

# **AERONAUTICS AND AEROSPACE ACHIEVEMENTS AND RESEARCHES IN UKRAINE**

**AIR TRANSPORT NETWORK**  
**Conference on International Aerospace**  
**London, 13 – 14 March, 2008**

**Prof. A. Zbrutsky**  
**Dean of Aerospace Systems Faculty**  
**NTUU “Kyiv Polytechnic Institute”**

# STRUCTURE

- ▶ 1. Space industry
- ▶ 2. Aeronautics
- ▶ 3. Universities

# Space industry of Ukraine

Kyiv



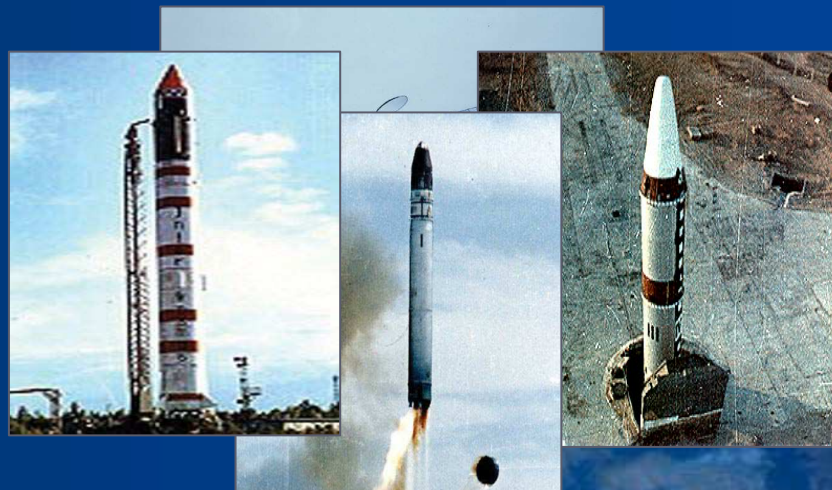




# History

## During 40 years of space era:

- developed **5 types of launch vehicles (Kosmos, Interkosmos, Cyclone-2, Cyclone-3, Zenit)**
- developed and launched **more than 400 satellites** for astrophysical and global research and the Earth remote sensing
- developed **four generations of combat strategic missile systems**
- produced **more than 10 000 ballistic missiles** that ensured parity in cold war



## Participated almost in every most important space projects of the USSR:

- Launch of the **first Earth satellite**
- **First human flight** to space
- Programs of **flights to the Moon and Solar system planets**
- **Interkosmos** international program
- Launch of **Salut** and **Mir** orbital stations
- Development of **Energiya-Buran** Space Launch System





# Organization of Ukrainian Space Industry

## National Space Agency of Ukraine

### Manufacturing enterprises

- PA Makarov "Yuzhmash" Plant
- Arsenal Plant, State Enterprise
- Khartron Public Company;
- PA Komunar
- Radio Measurement Research Institute, Public Company
- Kyiv Radio Plant, State Joint-Stock Holding Company
- Kyivprylad Production Association, State Enterprise
- Kharkiv Electric Equipment Plant, State Company
- The State Enterprise "Nikopol Trubny Works"
- Instrument-making Research Technological Institute
- PCB-Radiozavod, Public Company
- Kyiv Radio Plant, State Joint Stock Holding Company
- "Sokil" Instrument-making Plant, Public Company
- Kiev Radiozavod, Public Company

### Research institutes and design offices

- Yuzhnoye State Design Office
- Arsenal Central Design Office, State Enterprise
- Ukrainian Engineering Technology Research Institute, Public Company
- NASU-NSAU Technical Mechanics Institute
- Dnipropetrovsk State Design Institute
- Instrument-Making Research Technological Institute
- Soyuz Research and Design Institute
- NASU-NSAU Space Research Institute
- NANU-NSAU Kalmykov Earth Radio Physical Sensing Centre
- NSAU-NASU Space Research Institute Lviv Center

### Specialized Enterprises

- National Space Facilities Control and Test Center
- National Youth Aerospace Education Center
- Main Center for Special Control
- Pavlograd Chemical Plant, State Company
- Ukrkosmos State Company
- Pryroda State Research and Production Centre
- State Research and Engineering Center for Space Technique Certification





## Launch Vehicles. Cyclone Series



**CYCLONE-2**



**CYCLONE-3**



**CYCLONE-4**

	Cyclone-2	Cyclone-3	Cyclone-4
Launch weight, tons	183	187	193
Number of stages	2	3	3
Maximum payload weight, tons			
LEO	3,2	3,6	5,5
GTO		0,6	1,8
Number of launches	106	121	-





## Launch Vehicles. Zenit Series



**ZENIT-2**



**ZENIT-3SL**



**ZENIT-2SLB**



**ZENIT-3SLB**

	Zenit-2	Zenit-3SL	Zenit -2SLB	Zenit -3SLB
Launch weight, t	460	472	458,2	466,2
Number of stages	2	3	2	3
Maximum payload weight, tons				
LEO	11,42		12,03	
GTO		6,0		3,75
Number of launches	35	24	-	-



## Launch Vehicles. Dnipro Series



**DNIPRO**



**DNIPRO-M**

	Dnipro	Dnipro-M
Launch weight, tons	211	212,4
Number of stages	3	3
Maximum payload weight, tons		
LEO	3,5	3,8
GTO		
Number of launches	8	-





## Earth Observation Spacecraft



OKEAN - O



SICH-1M



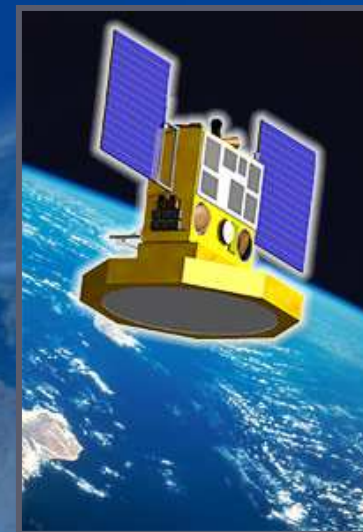
MS-2-8



MS-1-TK



SICH-3-O



SICH-3-P



# Communications Spacecraft



LYBID'

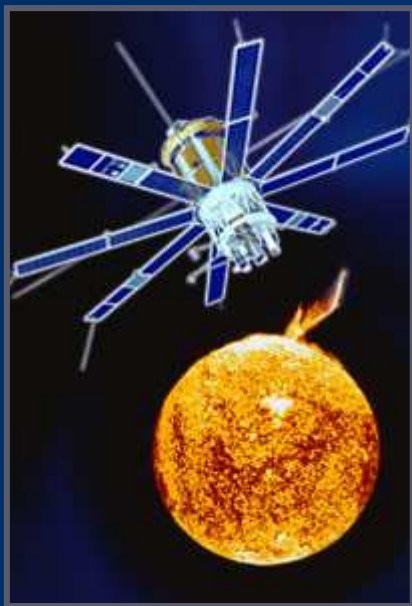


LYBID'-M





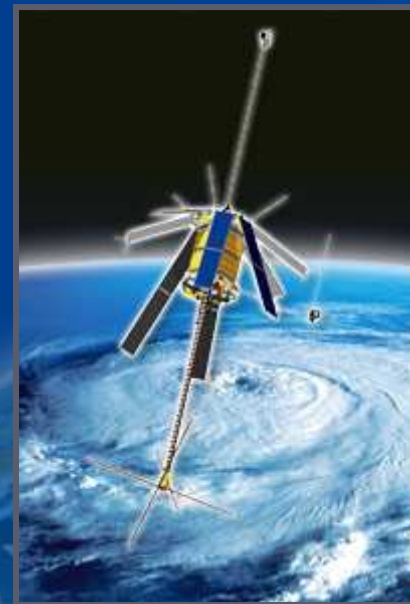
## Scientific Spacecraft



AUOS-SM-KF



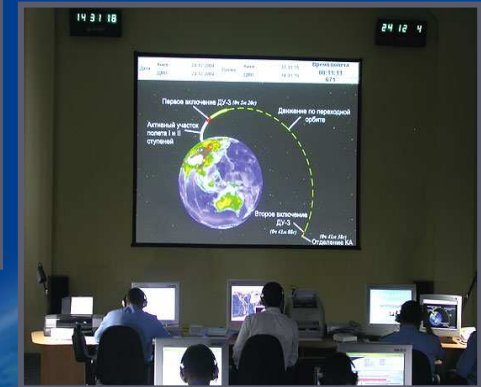
INTERBOL-  
PROGNOZ



WARNING



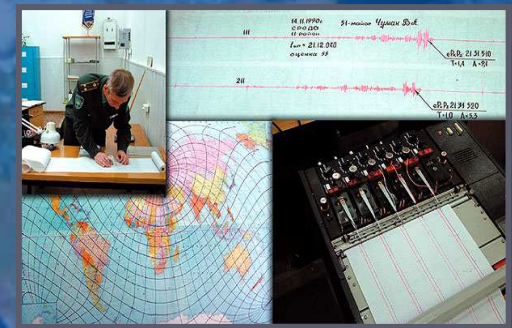
## Ground Infrastructure



National Space Facilities  
Control and Test Center

Satellite network  
for television channels  
broadcast

Head Center  
of Special Monitoring







# Commercial Space Projects

## SEA LAUNCH

### Mission:

Launch services for commercial spacecraft launches from Pacific water area to geostationary orbit



### Implementation:

24 launches, starting April, 1999

### Participants:

- Boeing (USA)
- Energia RSC (Russia)
- Kvaerner Group (Norway)
- Yuzhnoye State Design Office (Ukraine)
- YuzhMash Production Association (Ukraine)





# Commercial Space Projects

## DNEPR

### Mission:

Launch services with up to 3.5 ton payload injected into LEO and MEO



### Implementation:

8 commercial launches, 24 multipurpose satellites injected into orbit.

Aimed at further upgrade of the launch vehicle (Dnepr-1, Dnepr-M) that will improve power characteristics and essentially expand its area of application.

### Participants:

- Russian Federation,
- Ukraine







# Commercial Space Projects

## CYCLONE - 4

### Mission:

Cyclone-4 will possess a high-precision control system, and a new payload fairing.

Upgraded third stage with fuel capacity increased by 30%.

The third stage control system will conduct multiple engine restart.



### Participants:

- Ukraine
- Brazil





# International Cooperation

## Main Partners

- Russian Federation
- EU (ESA)
- USA
- China
- Brazil
- India, Argentina, Egypt, Turkey

Bilateral space agreements with 18 countries.

## Membership of Ukraine in international organizations

- Permanent member of the UN Committee on Peaceful Uses of Outer Space (**COPUOS**) since 1992.
- Member of the Committee on Earth Observation by Satellites (**CEOS**) since 1993.
- Member of the Committee on Space Research (**COSPAR**) since 1996.
- Member of the International Organization on Satellite Communication «**Intersputnik**» since 1997.
- Member of the **Missile Technology Control Regime** since 1998.



## International Space Projects

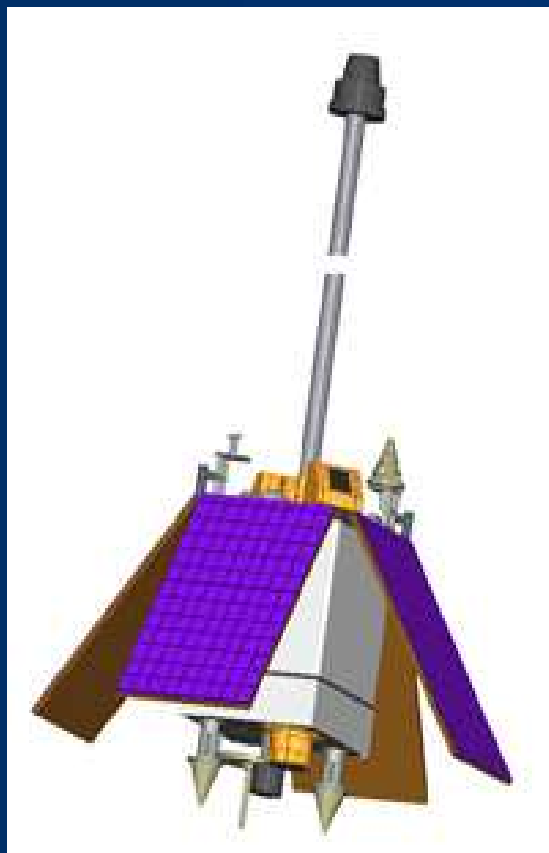
1. Sea Launch
2. Cyclone-4
3. Land Launch
4. Dnepr





## Prospective Space Projects

Egyptsat-1



Mayak Launch Vehicles



Air Start





# Main results of development of Ukraine's space industry

During 15 years of Ukraine's independence

Operation of **5** space launch systems

Agreements on cooperation in the space field signed with more than **16** countries

**98** launches by Ukrainian launch vehicles

Participation in more than **50** international space projects

**200** spacecraft launched for **10** countries

Participation in **10** international space organizations





## Priorities in research



### Earth observation

- Crop forecast
- Polluted sea surface real-time monitoring
- Monitoring of active atmospheric processes
- Real-time monitoring of ice status in the inland sea and Arctic region, snow melt dynamics

### Space Science

- Astrophysics
- Research of Ionosphere and Magnetosphere
- Solar physics

### Life Science

- Biology of a cell
- Developmental biology
- Virus resistance
- Biotechnology
- Prebiotic synthesis and exobiology
- Life duration and aging
- Space medicine

### Microgravity Science

- Hydrodynamics
- Cryogenic liquids
- Crystal growth
- Materials processing

### Technological support

- Welding and brazing instrument
- Cryogenic facilities
- Inflatable constructions
- Crystal growth facility
- Other perspective facilities





# SPACE EARTH OBSERVATIONS



## GMES project

### The purpose of the project

- Creation of Ukrainian GMES segment in accordance with criteria, standards and plans of creation GMES for satisfaction of needs in the information concerning environmental protection
- Besides utilization of space and ground ways of Ukraine, scientific potential for performance of tasks GMES is provided.

### Priority thematic directions of works under the project

- Loading on an environment, especially risks of water pollution and ground landslips
- Monitoring of a vegetative cover, especially agricultural objects of area of economic significance and forests
- Information support of management by risks (especially flooding and forest fires)
- Monitoring of the Azov and Black seas and coastal zones
- Monitoring of an atmosphere and space weather.





# AERONAUTICS



# Antonov Design Bureau

- ▶ ANTONOV Aeronautical Scientific/Technical Complex was founded in 1946 by Oleg Antonov, the famous aircraft designer.
- ▶ Since then, more than one hundred types and modifications of aircraft of various classes and purposes have been designed, including:
- ▶ AN-2 multipurpose aircraft, the father of the large family of ANTONOV aircraft;
- ▶ AN-8, AN-12, AN-22 Antei, AN-26, AN-32, AN-72, AN-74T, AN-124 and AN-124-100 Ruslan, AN-225 Mriya, AN-70 , AN-3T cargo aircraft;
- ▶ AN-10, AN-14, AN-24, AN-140 passenger aircraft;
- ▶ AN-28, AN-38-100, AN-38-200, AN-74TK-100, AN-74TK-200 and AN-74TK-300 convertible cargo/passenger aircraft;
- ▶ special-purpose aircraft, including: AN-2M and AN-3 agricultural aircraft, AN-2B seaplane, AN-30 aerial photography aircraft, AN-30M "sky-cleaner", AN-26P and AN-32P fire-fighters, AN-26M rescue aircraft, AN-74 polar aircraft, AN-72 patrol aircraft, AN-71 AEW aircraft, etc. In addition, several types of gliders, hang-gliders and motor hang-gliders have also being developed.
- ▶ The characteristic advantages of ANTONOV aircraft include structural reliability and economic efficiency, flexibility of transport operations, ability to use unpaved airfields and easy maintenance. Due to these qualities, over one and a half thousand Antonov aircraft have been exported to more than 50 countries all over the world. All in all more than 22,000 aircraft have been built.



- ▶ Nowadays the ANTONOV Complex is engaged in designing and building new aircraft prototypes as well as modifications of earlier designs, the provision of operational and product support and engineering work on extending the service life of existing aircraft. It also provides services such as basic and conversion training for flight and maintenance crews and international air charter transportation, particularly of outsized cargoes. On-site training of local personnel is available to ensure their mastery of their chosen aircraft. Antonov also participates in international cooperation in the field of aircraft and equipment design and manufacture as well as the development of land transit vehicles.
- ▶ ANTONOV Complex has invested heavily in computer-aided techniques in design and analysis work thereby creating a powerful engineering and research potential. In-house wind tunnel facilities enable the testing of aircraft models. All aircraft types, including such giants as the Ruslan and Mriya, can be subjected to structural tests to determine their service lives in one of the largest fatigue test laboratories in Europe. Finally, Antonov completes the development cycle of the aircraft with flight test programmes to demonstrate the compliance of the aircraft with airworthiness requirements and the customer's specifications.



# Antonov aircrafts

AN-3T



AN-32



AN-38D



AN-70



AN-74T



AN-124 "Ruslan"



AN-225 "Mriya"



# Kyiv Aviation Plant "Aviant"

Kyiv Aviation Plant was founded in 1920. Within a short period of time the facilities covered the way from refitting aircraft to series production of vehicles. The "Aviant" facilities cover a great working area, the company has a set of specialized and multi-purpose equipment to produce aircraft details, auxiliaries and tools; it also possesses a system of preparing series production. All these enable mastering manufacture of various types of airplanes.

What is characteristic for AVIANT is availability of almost every kind of production necessary for all-cycle manufacturing and testing aircraft of different classes and purposes.

Since 1982 the company has been realizing the production program of a multi-purpose transport aircraft An-32, that had a particular success in Indian climate. The vehicle is manufactured in the transport (An-32B) and water bomber (AN-32P) variants. In total, 361 airplanes of the type have been already built. Nowadays the enterprise is updating the vehicle by means of raising carrying capacity, range and the engine service life, as well as by reducing the crew size.

Besides continuing manufacture of the An-32, the AVIANT collective connect their plans with mastering and series production of An-148s, An-70s, Tu-334s and An-3s, as well as with debugging of the An-124 by converting it into the civil variant An-124-100.



# Kyiv Aviation Plant "AVIANT"

The An-148 is designed to carry up to 70 passengers at the range from 2,000 through 11,000 km at the speed of 850 kph.

On December 17, 2004 the An-148 made its maiden flight, and now it is successfully passing certification tests.

The company will realize the series launch of a batch of five aircraft.

The An-70 is a unique military transport aircraft with no analogues. It ensures carriage of almost every type of armament and defense technology weighing 30-47t at the range correspondingly 5000-1350 km at the speed of 750-800 kph, as well as equipment landing and troops parachuting from high and low altitudes. Depending on the way of use, the An-70 can take off both from paved runway with the length of 1800 km and unpaved landing strips with the length of 600-900 km.

Presently AVIANT is fulfilling its contract with the Ukrainian Defense Ministry for delivery of five first An-70s.

The Tu-334 baseline model, the Tu-334-100 is designed to carry 102 passengers in the economy class at the range of 3150 km at the speed of 820 kph. On December 30, 2003 the Tu-334-100 received a type certificate. The company in cooperation with Russian enterprises began series production of the first five airplanes.

In addition to the abovementioned aircraft the company continues manufacturing trolleybuses K-12 "Kyivsky" that are manufactured under aviation technologies and are made of various aviation materials, and TNP.

"Aviant" has every reason to have optimistic plans for its future. For the last few years the company has been raising scope of production, and there are grounds to expect this tendency to continue.

"Aviant" welcomes all potential partners and customers to mutually beneficial cooperation.

## Zaporozhye Machine-Building Design Bureau "Progress"

**Sphere of activity of the enterprise: designing, manufacturing, test, operational development, sertification and repair gas turbine engines of air and industrial application. A high level of aeroengines designed by the SE Ivchenko-Progress is confirmed with the Certificates of GosAviaSluzhba of Ukraine, Aviation Register of Interstate Aviation Committee of CIS countries (ARMAK) and Bureau Veritas.**

▶ ***10.07.2007***

**AI-222-25F engine reached Full Reheat power (4200 kgf).**

▶ ***27.06.2007***

**AI-222-25F engine completed its first start.**

▶ ***15.06.2007***

**The first reheated turbofan engine in Ukraine, AI-222-25F, designed by SE IVCHENKO-PROGRESS was installed on test bench.**

# Zaporozhye Machine-Building Design Bureau "Progress"

## Turbofan Engines

AI-22  
AI-222-25  
AI-25  
AI-25TL  
AI-25TLSh  
D-18T  
D-36, Series 1, 1A, 2A, 3A  
D-36, Series 4A  
D-436T1/T2/T3  
D-436TP  
D-436-148

## Propfan Engines

D-27

## Turboshaft Engines

AI-450  
D-136

## Turboprop Engines

AI-20  
AI-24  
TV3-117VMA-SBM1

## Auxiliary Power Units

AI-8  
AI-9  
AI-9V  
AI9-3B



# Motor Sich

History of the Company commenced in 1907. Till the month of December, 1915, the Company manufactured agricultural machinery and implements, performed different kinds of machining, produced iron and copper castings. In December, 1915, Duflon, Konstantinovich & Co (Deka) JSC bought the production facilities and changed the profile of production activities. In November, 1916, the first six-cylinder water cooled engine Deka M-100 was assembled. Since then the Company mastered production and for a long time manufactured a wide gamut of piston engines: M-6, M-11, M-22, M-85, M-86, M-87, M-88, Ash-87FN, Ash-62IR, which were not inferior and in a number of cases superior to similar foreign engines at that time. In the year 1953 the factory started manufacture of jet engines RD-45, RD-500, which initiated beginning of entry into the gas turbine engine era. The new generation of engines was represented by AI-20 (1957) and AI-24 (1962) turboprops designed by A.G. Ivchenko. Different modifications of these engines are in service till the present time.

In the year 1967 the factory started mastering production of by-pass turbojet engines, and one after another commenced production of the AI-25, AI-25TL, D-36, D-18T and D436T1/TP engines. Gas turbine turboshaft engines of the TV3-117, VK-1500, BK-2500 families along with the D-136 engine bring to the sky the helicopters of Mil (Mi) and Kamov (Ka) design. In the year 1995 the factory was transformed into Motor Sich Joint Stock Company (Public). At the present time the Company is busily engaged in preparation for series production of aircraft engines D-27, AI-22, AI-222, VK-1500, AI-450, D-36, Series 4A, D-436-148, AI-25 TLSh for powering airplanes An-70, Tu-324, Yak-48, Yak-130, L-159, An-3, An-38, Be-132MK, An-74TK-300, An 148, helicopter Ka-226 and for retrofitting aircraft Yak-42, An-2, Mi-2 and L-39 being in operation.

# Motor Sich

*The Zaporozhye Motor Sich Public Joint Stock Company is among the largest in the world and the only enterprise in Ukraine manufacturing engines for airplanes and helicopters as well as industrial gas turbine installations. MOTOR SICH JSC incorporates the following structural units located in Ukraine:*

## **Zaporozhye Engine-Building Plant**

The main structural unit manufactures aircraft engines, overhauls and maintains them, produces drives for gas/oil pumping units, mobile automated power generating sets and a number of consumer goods.

## **Zaporozhye Omelchenko Machine-Building Plant**

The main direction of the factory's activity is casting (manufacturing blades by oriented crystallization casting) and testing the D-18 engines.

The plant manufactures 1000 kW and 6000 kW gas-turbine power generating sets.

## **Volochisk Machine-Building Plant**

In 1971 in the town of Volochisk in Khmelnytsky region the Volochisk Machine-Building Plant was established.

The basic task for this plant was to provide large quantities of parts and metal products for assembly of aircraft engines and to produce technological tooling.

## **Motor Sich Airline**

Founded in 1984, the air carrier is one of the subdivisions incorporated in Motor Sich JSC. The airline is furnished with passenger and transport airplanes and helicopters. The crews of aircraft have all necessary certificates and licences, which give permission for transportation of passengers and cargo.

# Motor Sich Production

## **Aircraft engines**

- Turboshaft engine
- Turboprop engines
- Turbofan engines
- Auxiliary power units
- Turbopropfan engines
- Service - under development...

## **Industrial installations**

- Gas-turbine engines
- Power generating sets
- Industrial installations
- Service - under development...

## **Consumer Goods**

- Internal combustion engines
- Agricultural equipment
- Boats, motor boats, propulsion units
- Petrol power and electrical saws
- Separators
- Heating equipment
- Utility items
- Service - under development...
- Shops



# Kharkov State Aircraft Manufacturing Company

For more than 20 years the primary production activities of KSAMC have involved aircraft designed by Antonov ASTC. The company manufactured the An-72 light transport and its modifications operating in the USSR Air forces; in the early 1990s the company switched to the production of the An-74 for the commercial aviation needs and since 1999 it has been producing the regional turboprop An-140.

The big number of An-74 modifications symbolizes KSAMC's aspiration to offer multipurpose modular basis vehicle to its customers. Designed as a military transport aircraft, the An-74 can today perform both civil and military missions.

The An-74TK-300VIP modification proves the company's will to strengthen its positions in the top sector of the prestigious market niche of the corporate middle-fuselage aircraft. The company aims at offering to the customers the aircraft providing the combination of high standards of comfort, aesthetic appeal, and excellent performance at more attractive price compared to that of its competitors. The unbeatable advantage of the new aircraft is the widest in its class passenger cabin providing the maximum possibilities to modify its interior.

# Kharkov State Aircraft Manufacturing Company

The other modification of the aircraft - the unique An-74T-200A - remains the only light turboprop in series production able to compete with such turboprops as G-222 (Italy), C-27J Spartan (Italy/the USA) and CASA CN-295 (Spain). The aircraft is equipped with modern digital navigation complex that considerably lessens workload on pilots. Mounting digital navigation equipment in the new semi glass cockpit allowed reducing the crew of the An-74T-200A to two pilots. Today the An-74T-200A is one of the best solutions to update the fleet of light transport and special-missions aircraft of many world countries.

Another novelty manufactured at KSAMC - the regional turboprop An-140 of the 100 modification - is the most modern aircraft in its category with the lowest operational costs compared to its other 50-seat analogues. The realization of the program of the An-140 production demanded the complex re-equipment of KSAMC facilities, optimization of production process, integration of new solutions in the field of technology at all the production stages and implementing the system of tight control of units delivered from subcontractors.

At present, combining the high fuel efficiency with the biggest flight range among the aircraft in its class, the biggest payload and the high level of comfort for passengers, the An-140-100 is an ideal aircraft for regional airlines.

# PRIVATE COMPANIES

- ▶ Aeros
- ▶ Aeroprakt
- ▶ Aerokopter



# UNIVERSITIES

**National University “Kharkov Aviation Institute”**

**National Aviation University, Kyiv**

**Dnepropetrovsk national University**

**Natinal Technical University “Kyiv Polytechnic Institute”**

**National Technical University of Ukraine**

**“Kyiv Polytechnic Institute”**

*Faculty of Aerospace Systems NTUU “KPI”*

# **Unmanned and Ultra-light Flying Vehicles**



# NATIONAL TECHNICAL UNIVERSITY OF UKRAINE “KPI”

## PILOTED ULTRA-LIGHT AIRCRAFTS

### AREAS OF USING

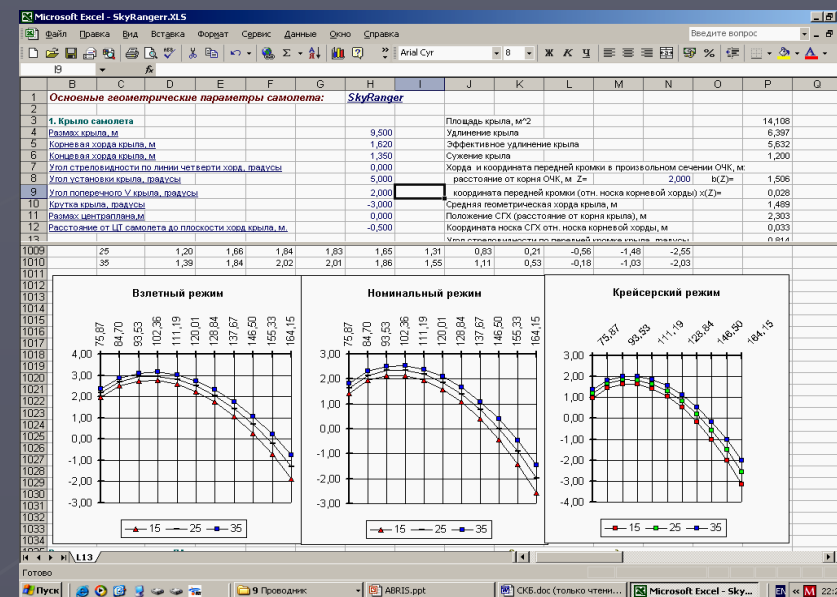
agricultural activities, district patrolling,  
training of pilots, entertaining and survey flights,  
delivery of passengers and cargo, etc.

### PERFORMANCES

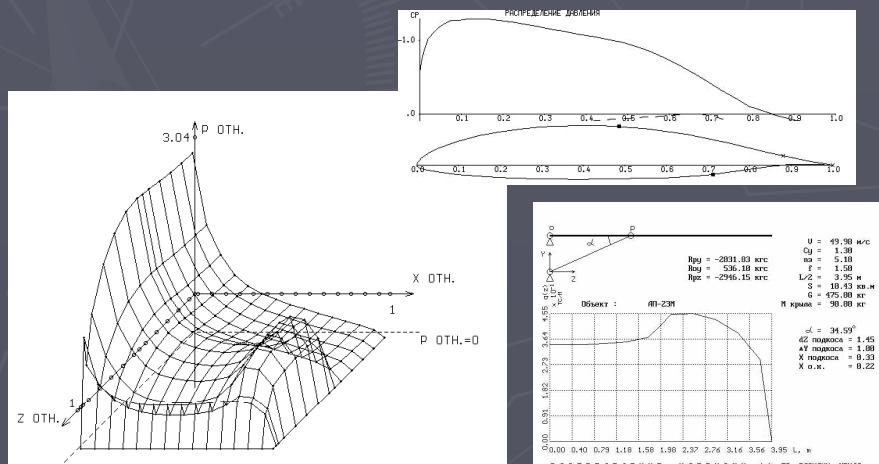
weight - 450 ... 650 kg;  
number of passengers - 1...2; flight  
duration - 2 ... 8 hours;  
speed of flight - 130 ... 570 km/h

COSTS \$25000...100000

### “RADAR” software for airplane’s performance calculation



### “ADL” software for calculation of airplane’s aerodynamic loading





# UNMANNED FLYING VEHICLES

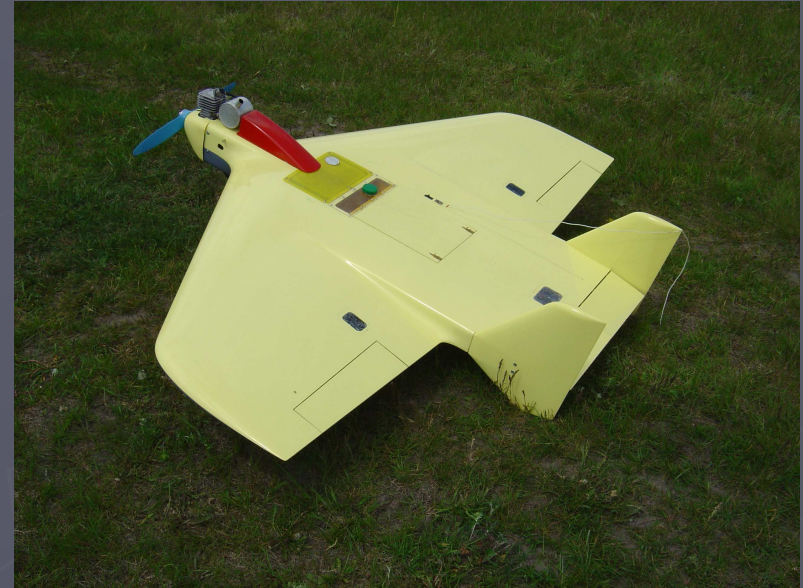
## AREAS OF USING

agricultural activities, district patrolling, monitoring of environment and extended technical facilities, etc.

## PERFORMANCES

weight - 15 ... 130 kg; payload - 3 ... 60 kg;  
flight duration - 1,5 ... 6 hours; speed of flight - 50 ... 320 km/h;  
take-off - from a hand, catapult, or aircraft-type;  
landing - with the help of parachute or aircraft-type;  
flight - radio-controlled or in automatic mode in accordance with program; observational data are stored onboard or transmitted by radio-channel

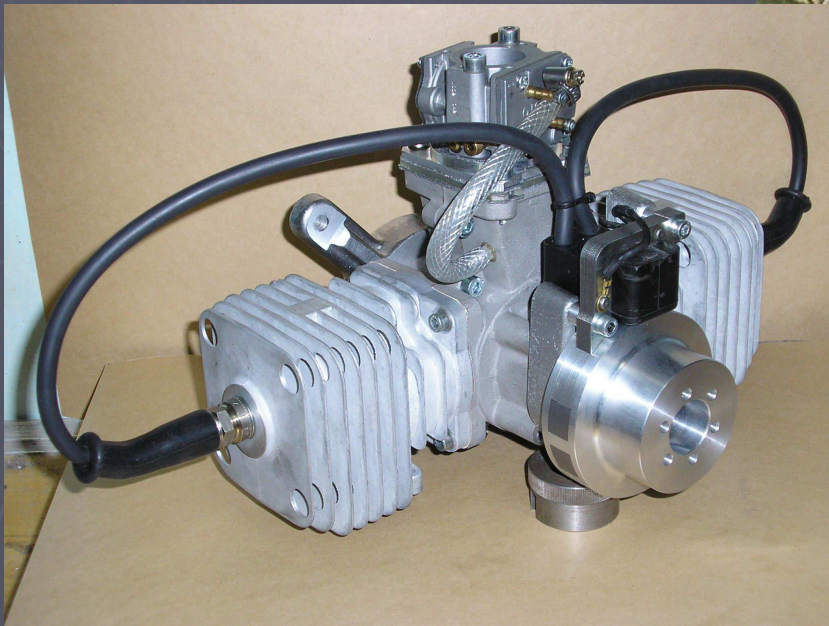
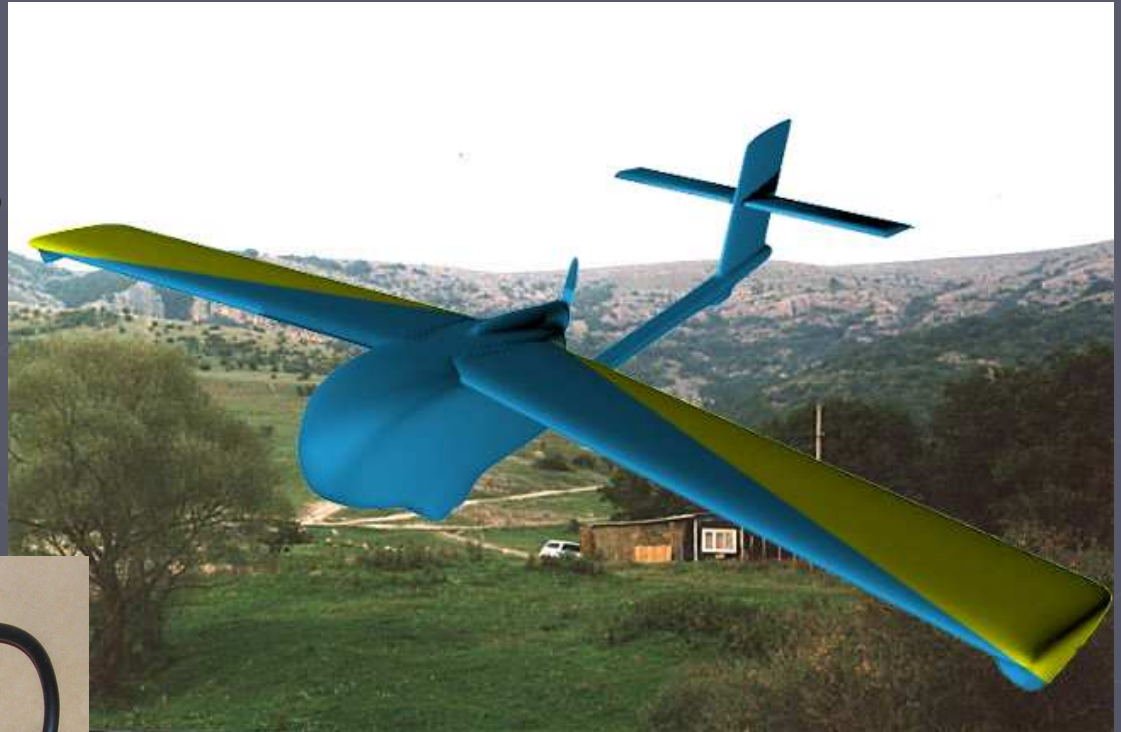
COSTS \$5000...30000



## “KORDON-1”

(current project of unmanned flying vehicles)

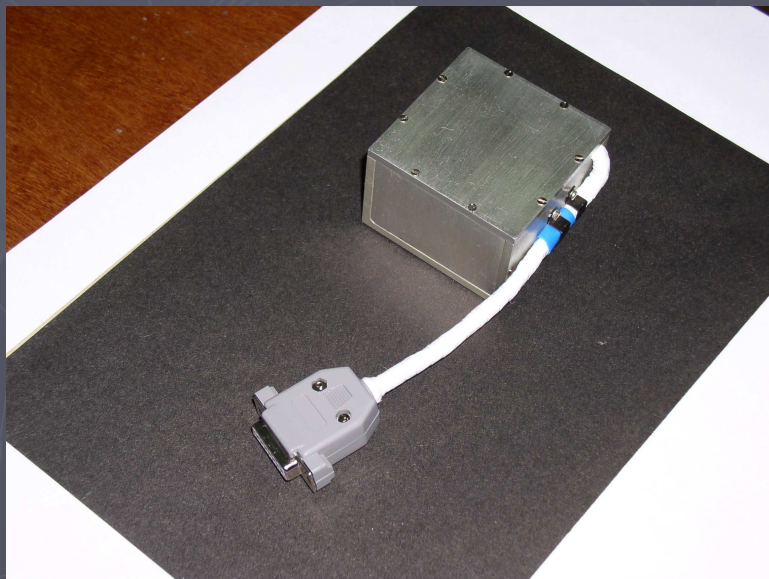
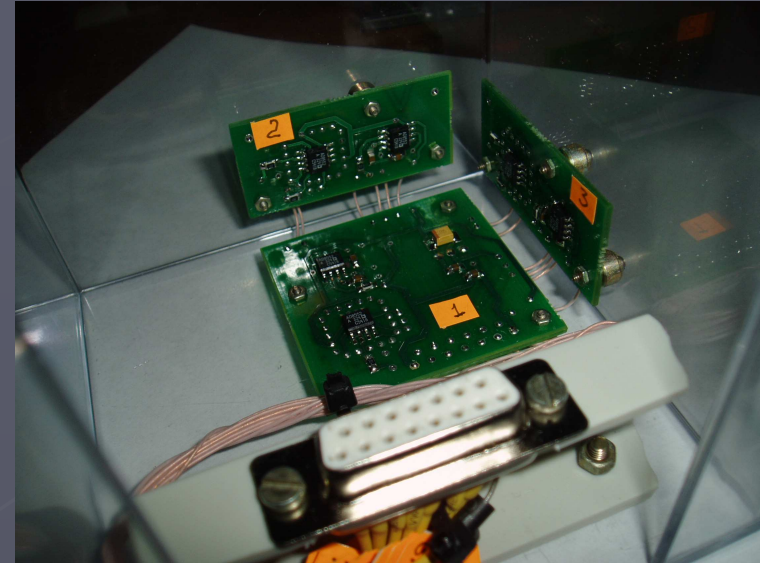
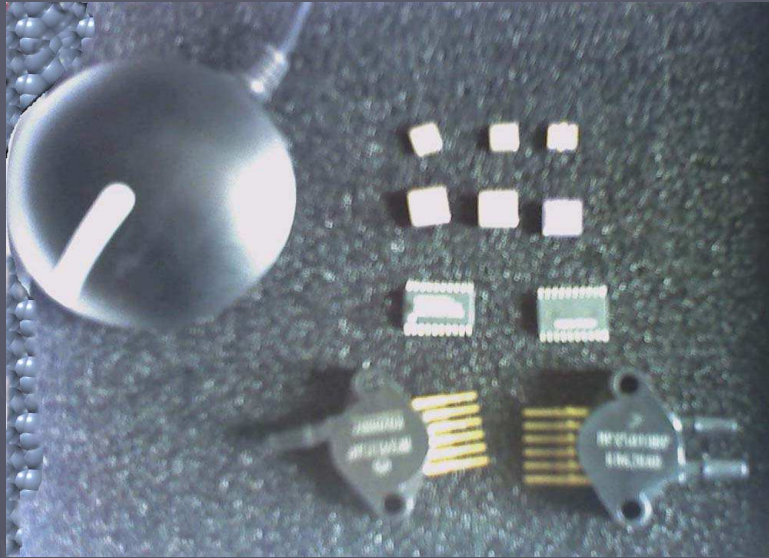
- Wing span: 5 m
- Power Plant: gasoline, 15 hp
- Range of speed 95-160 km/h
- Weight: 85 kg
- Payload: 25 kg





## AUTOPILOT

(MEMS, GPS receiver, magnetometers, pressure sensors, onboard processor)



### System accuracy:

plane coordinates – 10 m;

altitude – 1...2 m;

attitude - 0,5...1 deg;

velocity – 0,5 m/s



*National Technical University Of Ukraine  
"Kyiv Polytechnic Institute"  
The Ionosphere Satellite Project "MS-KPI"*



## **The Aim Of The Project**

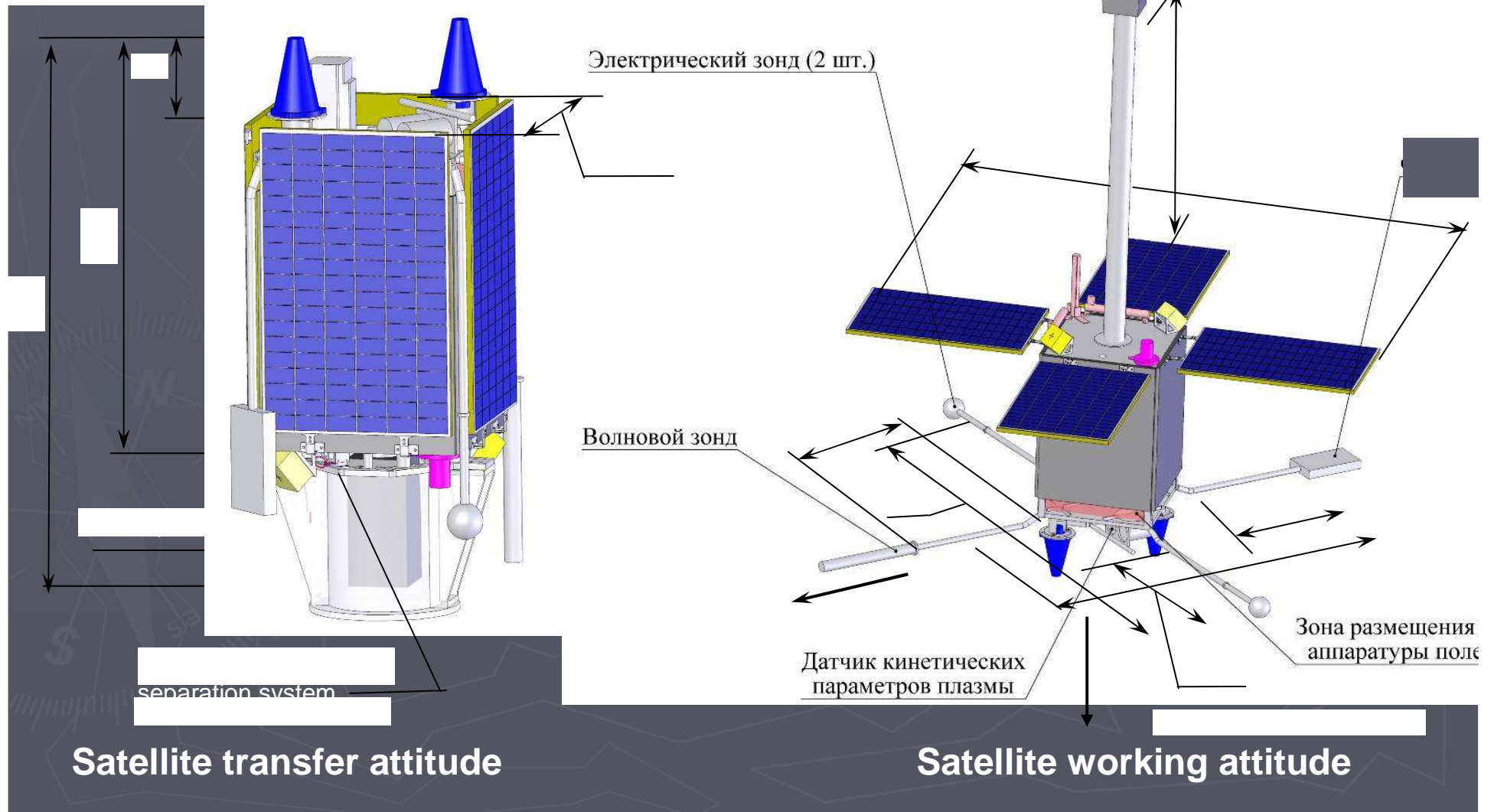
**The micro satellite developing for the fundamental scientific researches in the field of the ionosphere physics, the creation of the methods for the near Earth space monitoring. The feature of the space experiment is the micro satellite using for the direct ionosphere disturbance registration, which was produced by the solar geomagnetic activity and for the ionosphere response registration on natural and human activity from the Earth.**

# The Expected Technical Characteristics Of The MS

#	Parameter	MS-KPI	Characteristics of the other platforms	
			MS-1-TK	MS-2-8
1	Platform mass	~25	60	120
2	Average daily power of the electricity subsystem	30	19	52
3	Max short term electricity utilization by the onboard devices, W	80	25	370
4	Payload mass, kg	Up to 50	Up to 10	40
5	Average daily power for the payload use, W	12	3	12
6	Satellite control and data transfer in S-range: ► transfer speed "up", Kb/s ► transfer speed "down", Kb/s	32 256	1 32	32 32
7	Precise of the 3axis orientation	$\pm 3^0$	$\pm 6^0$	$\pm 0.2^0$
8	Orbit (H, km, I, deg)	600-1000 0-100 <sup>0</sup>	650 82.5 <sup>0</sup>	668 98 <sup>0</sup>
9	Rocket launcher	Dnipro Cyclon 4	Cyclon 3	Dnypro
10	Term of the active using, years	1	3	5



# The Satellite General View





▶ **THANK YOU FOR YOUR  
ATTENTION!**

