The Future of Space Medicine

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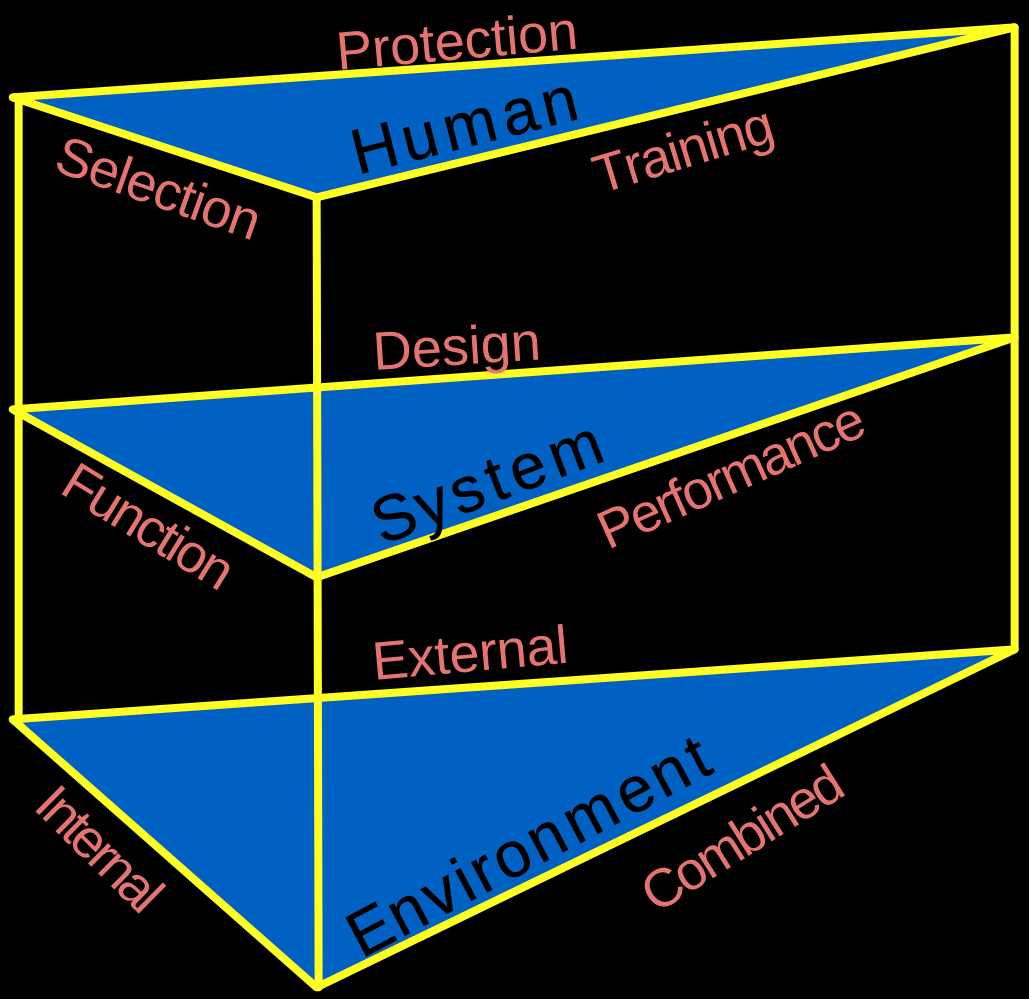
Elements of Human Space Flight

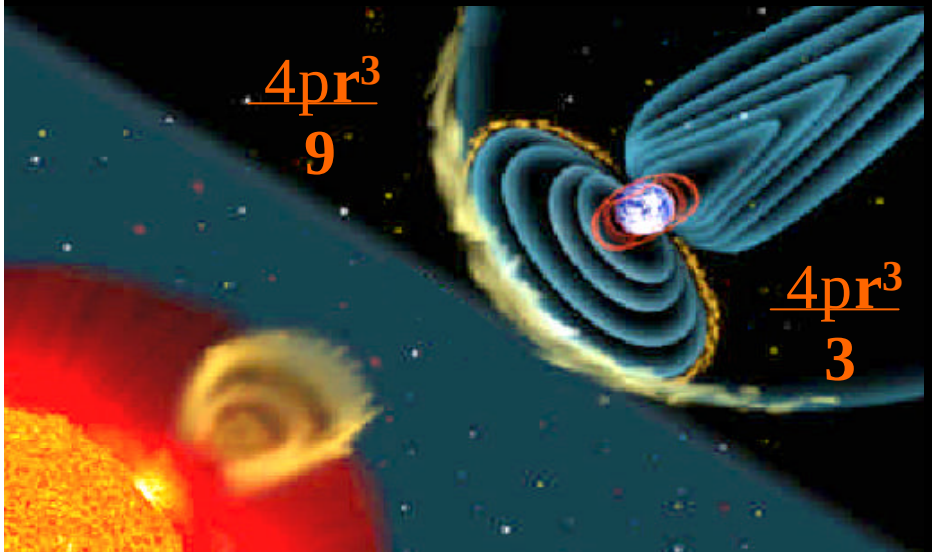


Designers must facilitate Human performance by creating…

…a System that responds effectively to…

…the challenges of the space flight Environment.

Environment



External

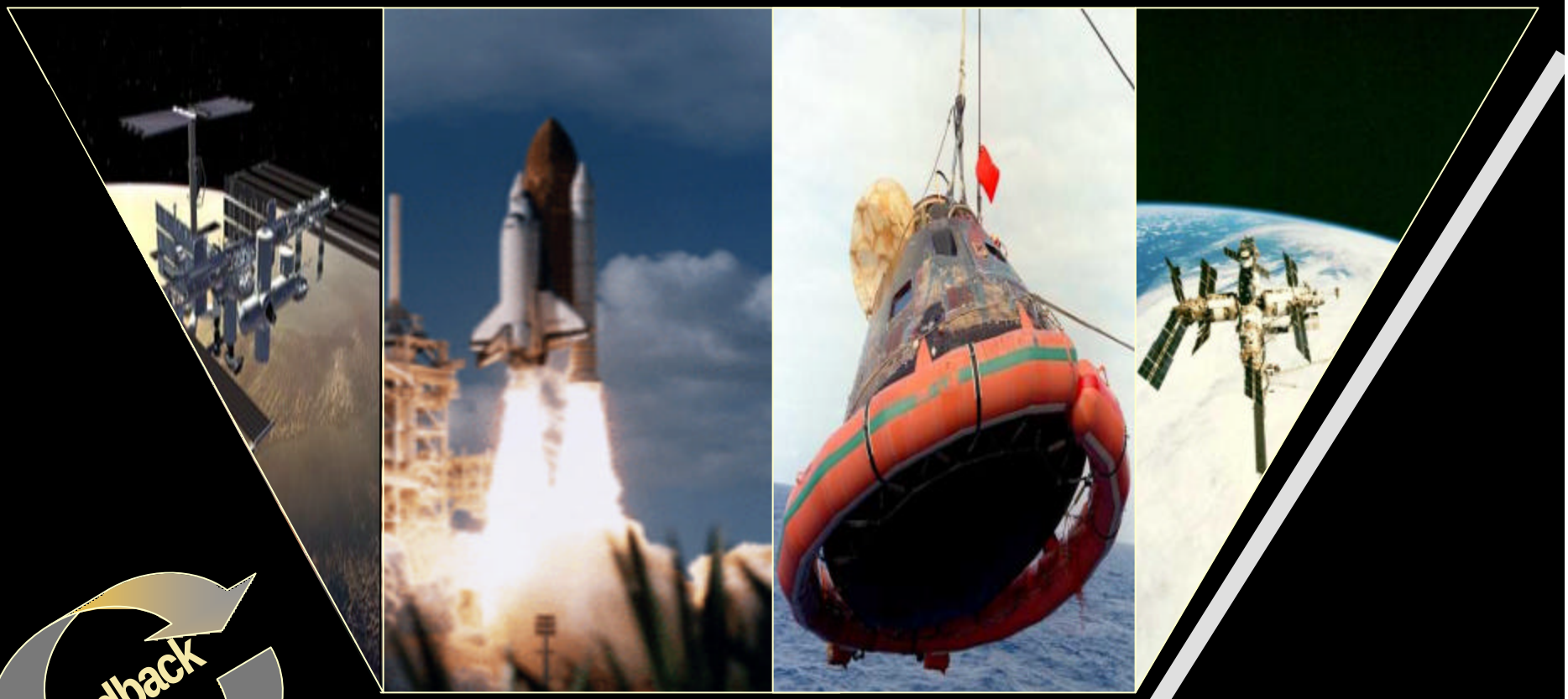
- Variable gravity
- Radiation
- Temperature extremes
- Pressure extremes
- New ecological systems
- Planetary materials & composition

Internal

- Atmospheric composition
- Toxicology
- Crew living conditions
- Habitat configuration (compatibility)

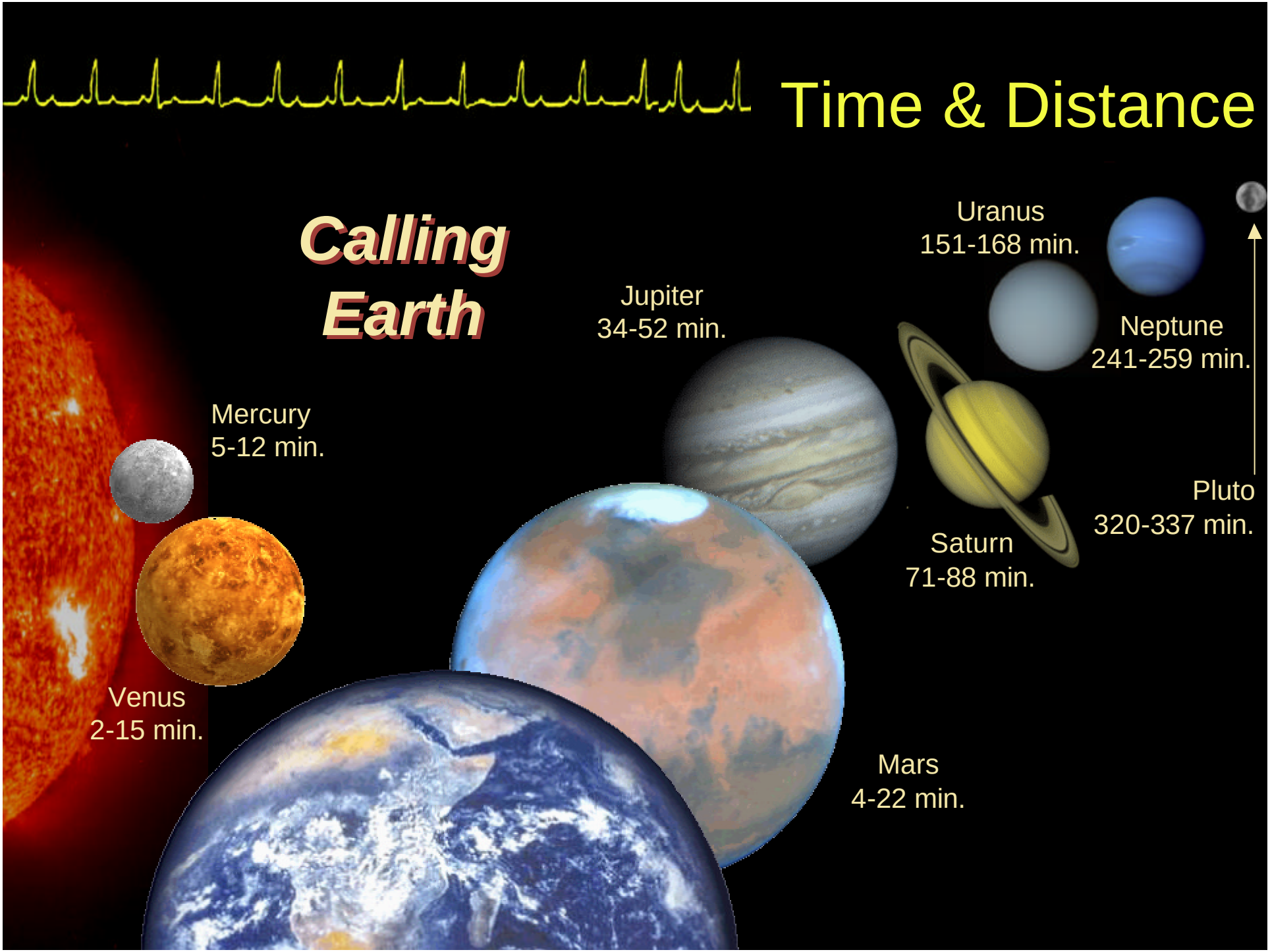
System

Function → Performance

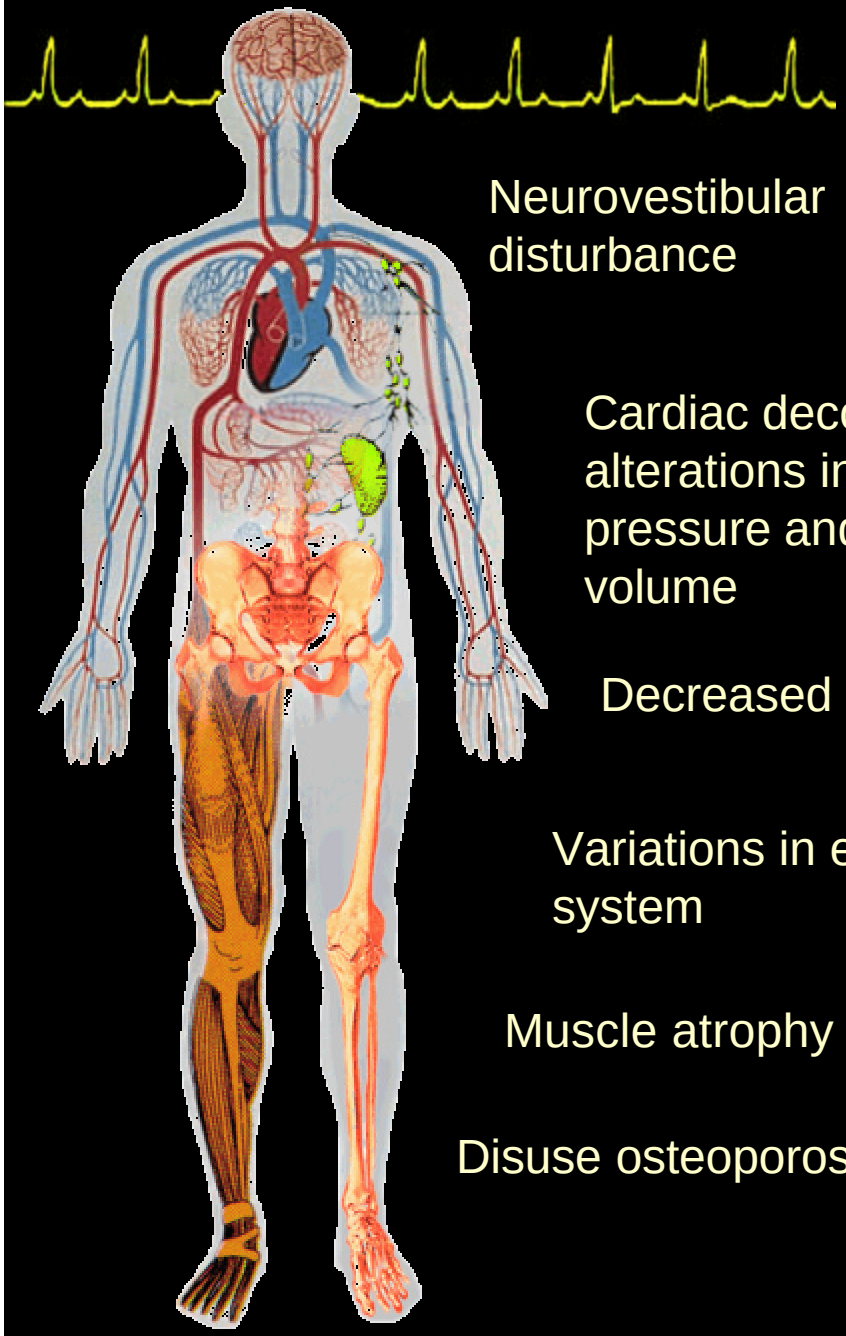


Feedback loop

Design


Time & Distance
Calling Earth
Uranus
151-168 min.
Neptune
241-259 min.
Jupiter
34-52 min.
Mercury
5-12 min.
Pluto
320-337 min.
Saturn
71-88 min.
Venus
2-15 min.
Mars
4-22 min.

Humans in Microgravity



Neurovestibular disturbance

Cardiac deconditioning; alterations in blood pressure and blood/ fluid volume

Decreased immune function

Variations in endocrine system

Muscle atrophy

Disuse osteoporosis

The human body experiences numerous changes during exposure to microgravity and the readaptation to Earth's gravity.

Human Element

Selection

Medical considerations and requirements will vary with mission duration and complexity.

Training

Crews will undergo continuous, rigorous training in order to maintain proficiency.

Protection

Countermeasures ensure crew protection from the physiological and environmental factors of spaceflight

The Future of Space Medicine

A convergence of...

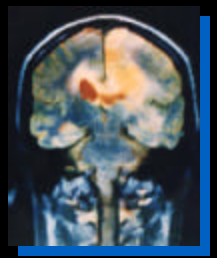
- Portability & miniaturization
- Informatics
- Nanotechnology
- Virtual reality
- Biologically-inspired technology
- Haptic “smart” systems

...to create self-repairing, autonomous, “smart” systems that provides medical care to distant crews

Portability & Miniaturization

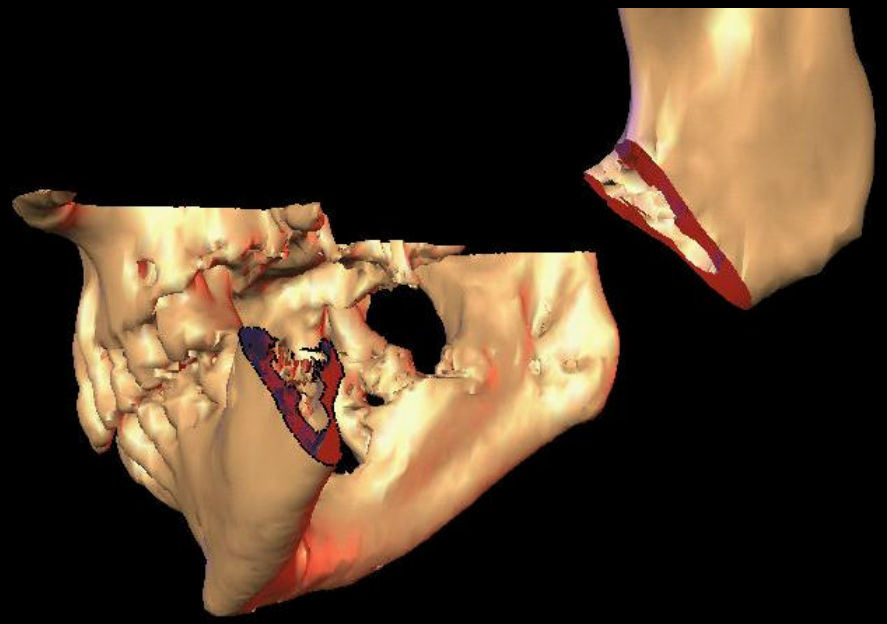
- Sensors, effectors, & transmitters
  - Surgical instruments
  - Analyzers
    - "Smart" T-shirts
    - "Smart" suits

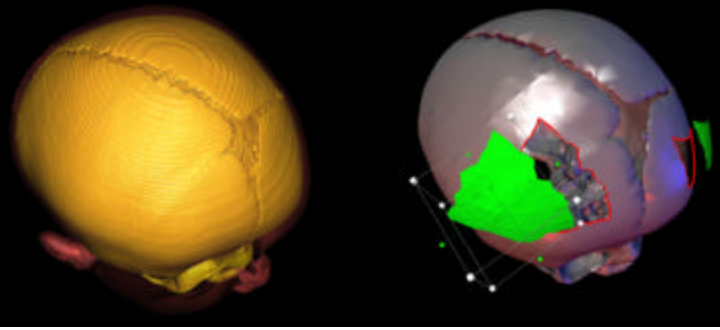
- Monitors
  - Telemedicine Instrumentation Pack (TIP)
  - Blood pressure monitor
- Imagers
  - X-ray
  - MRI
  - Ultrasound



Informatics

- Telemedicine
  - Consultation
  - Diagnosis
  - Monitoring/imaging
  - Surgery
- Telescience
- Teleducation
  - Training
  - Simulation

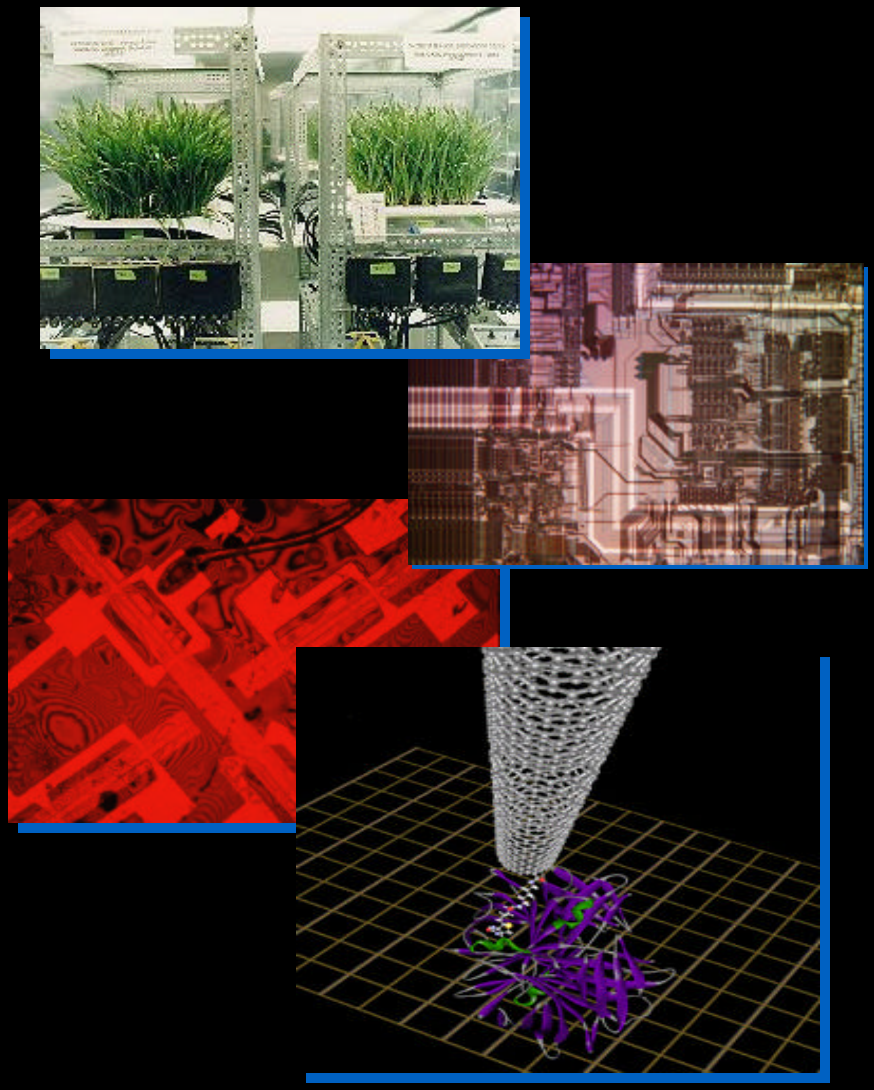




***Informatics*: the integration of telecommunications, information, and technology to enhance delivery of health care to and in remote locations**

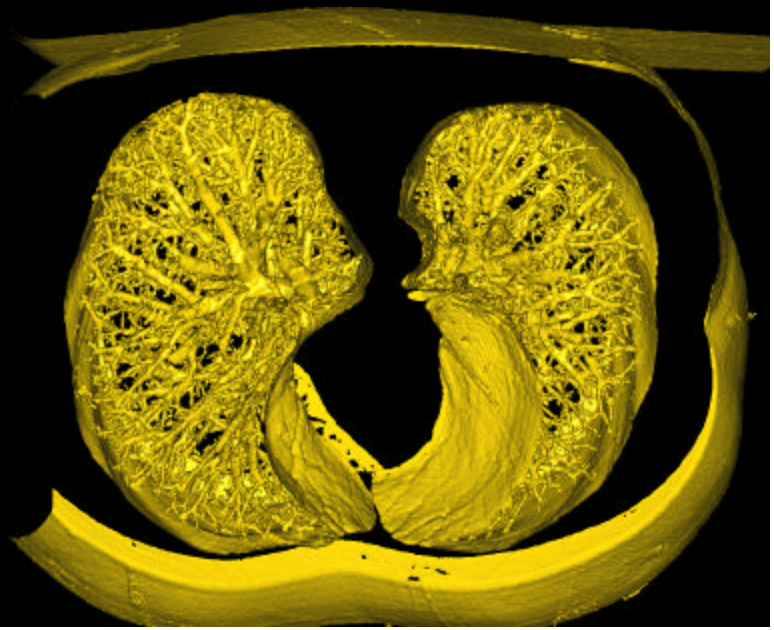
Nanotechnology

- Life support
  - Sensors
  - Effectors
- Medical care
  - Diagnostic probes
  - Treatment & delivery systems
  - Tissue replacement
- Autonomous exploration



Virtual Reality

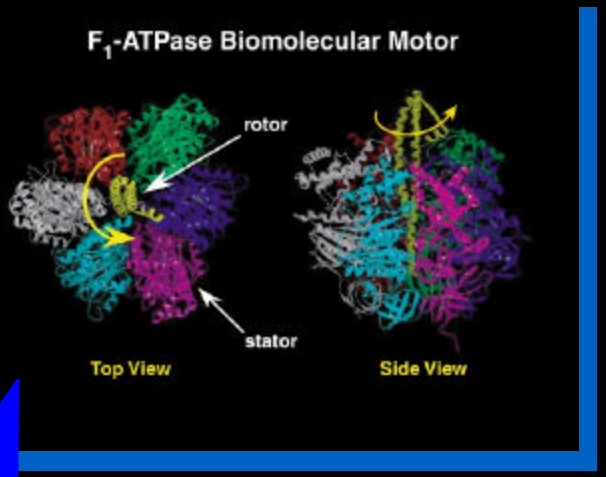
- Improved skills
- Training
- Pre-surgery planning
- New techniques testing
- Immersive robotic surgery



Biologically-Inspired Technology

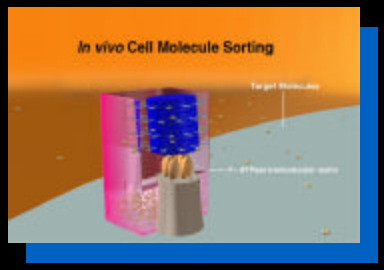
Biologically-inspired technology is…

- Adaptive
- Anticipatory
- Collaborative
- Curious
- Guided
- Self-modeling
- Self-repairing



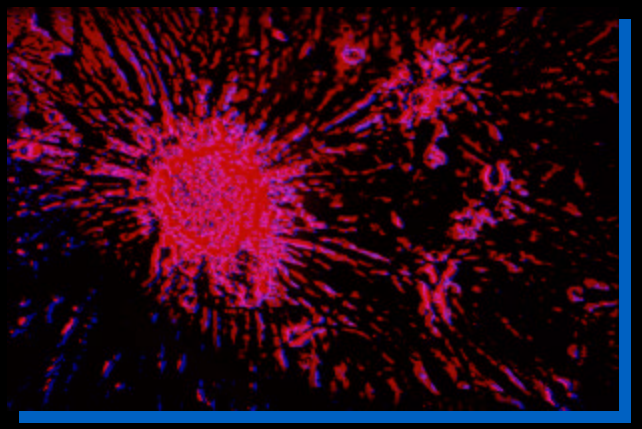
…and assists in the creation of

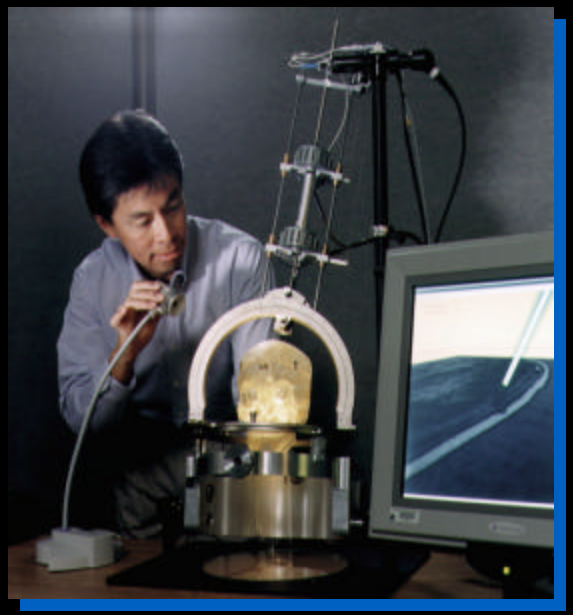
- Human-centered systems
- Robotics
- Smart materials and structures



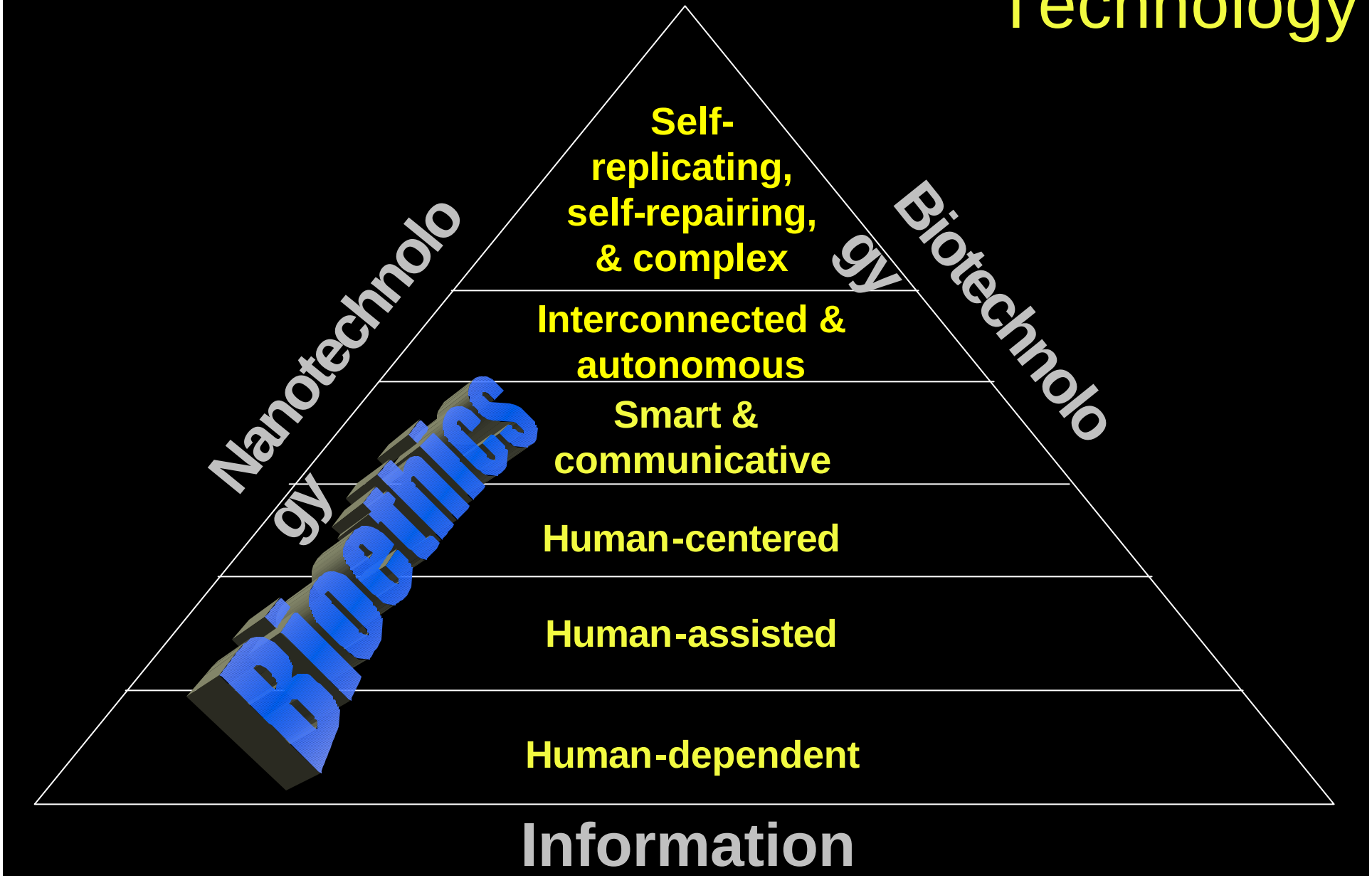
Haptic “Smart” Systems

- Cybersurgery
- Microsurgical probes
- Force sensors
- Tissue engineering





Hierarchy of Medical Technology



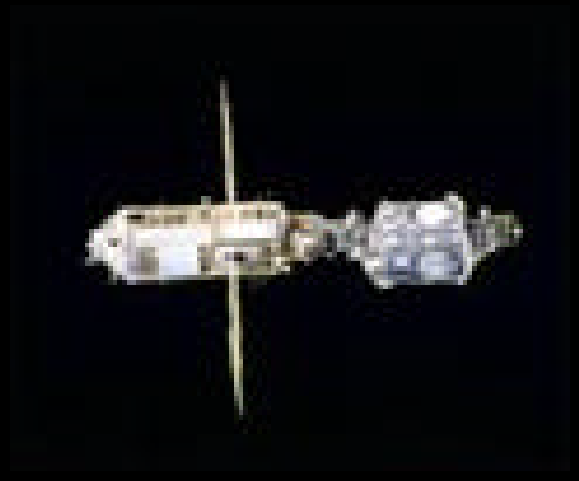
Human Support Technology

Today

Mechanical

Human-dependent

Technological Evolution & Revolution



Tomorrow

Adaptive

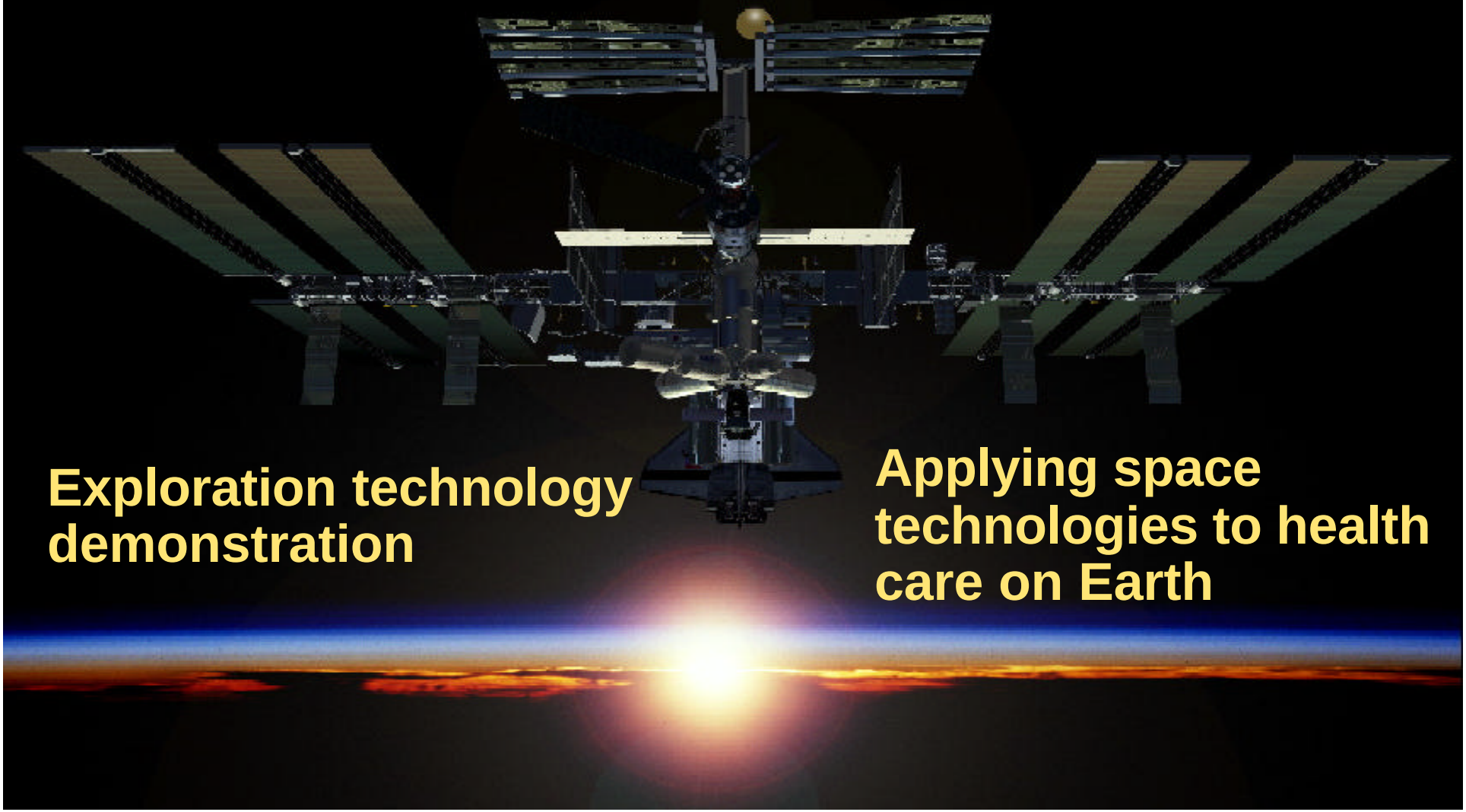
Autonomous

Virtual

Human-centered

The ISS

The ISS is a testbed for...



Exploration technology demonstration

Applying space technologies to health care on Earth

Conclusion

The insight we have gained from NASA's space medicine activities, combined with tomorrow's space medicine technology, will allow NASA to send astronauts on safe, productive long-term explorations, while improving the quality of life on Earth.