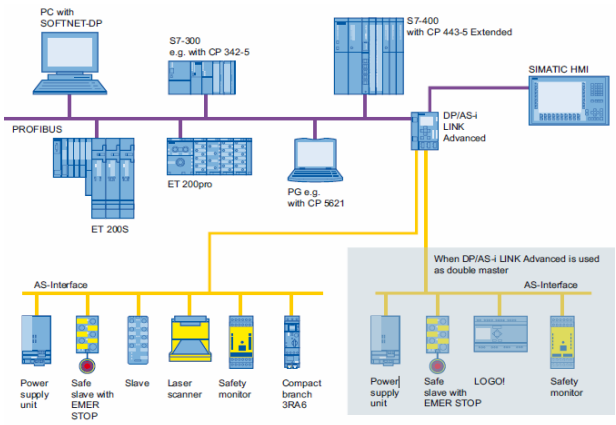


Figure 20.

All components fit in SIMATIC NET bus so that they can be connected to AS-Interface, PROFIBUS and Industrial Ethernet from interfaces integrated or specialized communication processors described above. Modules of inputs and outputs that are not located in central drawer are placed away from the main unit and can be used as modular distribution I / O.

On PROFIBUS lines are connected:

- Industrial PC running the software STEP7;
- PLC modules S300 family and CP342;
- PLC modules ET2005 family;
- PLC modules ET200 family;
- PLC modules S7-400 family;
- Display mode SIMATIC HMI.

All other modules are connected to a module DP / AS-i LINK ADVANCED that establishes the protocol with AS-i bus, where through two wires are connected the peripherals, sensors, display, scanners and buttons.

Figure 21 shows the connection between PROFIBUS and AS-i bus. On the AS-i bus are connected transducers, buttons (ex. Emergency STOP) scanners, displays etc., all connected to the same two-wire cable AS-i and via DP / AS-i Link 20E module they are connected to the facility automation bus (PROFIBUS - SIEMENS RS485 protocol).

Note. Such a solution has been implemented by INCDMTM for the automation of adaptronic assembly equipment for auto engine heatsink which had a large variety of parts, depending on engine type and heatsinks type. In figure 20 we are:

- PC / IPC - PLC Modular equipment drawer CP5621 family;
- S7-300 - drawer with S7-300 series PLC equipment;
- S7-400 - drawer with S7-400 series PLC equipment and CP443-5;
- DP / AS - Interface - the interface between hard PROFIBUS and AS-i Link 20 E type;
- AS-i bus (standard colored yellow) at this various peripherals is connected (power supply, buttons, posters, scanners, etc).

Figure 22 shows an example of architecture of remote monitoring via the Internet (WAN) connection at which Industrial Ethernet network (LAN) is done using a router. The dotted line shows a variant of ISDN modem connection. Where:

- OP – the operator panel;
- PC – general purpose computer connected to Internet;
- STEP7 – NCMS7 – an alternative to OP and PC consists of a specialized laptop SIEMENS;
- S7-400 – PLC drawer modules, connected to ETHERNET;
- S7-300 – PLC drawer modules, connected to ETHERNET;
- router – general or industrial ISDN type;
- modems– general or industrial ISDN type;

TS Adapter – SIEMENS specialized adapter that connects a modem to PLC via RS232 serial communication.

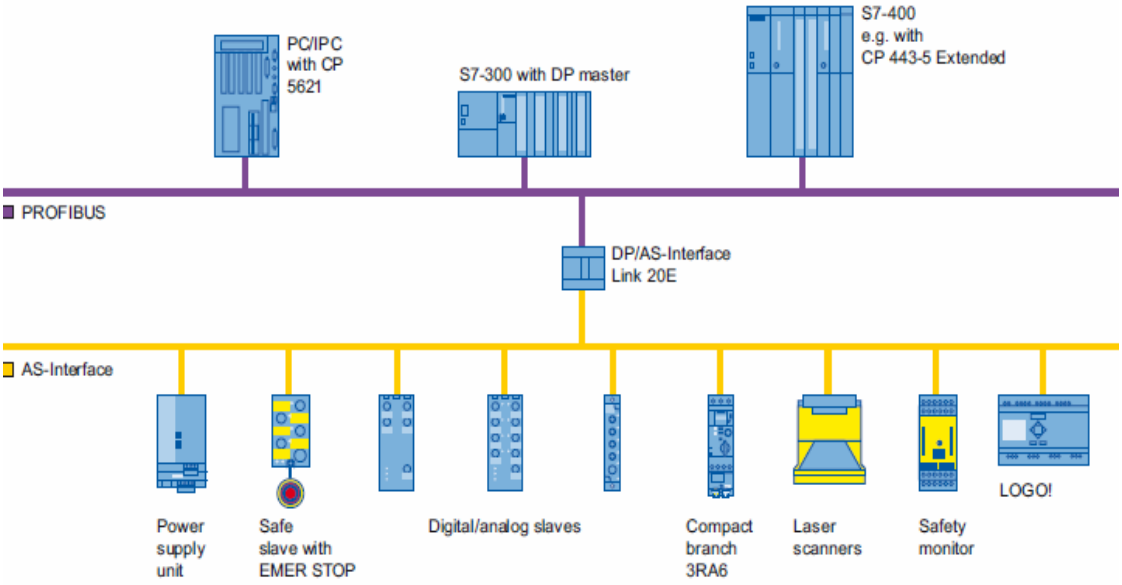


Figure 21.

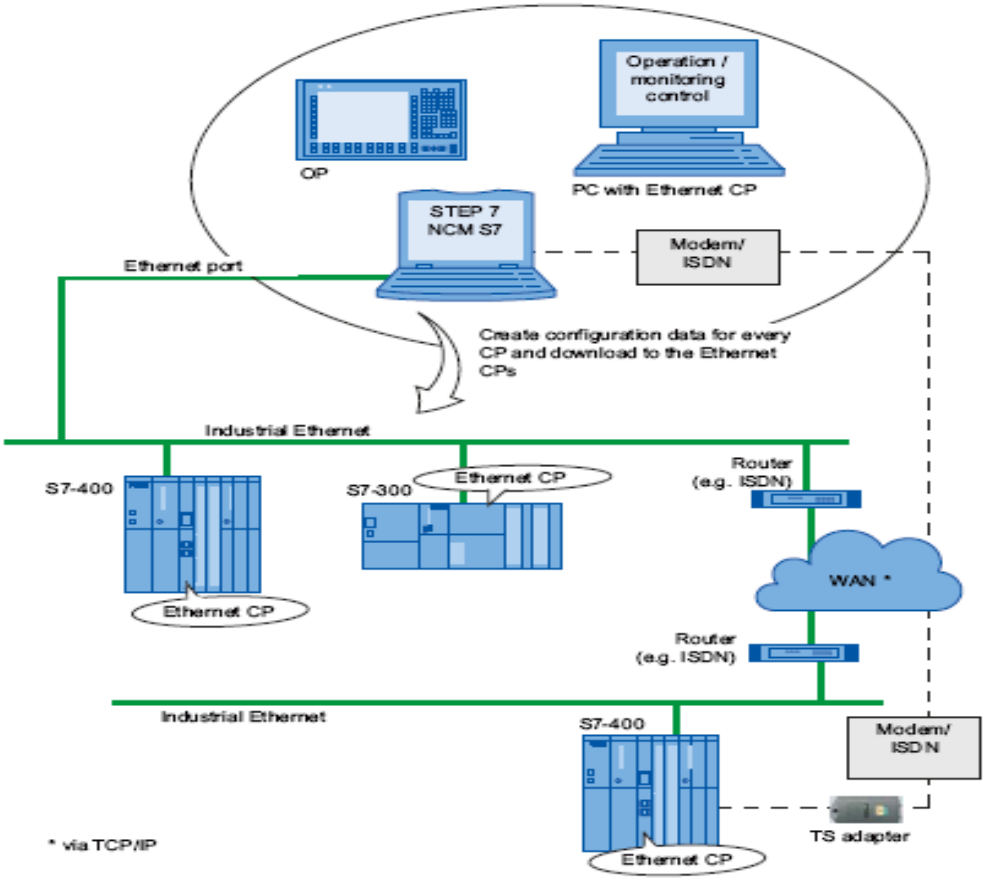


Figure 22.

Figure 23 is a block diagram of remote monitoring and configuration GPS-GPRS and Internet for intelligent adaptronic equipment found on SC Renault - Dacia Pitesti, which uses two GPS modules type DCF 77 via mobile communication and more adaptronic systems for remote automation, symbolized by TM and CPU.

On the command center is a server installed with the programming software STEP 7 and WCC- Flexible that allows and adaptability and full remote monitoring of any of the facilities (modification of the software and user interface and real time monitoring).

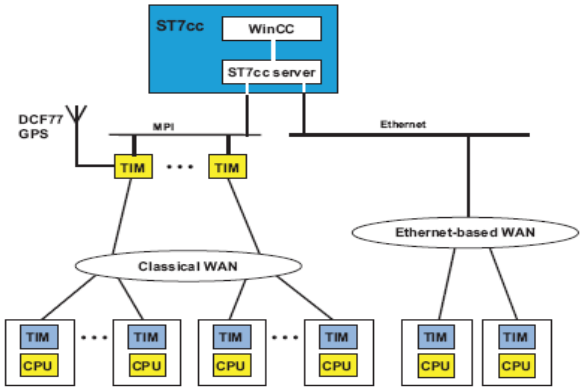


Figure 23.

If the infrastructure allows, the connection can also be made via the WAN (Internet) by respecting and the implementation of supplementary measures relating to the data security.

By GPS-GPRS communication, the remote monitoring and configuration function of key system parameters will be performed via a mobile phone or specialized office equipment. Software modules were designed that allow configuration and testing of the input vectors space from a minimal automation system/ equipment implemented with automatic Siemens (family S7- 300) via a PC connected to the Internet.

There were tested some intelligent adaptronic equipment delivered at SC Renault - Dacia Pitesti, and based on screen capture, S7- 300 PLC configuration, monitoring test vectors and input vectors Intranet and LOCAL entry, test results are compliant and can be extended the monitoring distance adaptronic process to other equipment already delivered to the recipient.

- Examples of tele-monitoring, tele-service and tele-control demonstration of intelligent cyber-adaptronic equipment implemented at SC Renault - Dacia SA :

(a) hardware configuration for remote monitoring and configuration **(Fig. 24),** includes a Siemens module to connect to GSM/GPRS modem.

(b) tele-control involves connection of distant process stations to one or more intelligent adaptronic equipment for integrated control, using various public/ private communication networks of cyclical data processing using special tele-control protocols and connection to control command center – remote control based on GPRS techniques and several PLC.

(c) tele-service involves the data exchange via the telephone line or Internet with remote equipment and systems (computers/ machineries/ installations/ production lines, for faults detection, diagnosis, optimization of maintenance activity, repairs or production optimization);

(d) tele-maintenance determines the proper functioning of adaptronic equipment and is based on periodic interrogation of installations/ equipment (sequencer step/ loading error/ operator error/ hardware error);

(e) tele-diagnosis involves, depending on the error code, interrogation of control installation/ equipment on the status of certain hardware components up to detection of faulty component;

(f) the user interface is presented -**Fig. 25.**

(g) the PC executable program with remote monitoring example of process variables is shown - **Fig.26.**

(h) example of selecting a particular adaptronic system monitored by program accessed in browser **Fig. 27.**

(i) monitoring digital inputs and outputs of PLC equipment for an experimental model is in **Fig. 28.**

(j) an example of the sever application screen **Fig. 29**

(k) an example of client application is shown in **Fig. 30**

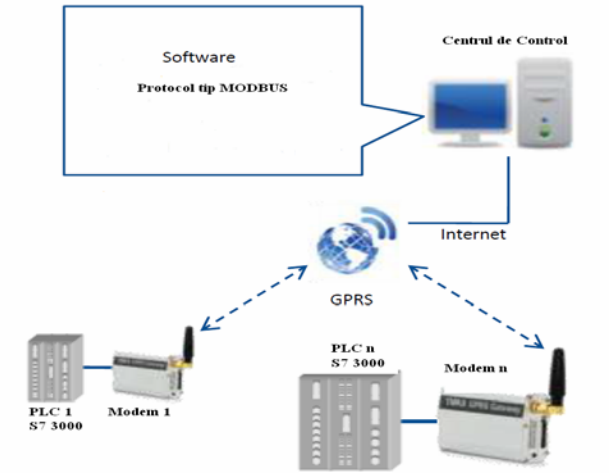


Figure 24.

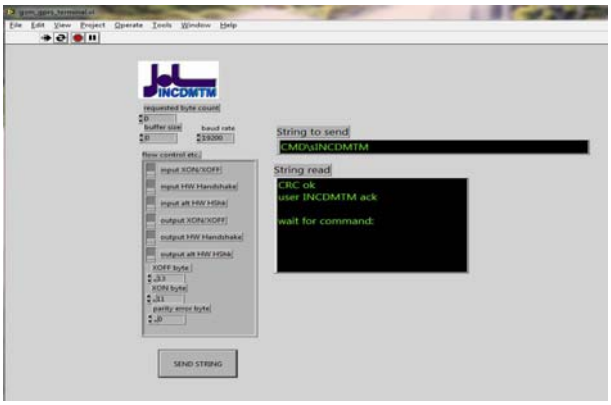


Figure 25.

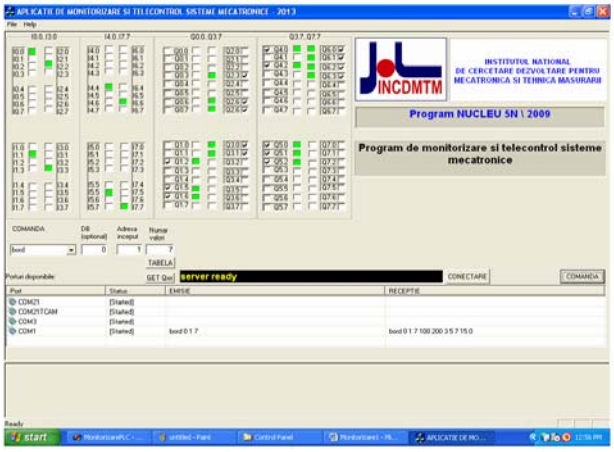


Figure 26.

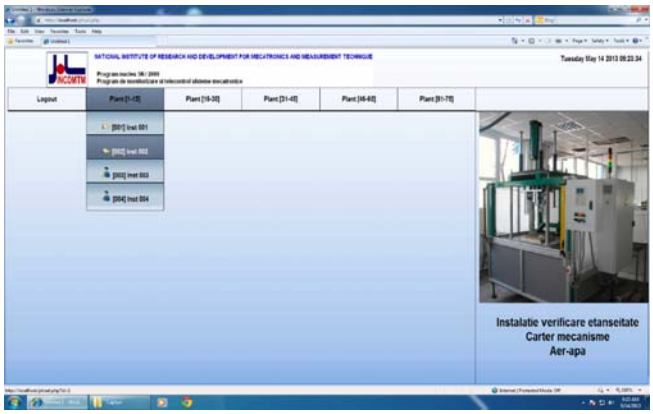


Figure 27.

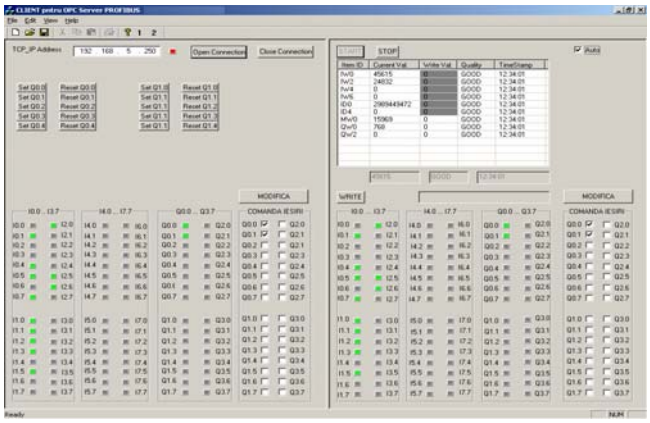


Figure 28.

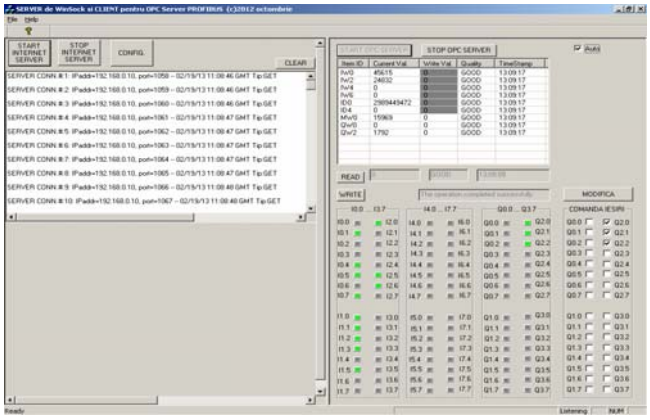


Figure 29.

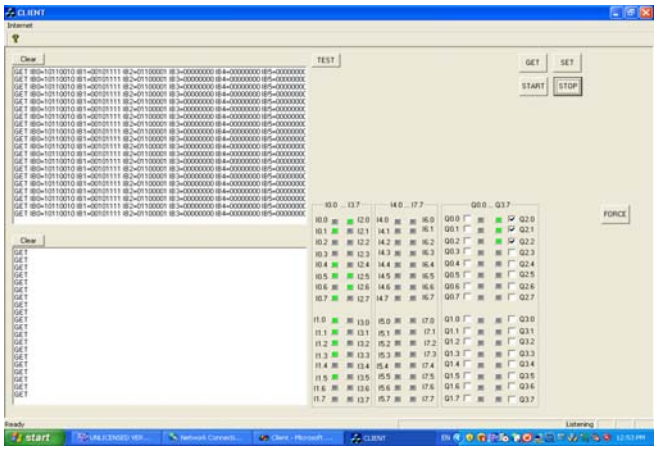


Figure 30.

4. CONCLUSION

The scientific work demonstrates the need to develop engineering education in Adaptative Adaptronics field, both as support for advanced research and for the creation and realization of technology merged value chain of Adaptronics and Adaptative

Adaptronics engineering, thus contributing to the construction of intelligent manufacturing of advanced cyber-adaptronic products and technologies, for a new synergetic integration of intelligent specialized field in Romanian industry, economy and society.

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