National **A**uthority for **R**emote **S**ensing and **S**pace Sciences

Effectiveness of Technology Transfer Programs in High Tech Projects – The Egyptian Space Program

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ESP- Background

- **Several attempts were initiated to start a space program in Egypt since the fifties of the last century.**
- **In 1998 the space council was established within the academy of scientific research and technology.**
- **In 1999 the space council approved the start of the current phase of ESP within the National Authority of Remote Sensing and Space Sciences (NARSS).**

Egyptian Space Program Strategic Objectives

1. Introducing Egypt to the space age by the gradual design and manufacturing of remote sensing and small satellites for scientific research.

2. Transfer of the technology of design and manufacturing of small satellites to Egypt.
3. Establishment of a scientific and technological base for space and high tech industries in Egypt.
4. Development of the human base for space technology.

Egyptian Space Program Strategic Objectives

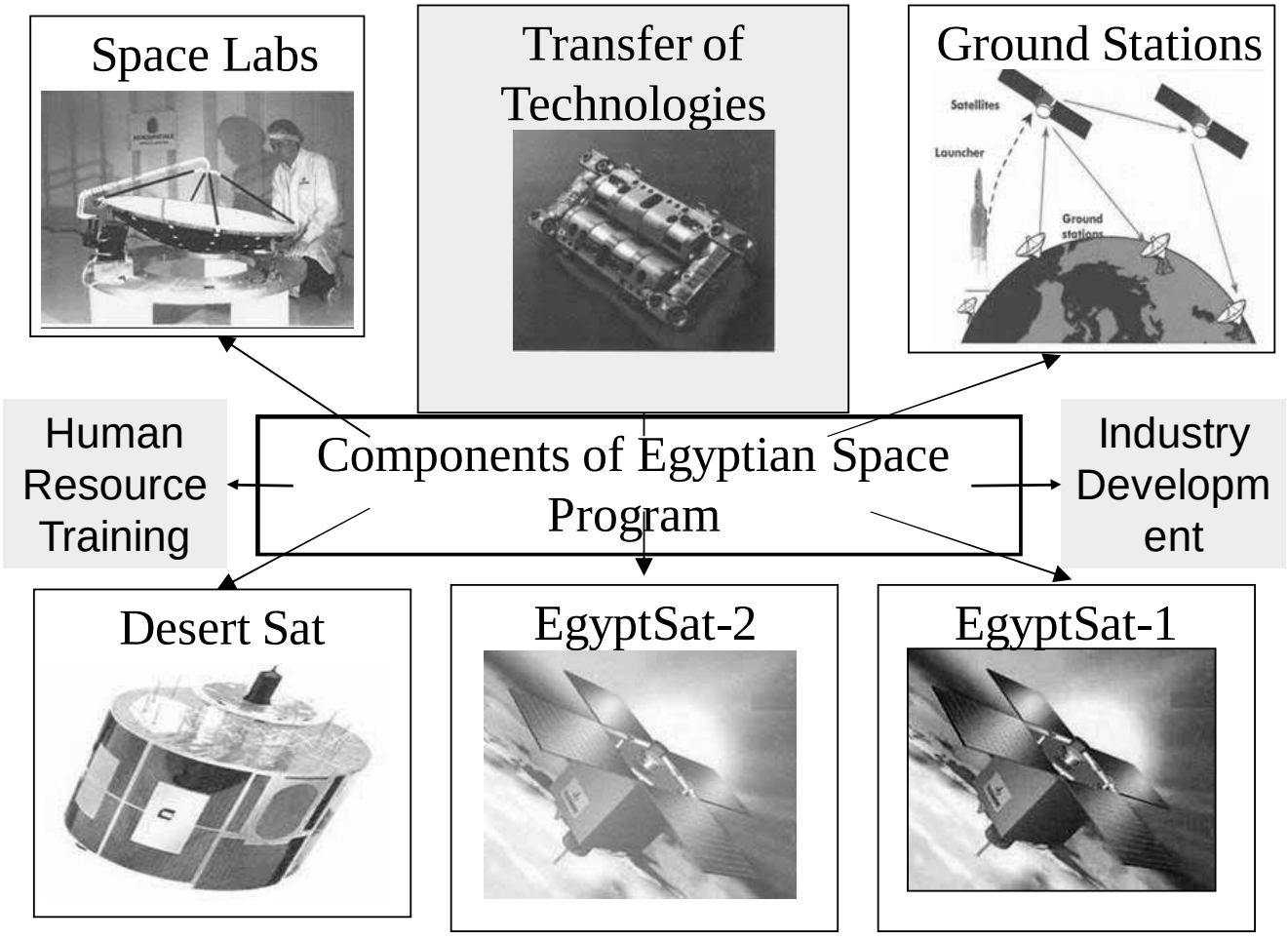
5. Provision for space images necessary for the development plans in Egypt.
6. Utilization of the space technologies and applications in advancement of the scientific research and technology development in Egypt and serving the development plans of the country.
7. Dissemination of the culture of science in the Egyptian society.
8. Development of a specialized authority for space in Egypt.

Elements of the Egyptian Space Program

- <u>Egyptian Space Program 1997 – 2017:</u>
  - First Egyptian Satellite EgyptSat-1:
    - Designed and manufactured in Ukraine with Egyptian Participation (2002-2007).
    - Transfer of the technology of design, manufacturing and testing of small satellites to Egypt.
  - Second Egyptian Satellite EgyptSat-2:
    - Based on knowledge from the first satellite with modifications.
    - Establishment of know-how and technology with much less foreign technical assistance (2007-2013).

Elements of the Egyptian Space Program

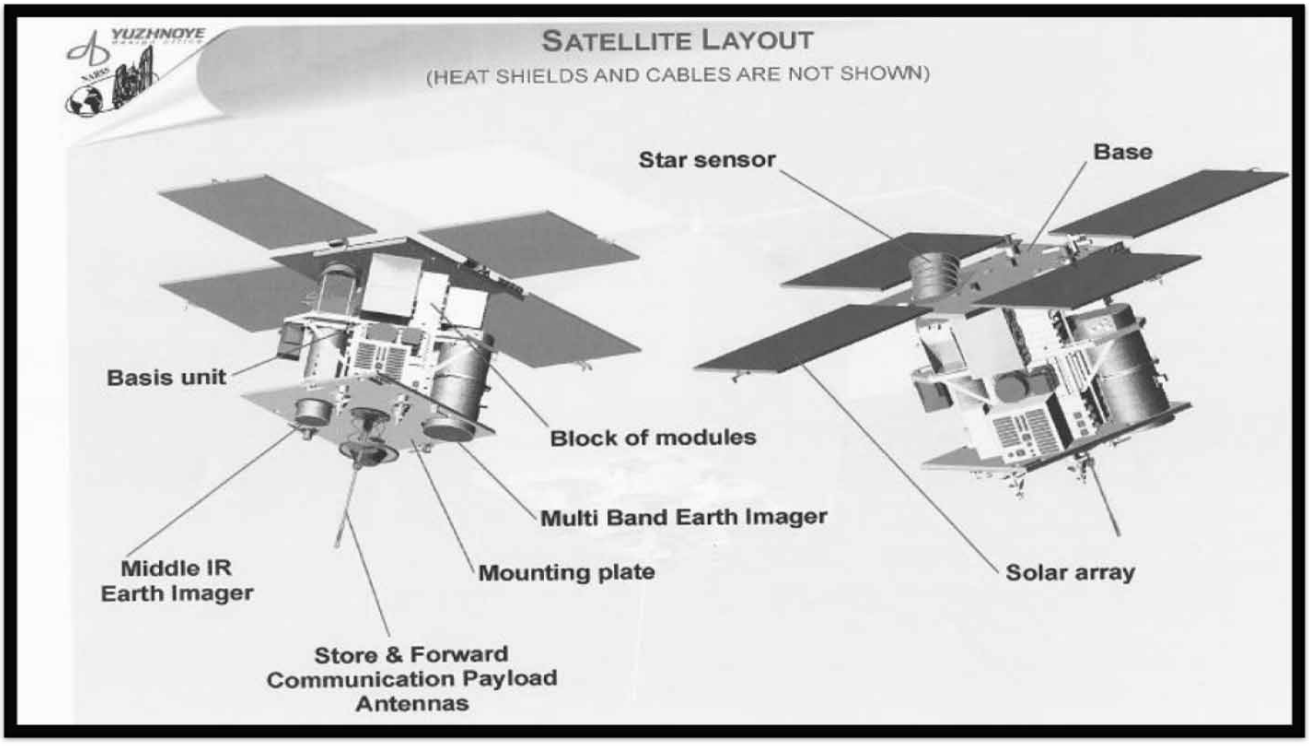
- The third Egyptian satellite DesertSat:
  - Egyptian design and manufacturing with limited foreign technical assistance (2012-2017).
  - Utilization of Radar Technology.
- Manufacturing of nine technology components in Egypt.
- Establishment of control and receiving stations.
- Establishment of assembly, Integration, testing and development labs.
- Establishing relationship with R&D centers, industrial centers and universities.
- University Satellites



Current Status of the ESP

- EgyptSat-1, EgyptSat-2 Projects.
- Ground Segment (Stations).
- Space Labs.
- Human Resources.

The Egyptian Satellite EgyptSat-1



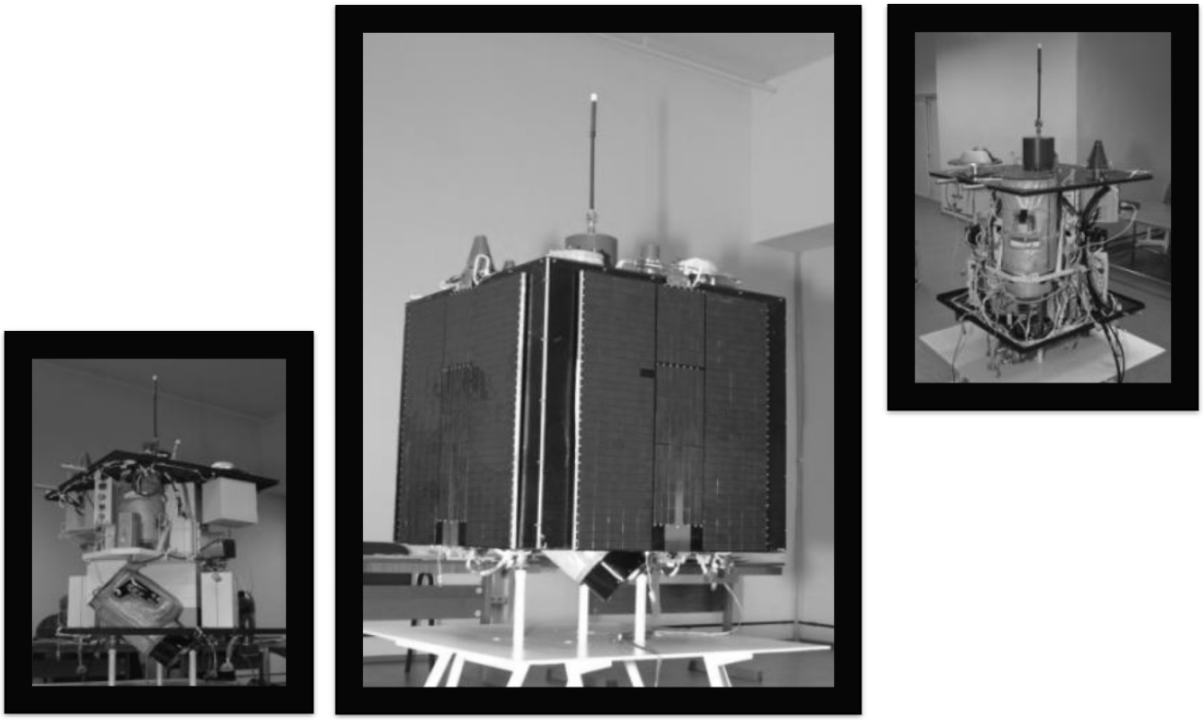
EGYPTSAT-1 SATELLITE MAIN CHARACTERISTICS

Mass, kg	157
Payload mass, kg	49
Dimensions, m	2.35 x 2.36 x 1.57
Orbit - type - altitude, km - inclination, deg - ascending node local time	 Sun-synchronous 668 98 22:30
Attitude - type - accuracy at imaging, deg - angular rate of stabilization at imaging, deg/s - range of rotation angles in roll and pitch channels, deg	 active, 3 axes 0.2 0.005 ±35
Satellite S-band control, frequencies - uplink, MHz - downlink, MHz	 2089.0 2268.6
Image data transmission frequency (X-band), MHz	8192
Power - maximum, W - daily average, W	 370 53
Lifetime	5 years
Launch vehicle	Dnepr-1
Launch site	Baikonur

System Characteristics

Image mode	panchromatic	multispectral	IR
Wavelength bands, μm	0.51…0.90	0.51…0.59 0.61…0.68 0.80…0.89	1.51…1.70
Projection of CCD pixel step on the Earth surface at nadir imaging, m	7.8	7.8	39.5
Swath width, km (at 668 km)	46.6	46.6	55.5
Width of access area, km	± 519		
Revisit time, day	4		
Time of image delivery, day	0.4…5.5		
Mass memory capacity for image data, Gbyte	2		
Image data transmission rate, Mbit/s	30.72		
Store & forward communication payload provides transmission of messages in the following frequency bands - uplink, MHz - downlink, MHz with data transmission rate (in packet), bit/s	 145.50 435.275 9600		

The Egyptian Satellite EgyptSat-1



Tests of EgyptSat-1

Testing of the Satellite in Dnepropetrovsk

Installing the Satellite on the Dnepr Rocket

Launching of the EgyptSat-1 Satellite

EgyptSat-1 Satellite was launched successfully on April 17 2007

EgyptSat-1 & EgyptSat-2

- Communication was lost with the Satellite on July 19th 2010 due to loss of S-band (Control Signal) Communication.
- An Archive of 5000 scenes were imaged by the Satellite from 2008 to 2010.
- An RFI was issued for the Second Satellite on March 2010 and preliminary phases are under way.

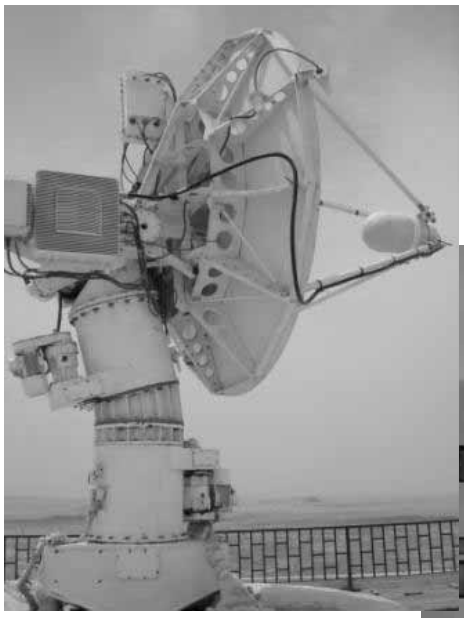
Ground Segment (Stations)

- Ground Control Station & Flight Control Center (FCC) – Outside Cairo.

- Data Receiving Station (in Aswan).

Aswan Receiving Station

NARSS Ground Control Station



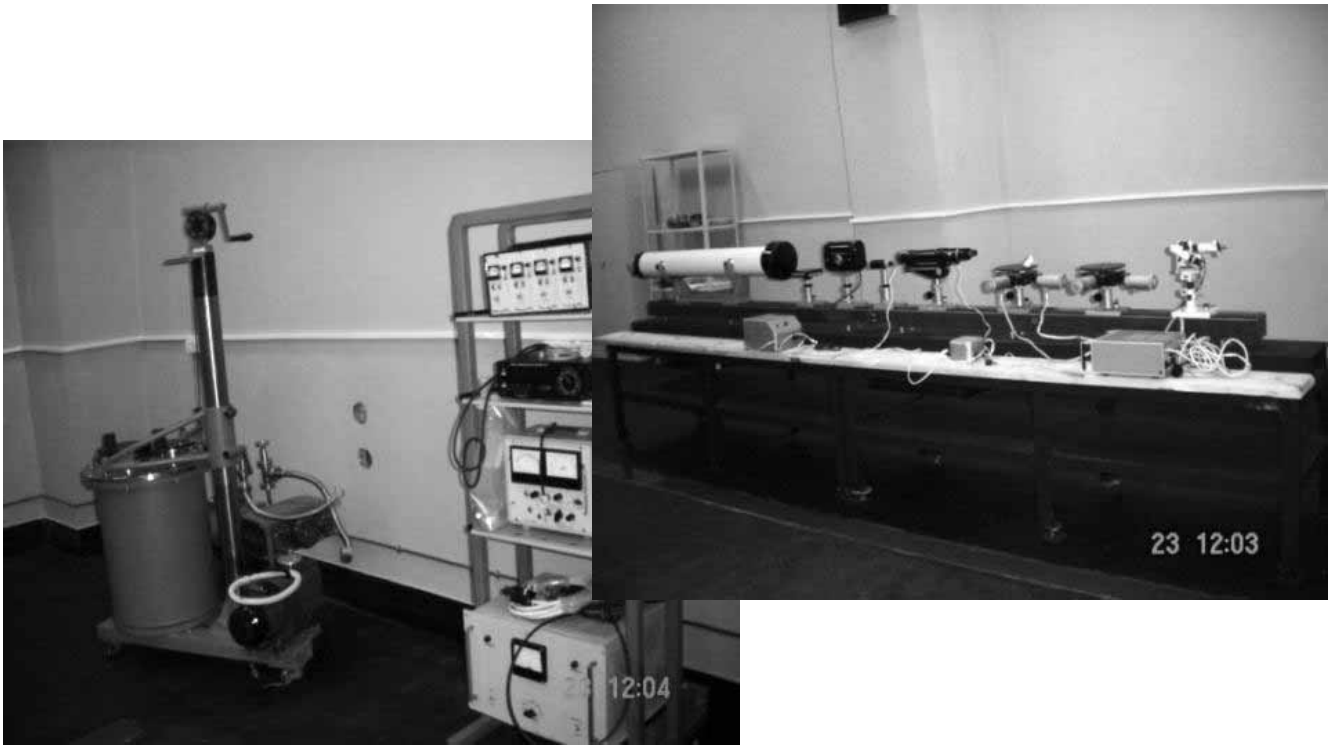
NARSS Ground Control Station

NARSS Ground Control Station

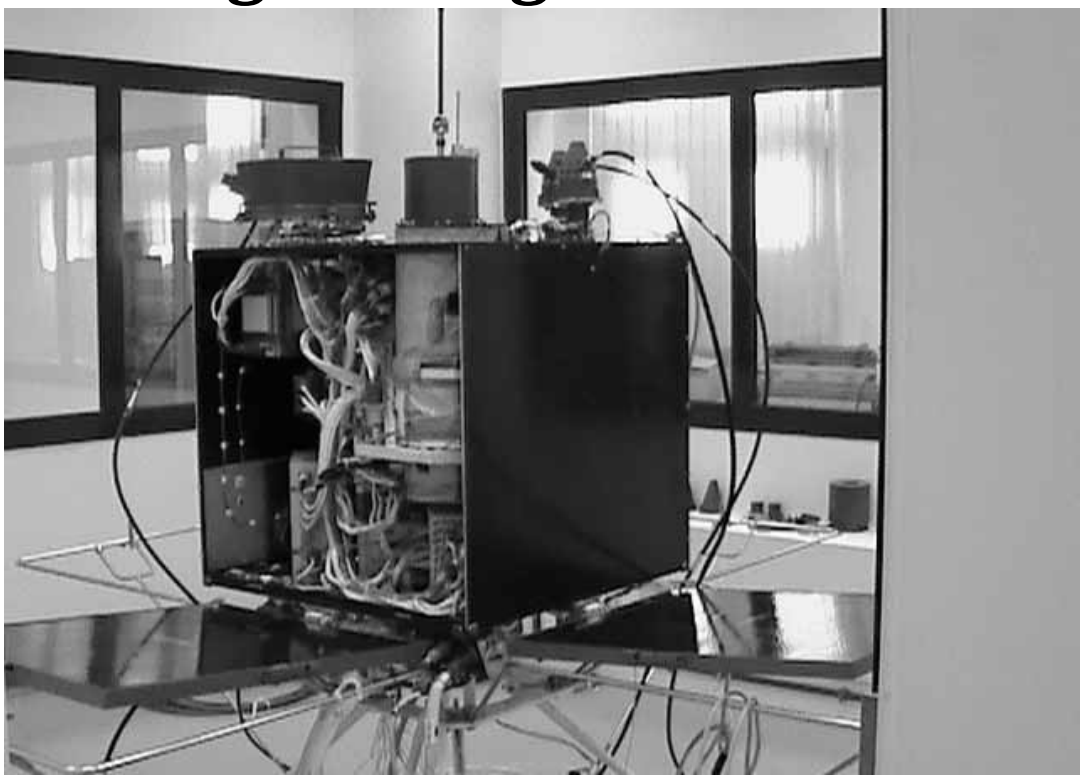
Space Labs

- PayLoad Lab.
- Design Office Lab.
- Engineering Model & Checkout Equipment Lab.
- Manufacturing Components Lab.
- Communications Lab.

Space Payload Lab.



Engineering Model Lab.



Engineering Model Lab.

Human Resources

- **The staff of the ESP is formed of 120 specialist**:
  - **15 Ph.D's**
  - **50 Design & R/D Engineers.**
  - **40 Engineers and Technicians for operating ground segment stations.**
  - **15 Supporting Technicians.**
  - **Besides Administration and Support Staff.**

Role of Technology Transfer in ESP

- Training of more than 60 Experts and Engineers for a period of three years in the subcontractors' facilities on the design, development, testing and integration of the microsatellites.
- Transfer of the technology of manufacturing 8 components of the satellite (On-board Computer, Magnetometer, magneto-torquer, MIR Imager, ..)

Role of Technology Transfer in ESP

- Training of more than 40 Engineers for a period of three months on the operation of the satellite and the control station in Egypt (on-the-job training).
- More than 5000 document describe the mission definition, requirement definition, design, testing, integration and commissioning phases.
- These are the most valuable outcomes of the project.

Effectiveness of Technology Transfer in ESP

- Measure of effectiveness of technology transfer:
  - Assessment of the level of the trainees.
  - Measure of the degree of self dependence in the next phase (capability to repeat the exercise).
  - Level of documentation and development of the memory of the ESP.
- How to improve the effectiveness of technology transfer.

How to Improve the Effectiveness of the Technology Transfer (T.T) in High Tech Projects – Lessons Learned

- Clear definition of objectives of the T.T.
- Careful contractual obligations and explicit commitments.
- Preparation of the team who will receive the know how and the training (technical background, language, cultural orientation).
- Proper sizing of the team of trainees depending on the functions to be performed.

How to Improve the Effectiveness of the Technology Transfer (T.T) in High Tech Projects – Lessons Learned

- Preparation and mobilization of the required resources at the proper time (Labs, Buildings, Facilities, ..) so that the acquired know how can be applied and developed.
- Proper planning for retaining the trained team (both financial and technical incentives).

How to Improve the Effectiveness of the Technology Transfer (T.T) in High Tech Projects – Lessons Learned

- Proper documentation of the stages of technology transfer (building up the project memory).
- Development of an assessment mechanism for the T.T. process from the beginning and do not let it till the end of the project.
- Exchange of experience with peer organizations regarding T.T. processes (South–to–South cooperation).

Conclusions and Recommendations

- Technology Transfer (T.T.) programs are essential components of High Tech. projects and they need to be well planned and implemented.
- Best practices need to be developed for T.T.
- Success of the T.T. program depends mainly on the human resources who will receive the know how to be transferred.

Thank You