SDO YUZHNOYE’S INNOVATIVE PROJECTS

INTERNATIONAL EU-RUSSIA/CIS CONFERENCE ON TECHNOLOGIES OF THE FUTURE:
SPAIN-ISTC/STCU COOPERATION
MADRID, APRIL 22-23, 2010
LOCATION: Dniepropetrovsk – industrial, business and scientific capital of Ukraine; aerospace and metallurgical centre of Ukrainian industry

YEAR OF ESTABLISHMENT: 1954

NUMBER OF EMPLOYEES: 4500

REPRESENTATIVE OFFICES: Brussels (Belgium), Long Beach (USA), Kiev (Ukraine)

JOINT VENTURES: Sea Launch (Ukraine, USA, Russia, Norway), Kosmotras (Ukraine, Russia), Space International Services (Ukraine, Russia), Alcantara Cyclone Space (Ukraine, Brazil)

HERITAGE: Development and production of four generations of strategic missiles, represented by 13 modifications which formed the basis of Soviet Union strategic missile forces. There were also produced 7 types of world-class launch vehicles (Kosmos, Interkosmos, Cyclone-2, Cyclone-3, Zenit-2, Zenit-3SL, Dnepr).
Spacecraft

More than 400 spacecraft of 70 types were designed and launched.

Large-scale production of unified spacecraft on their basis was organized for the first time in the world.
11 types of main liquid-propellant engines with thrust level from 500 kg to 48,000 kg
6 types of liquid-propellant control rocket engines with thrust level from 5,000 kg to 29,000 kg
16 types of liquid, gas jet and electrical jet spacecraft propulsion systems with thrust level from 0.005 kg to 10 kg
7 types of main solid-propellant rocket motors with thrust level from 150,000 kg to 300,000 kg
more than 100 types of special purpose solid-propellant rocket motors, pressure accumulators and gas generators
8 types of electric power units to provide hydraulic power to steering systems

Rocket Engines

RD-860
RD-8
AUOS-Z spacecraft gas jet propulsion system
Okean-0 spacecraft thruster
Sich-2 spacecraft ammonia thruster
Advanced Materials and Technology

- Non-metallic composites
  - Wind power generator blades and mine structures made of fiberglass plastic

- Metal Composites
  - Are produced by explosion welding
  - Multilayer composites
  - Plain bearings
  - Bimetallic adapters
  - Heat exchangers

- Solid rocket motor body of "cocoon" type

- Nozzle inserts and bells made of carbon-carbon composite

- Metal-Plastic Composites
  - Metal plastic bottles

- Launch vehicle aft sections and spacecraft trusses made of carbon fiber composite

- 3-layer honeycomb structures
Experimental and certification testing

Strength testing

Fire testing

Antenna systems

Functional testing

Full telemetry support for space rocket systems testing and nominal operation
MAIN DIRECTIONS OF ACTIVITY

SPACE TECHNOLOGIES
- Launch vehicles
- Earth remote sensing satellites
- Propulsion systems for LVs
- Advanced composite materials for space application

GLOBAL SPACE PROJECTS
- Solar Key
- Radioactive waste removal into outer space
- Anti-asteroid protection of the Earth

INNOVATIVE CIVIL PROJECTS
Results of conversional developments and new innovative solutions in the sphere of power engineering, advanced composite materials, theoretical mechanics, civil aviation etc.
YUZHNOYE AND EUROPE

- Close interaction with European space agencies (ESA, ASI, CNES, BNSC)
- Participation in implementation of global European projects (partnership with AVIO, Italy on development of Main Engine Assembly that is a part of liquid-propulsion system for upper module of Vega LV)
- Participation in TWINNING and TEMPUS programs
- Participation in the Framework programs of European Commission (FP6, FP7)
- Partnerships with European companies under the STCU projects

WE APPRECIATE AND PROUD OF THIS MUTUALLY BENEFICIAL COOPERATION!
YUZHNOYE AND STCU

COMMENCEMENT OF COOPERATION: 1996

NUMBER OF PARTICIPANTS FROM YUZHNOYE SDO: more than 1000

NUMBER OF PROJECTS: 65 (including 10 Partner projects and 55 regular projects).
Currently 3 Partner projects and 5 regular projects are implemented by Yuzhnoye.

BENEFITS OF COOPERATION WITH STCU:
✓ opportunities for implementation of conversional projects and development of new state-of-the-art technologies;
✓ important experience of international cooperation with the partners from European Union, USA, Canada and CIS countries.

RESULTS OF STCU PROJECTS IMPLEMENTATION:
Development of high-technology products – advanced industrial, space, IT technologies, new equipment and materials etc. that are solving the current tasks of power engineering, ecology, water desalination, waste recycling, rocket propellant utilization and other technical problems at national and international level.
PROSPECTIVE PROJECTS
NEW INERTIAL ROTOR DYNAMICS
INERTIAL ROTOR DYNAMICS

Mathematical Models on the Basis of Inertial Characteristics of Different Rotor Systems

- Technology of mathematical models construction
- Balancing equipment: advanced stand for rotors’ dynamic balancing
- Software of MSC.Nastran – Rotor Dynamics type
- Autobalancing device

- Design of cutting-edge rotor machines with advanced technical and power characteristics
- Accurate definition of the value and locations of rotor’s unbalances
- Solution of revolutionary technical tasks on the stage of design of new machines and devices
- Rotor’s balancing at operating mode without extraction of the rotor from the object

- Mathematical models for main types of rotor systems have been developed
- The experimental stand for investigation of rotation dynamics of rotor systems’ models has been created
- Analytical algorithms for calculation of operation characteristics of rotor systems have been developed
- Simple and reliable device for efficient balancing of rotor machines at operating mode has been created
ACTUALITY: continuous increasing of the velocities of rotor machines’ assemblies and details, need in efficient elimination of harmful (dangerous) vibrations and decrease of power losses during rotor systems’ operation

SPHERES OF APPLICATION: all industrial fields where rotation elements are applied – aviation, automobile, shipbuilding, turbomachinery, gas-and-oil producing industry, chemical, textile, machine-tool, mining industries, pharmaceutics etc. including household appliances


UNIQUE FEATURES: The proposed technologies are based on new Inertial Rotor Dynamics. Such approach provides a possibility of correct mathematical models creation that describe a true rotation process of different rotor systems. It ensures the breakthrough in solution of earlier unsolvable practical tasks of rotor dynamics.

POTENTIAL MARKET: According to the preliminary marketing research, the volume of sales of similar software amounts to $35000000. Production of balancing and diagnostic equipment of Schenck GmbH Company exceeds 4000 items per year.

RESULTS OF TESTS AND EXPERIMENTS: mathematical models that describe the rotation of vertical and horizontal rotor systems are proved by the results of theoretical and experimental researches
## COMPETITIVE MATRIX: ADVANCED SOFTWARE

<table>
<thead>
<tr>
<th>KEY CHARACTERISTICS</th>
<th>New Software Product on the basis of Inertial Rotor Dynamics</th>
<th>“MSC.Nastran - Rotor Dynamics”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of correct mathematical models in software</td>
<td>Available</td>
<td>Not available</td>
</tr>
<tr>
<td>Developed solution algorithm</td>
<td>Analytical algorithms</td>
<td>Iterative solution process</td>
</tr>
<tr>
<td>Application of data bases on parameters of typical rotor systems</td>
<td>Not required</td>
<td>Big-volume data bases are used</td>
</tr>
<tr>
<td>Necessity of preparation of the detailed 3D-models</td>
<td>Not required</td>
<td>Construction of the detailed 3D-models is obligatory</td>
</tr>
<tr>
<td>Accuracy of calculations</td>
<td>High (analytical solutions are applied)</td>
<td>Low accuracy, if construction of rotor system considerably differs from the typical one</td>
</tr>
<tr>
<td>Speed of calculations (e.g.: calculation of critical velocity)</td>
<td>5 – 10 sec</td>
<td>2 -3 hours</td>
</tr>
<tr>
<td>Special qualification of the staff</td>
<td>Not required</td>
<td>Highly qualified specialists are required</td>
</tr>
<tr>
<td>Cost of software</td>
<td>Less than $10000</td>
<td>Cost of 1-year license $70000</td>
</tr>
</tbody>
</table>
COMMERCIAL AIRCRAFT PROTECTION
The project is devoted to creation of unique countermeasure system, called SPATIAL DISPLACEMENT OF THERMAL IMAGE (SDTI), which differs in its principle from existing systems and other systems that are under development.

- The market for SDTI is very perspective in all economically developed countries of the world.

- The analysis says consumers will pay out for protection technologies approximately $20 billion from 2012 to 2016. The market value reflects the forthcoming introduction of major new aircraft platforms that will require the most advanced self-protection systems available.

- Defense departments will spend $11.8 billion over the next decade on developing and producing these key countermeasure systems.

- The basic market sector of the given technology is aviation industry. The activity will be concentrated on commercial companies engaged in cargo and passengers air transportation (civil and transport aviation).
**SPHERES OF APPLICATION:** protection of commercial aircraft – passenger airliners, cargo and VIP aircraft

**ANALOGUES:** SDTI technology has no analogues in the world

**PATENTS:** SDTI is protected by patents in Russia and Ukraine. A provisional patent was filed in the US

**TARGET CUSTOMERS:** major commercial airlines and governments of different countries. The current international commercial fleet includes 10,000 jets, with 17,000 new aircraft projected to be added during the decade 2010-2020

**FINAL OBJECTIVE:** application of SDTI protection system on commercial aircraft fleet worldwide

**PROPOSED MECHANISM OF COOPERATION:**

- **Yuzhnoye SDO (Ukraine)**
- **InterTEC Company (Ukraine)**
- **Industrial Partner (Europe or USA)**
The **EXISTING TECHNOLOGIES** for heat-seeking missiles countermeasure are based on laser systems and they have the following **DISADVANTAGES**:

- low efficiency of electric power transfer into heat power;
- high requirements to precise direction of laser beam;
- high probability to miss the high-velocity target;
- inefficiency at processing of several targets;
- necessity to detect precisely target and to track it;
- comparatively high response time of the mechanical parts of the system, especially at take-off and landing;
- high energy consumption;
- high cost.

The proposed **SDTI TECHNOLOGY** is free from such disadvantages and has the following **ADVANTAGES**:

- ability to produce false images in a commanded location and control their apparent motion;
- being able to do this without prior knowledge of the missile type or location;
- equally effective against multiple simultaneous missile launches;
- radiation from the false image is going out with near uniformity in all directions;
- low power consumption;
- the technology doesn’t expose its operators to environmental liability;
- low cost;
- high efficiency and reliability.
VIBRODIAGNOSTICS
VIBRODIAGNOSTIC MONITORING

- Possibility to determine defect load-bearing or support elements of large objects;
- Possibility to determine marginal state and residual operational lifetime of the element;
- Possibility to apply the method for the objects that are in design phase, under development, construction or in operation;
- Transmission of the data through satellite channels will allow to provide efficient information to the regional processing centers to facilitate the process of decision-making.

The object of monitoring can be load-bearing structures: bridges, arches, nuclear stations, domes of sport facilities, for example aquaparks, stadiums and others that are under static, dynamic, acoustic and seismic loads.
Inexpensive - may even be able to use traffic vibrations as the vibration source;
Safe - no radiation, no chemicals, no unusual frequencies;
Dependable - rugged sensors, all-weather operation;
Permits continuous, real-time monitoring;
Applicable at many stages: design, manufacturing, assembly, after building and before commissioning, regular monitoring, emergency off-schedule monitoring;
Supports remote monitoring;
Uses standard PCs to run analysis and communication software;
Will have extensive laboratory and field testing;
Can be adapted to existing bridges.
ENERGY
PLANT FOR COAL BURNING AND GASIFICATION IN CIRCULATING BOILING LAYER UNDER PRESSURE

SPECIAL FEATURES:
- arrangement of two-stage thermal processing of coal: pyrolysis, burning or gasification in circulating boiling layer (CBL) with arrangement of coal pyrolysis by circulating ash;
- high multiplicity of circulation;
- combined coal supply: to the upper part of the reactor, to the coke-ash reminder (CAR) return channel and the pyrolyser (to ensure the conditions of volatiles extraction in the regenerating medium, to improve the conditions of heat and mass exchange, to avoid caking and slag formation);
- availability of CAR reburning chamber;
- availability of the chamber for mixing of the gases produced.

RESULTS:
- thermal processing of coal at lower temperatures (930°C);
- considerable reduction of creation of nitrogen oxides;
- sulphur bonding;
- 100% coal conversion and reduction of effluents of harmful substances to the level allowed.
The emulsifier is a unit for wet cleaning of flue gases of thermal power stations from ash and sulphur oxides.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity, thousand m³/hr</td>
<td>40-50</td>
</tr>
<tr>
<td>Cleaning effectiveness, %:</td>
<td></td>
</tr>
<tr>
<td>from ash</td>
<td>99.6-99.9</td>
</tr>
<tr>
<td>from sulphur oxides</td>
<td>80-95</td>
</tr>
<tr>
<td>Flow rate of spraying liquid, l/m³</td>
<td>0.25 ± 0.05</td>
</tr>
<tr>
<td>Permissible gas temperature at inlet, °C, no more than</td>
<td>180</td>
</tr>
<tr>
<td>Optimum velocity of gas flow, m/s</td>
<td>9.5</td>
</tr>
<tr>
<td>Hydraulic resistance, mm of water column</td>
<td>55</td>
</tr>
<tr>
<td>Dimensions of one cassette (length×width×height); m</td>
<td>2.2×2.2×1.5</td>
</tr>
<tr>
<td>Mass, kg</td>
<td>1790</td>
</tr>
</tbody>
</table>
WASTE PROCESSING
ANIMAL FAT AND VEGETABLE OIL PROCESSING PLANT

- **THE PROCESSED PRODUCTS:** animal fat, vegetable oil;
- **THE END PRODUCTS:** biodiesel, technical glycerin (productivity within the range of 1000-4000 kg/hour for biodiesel fuel, glycerin – 270 kg/hour.
- **THE BASIS OF TECHNOLOGY** is a reaction of etherification-methanol (ethanol) is added to vegetable oil or animal fat in the definite mass ration

**ADVANTAGES:**
- Productivity;
- Regulation of the operation modes depending on physical-chemical specifications of the initial feedstock;
- Cost of the Plant and net cost of the products produced

**STAGE OF DEVELOPMENT:** the experimental model of the plant has been created. It was tested and it confirmed the effectiveness of selected method

During designing of the Plant requirements to the sanitary standards, monitoring of the maximum permissible emissions to the atmosphere, protection of soil from pollution by industrial waste, protection of surface waters from pollution were taken into consideration.
The proposed technology is a unique, environmentally friendly, it has technically prospective nature and contributes into the world practice of creation of alternative sources of energy and energy carriers.

- **THE PROCESSED PRODUCTS**: solid residential waste;
- **THE END PRODUCTS**: energy and energy carriers

**ADVANTAGES:**

- Practically all types of SRW without their separation and classification by types, kinds and places of origin without limitations as to the initial moisture can be used as feedstock
- Cleaning of industrial regions and cities territories from SRW providing complete environmental safety
- Waste-free technology, absence of residuals that require utilization and therefore area for their burial

**PRODUCTIVITY:** Plants for SRW processing are the module complexes of different efficiency - from 10 up to 500 tones of the processed industrial waste per day.

**STAGE OF DEVELOPMENT:** the experimental model of the plant has been created
BIOGAS OBTAINING FROM THE WASTE OF CHICKEN BREEDING

PRIME ADVANTAGES OF THE METHOD:
- High productivity at the maximal coefficient of efficiency;
- Compactness;
- Low power consumption;
- Environmental friendliness.

PRODUCTIVITY: biogas 950 - 1500 m³/hour

ECONOMICAL EFFICIENCY: bioreactor with the gas volume of 1000 m³ uses 70% of gas as a “marketable” gas; 30% of gas is used for heating the reactor.

ECOLOGY: during biogas burning the emission of NO? is less than during natural gas burning. The maximum concentration of CO and NOx in combustion products is 2-3 times less than a standard.

STAGE OF DEVELOPMENT: the experimental model of the plant has been created
WATER DESALINATION
PURPOSE OF TECHNOLOGY: obtaining vapour with designated parameters or quality distillate, saline with increased salt content from the mineralized water (sea, mine, salt lake, artesian waters).

THE BASIS OF TECHNOLOGY: The technology is based on boiling of the mineralized water on nonisothermic heat-exchanging walls (HEW) while creating special conditions of boiling by selection of thermophysical properties of material and design parameters of HEW, density of thermal loads. It results in self-purification of HEW from the scale that is generated on the edges of HEW during boiling process.

The technology allows processing almost all types of natural mineralized water (with initial salt content up to 150 g/l and more).

ANALOGUES: Technology does not have analogues worldwide

ON THE BASIS OF TECHNOLOGY THE FOLLOWING PROJECTS CAN BE DEVELOPED:
- Desalinating plant of any capacity;
- Plant for evaporation of harmful substances of any capacity;
- Steam generator on the basis of mineralized water of any capacity.
DISTILLATION WATER-DESALINATING PLANT WITH PRODUCTIVITY 55 L PER DAY

PURPOSE OF TECHNOLOGY: obtaining drinking water from the mineralized waters

POTENTIAL CUSTOMERS: Individuals, remote enterprises and industries (weather stations, frontier posts etc.), emergencies ministries.

PROJECT BACKGROUND
Plant consists of: evaporator with heat-generator of 2 kwatt capacity which consists of nonisothermic heat-exchanging wall (HEW) and power supply device of pipe electrical heater that issued by industry and electric palm as well as hydraulic pump device, electrovalve, control unit and condensing unit.

Plant operates in automatic mode and generates the steam which turns in the condensing unit into distillate and brine of high concentration.

Plant weight is 32 kg.

Plant operates with self-cleaning of HEW from the acquired scale.

STAGE OF DEVELOPMENT: experimental model has been developed.
PURPOSE OF TECHNOLOGY: obtaining drinking water from the mineralized waters

POTENTIAL CUSTOMERS: Individual customers, small enterprises, farms etc.

ADVANTAGES:
- High efficiency and productivity comparing to the existing analogues;
- Free natural heat of the Sun;
- Compactness.

PROJECT BACKGROUND
The plant contains a solar-heat unit that includes a parabolic mirror reflector of 3 m diameter, supporting-turning device with the Sun tracking unit, power source of 100 W power, as well as water-processing unit that includes evaporator with raw water supply system and concentrated salt water discharge system. The water-processing unit has systems of hot steam and salt water utilization.

The plant directly uses a solar heat to evaporate the mineralized water.
COOLER FOR INTENSIVELY HEATED OBJECTS
SPHERE OF APPLICATION: blast furnaces, cupola furnaces, crystallizer, nuclear stations, electric steel-making furnaces, oxygen steel-making converters, furnaces of non-ferrous metallurgy, marine engines etc.

DISTINCTIVE FEATURES OF THE COOLER:

It has hollow box-type core and nonisothermic heat-exchanging wall (HEW). The conducted research has proved that nonisothermic finned heat-exchanging wall has 2 distinctive features:

- it can disperse big heat flows (with density of up to 400 Wt/sm² and more) to the boiling water, even during its periodical overheating;
- it can self-purify from the generated scale

Application of the cooler with the HEW allows to do the following - more efficiently than existing systems:

- ensure cooling of high-temperature intensively heated objects;
- increase the term of uninterrupted operation of the object;
- utilize low-potential heat of cooling liquid, even with power energy obtaining;
- apply the mineralized water for cooling;
- obtain the fresh waster as the output product etc.

Cooler or group of coolers of high-temperature intensively heated objects can be applied as steam generator for power energy generation and also as desalinating complex.
PRIORITY OF COOPERATION
TARGET

PARTICIPATION IN STCU PARTNER PROJECTS JOINTLY WITH EUROPEAN COMPANIES

- Development of new cutting-edge technologies for the benefit of EU and Ukraine
- Expanding strategic cooperation with Europe
- Intensification of interaction with STCU
CONTACT INFORMATION:

Diana Kolova
Senior Manager, Business Development
Yuzhnoye State Design Office

E-mail: space@yuzhnoye.com

Tel: +38 056 770 04 47
Fax: +38 056 770 01 25