Electrical, Computer, Software, and Bio-Inspired Engineering

- a historical perspective -

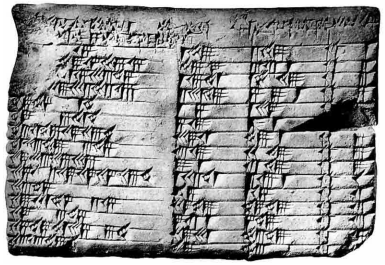
Emil M. Petriu,
School of Information Technology - SITE
University of Ottawa

Time | Science | Production of Goods and Services | Engineering

➢ Antiquity

- **Mathematics,**
- **Philosophy**

➢ ***Craftsmanship:***
* *Artisans*
* *Guilds*



True Mathematical Table Surviving from Old Babylonian Mathematics ; circa 1,822 BCE – 1,784 BCE

Euclid's of Alexandria (approx. 300 BCE), *Elements,* a logic and coherent framework, including rigorous mathematical proofs.

Hindu-Arabic numeral system. The inscriptions on the edicts of Ashoka (1st mill. BCE) display this number system used by the Imperial Mauryas.

Pyramid of Giza / **Pyramid of Khufu** 2589–2566 BCE

South Pointing Chariot one of the most complex geared Mechanisms, approx 2600 BCE, during the reign of mythical Yellow Emperor of China

The Four Great Inventions of ancient China are the Compass, Gunpowder, Papermaking, Printing.

Roman aqueduct - approx 19 BCE. Pont du Gard, France,

© *Emil M. Petriu*

Time	Science	Production of Goods and Services	Engineering

Antiquity

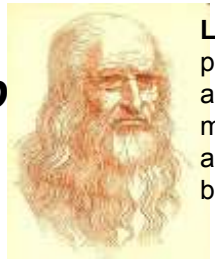
XV Century

- **Mathematics,**
- **Philosophy**

➢ ***Craftsmanship***

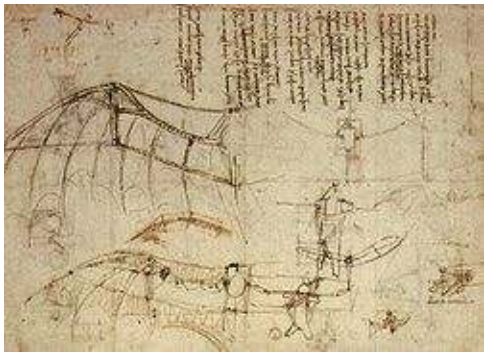
** Artisans*

** Guilds*

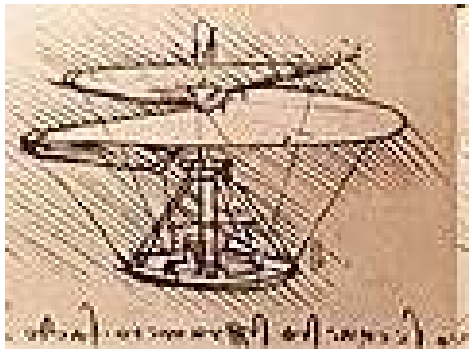


Leonardo da Vinci (1452 –1519), polymath: painter, sculptor, architect, musician, scientist, mathematician,engineer, inventor, anatomist,geologist, cartographer, botanist and writer..

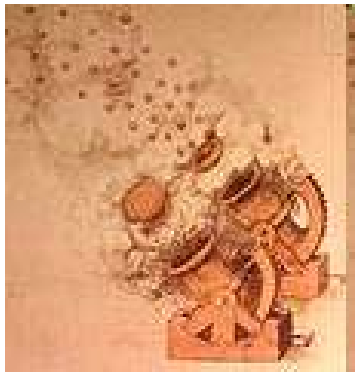
❑ ***Military Eng..***



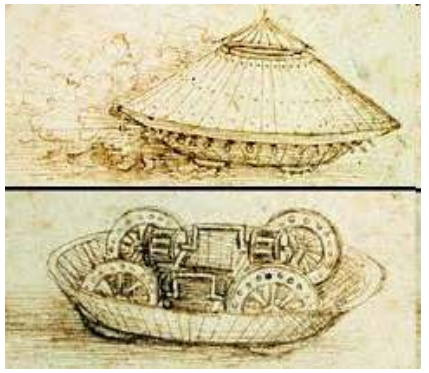
Design for a flying machine with wings based upon a bat's wings model.



"Aerial Screw", an early helicopter.



Cannons



Tank

© *Emil M. Petriu*

Time	Science	Production of Goods and Services	Engineering

- Antiquity
- *XV* Century
- *XVIII* Century
- *XIX* Century

- **Mathematics,**
- **Philosophy**
- **Chemistry,**
- **Physics**
- **Biology,**

➢ ***Craftsmanship***:
* *Artisans*
* *Guilds*

Industrial Revolution: mechanization of industry; late 1800s - early 1900s

➢ **Industry**:
- Engineers/ Product Develop.
- Capitalists
- Workers

❑ ***Military Eng***..

❑ Civil Eng..

❑ Mechanical Eng..

❑ Chemical Eng..

© *Emil M. Petriu*

Time	Science	Production of Goods and Services	Engineering

- Antiquity
- *XV* Century
- *XVIII* Century
- *XIX* Century
- XX Century

- **Mathematics,**
- **Philosophy**
- **Chemistry,**
- **Physics**
- **Biology,**

➢ ***Craftsmanship***:
* *Artisans*
* *Guilds*

Industrial Revolution: mechanization of industry; late 1800s - early 1900s

➢ **Industry**:
- Engineers/ Product Develop.
- Capitalists
- Workers
- ***Entrepreneurs***

1946 …

1972 …

❑ ***Military Eng.***.

❑ Civil Eng..

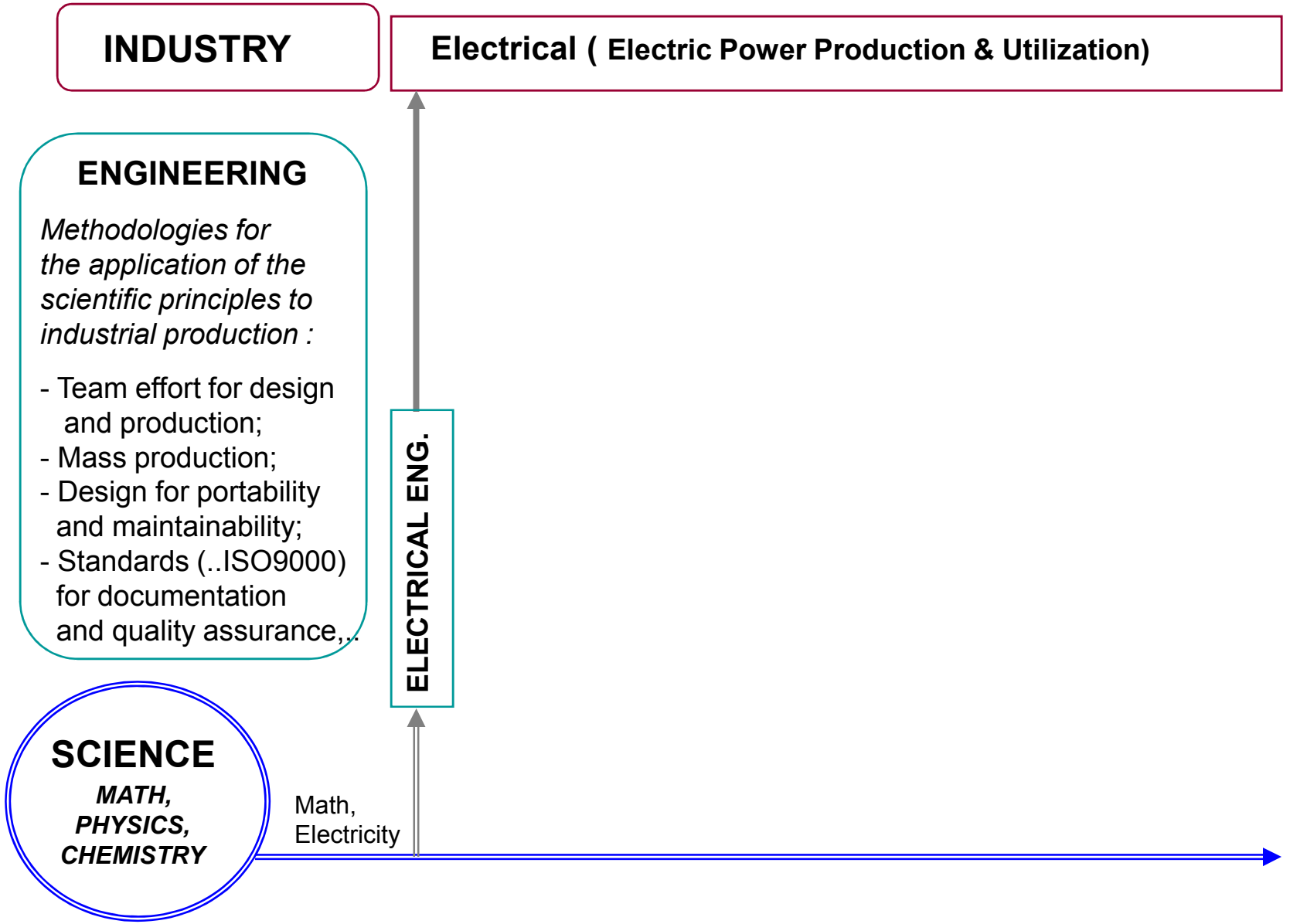
❑ Mechanical Eng..

❑ Chemical Eng..

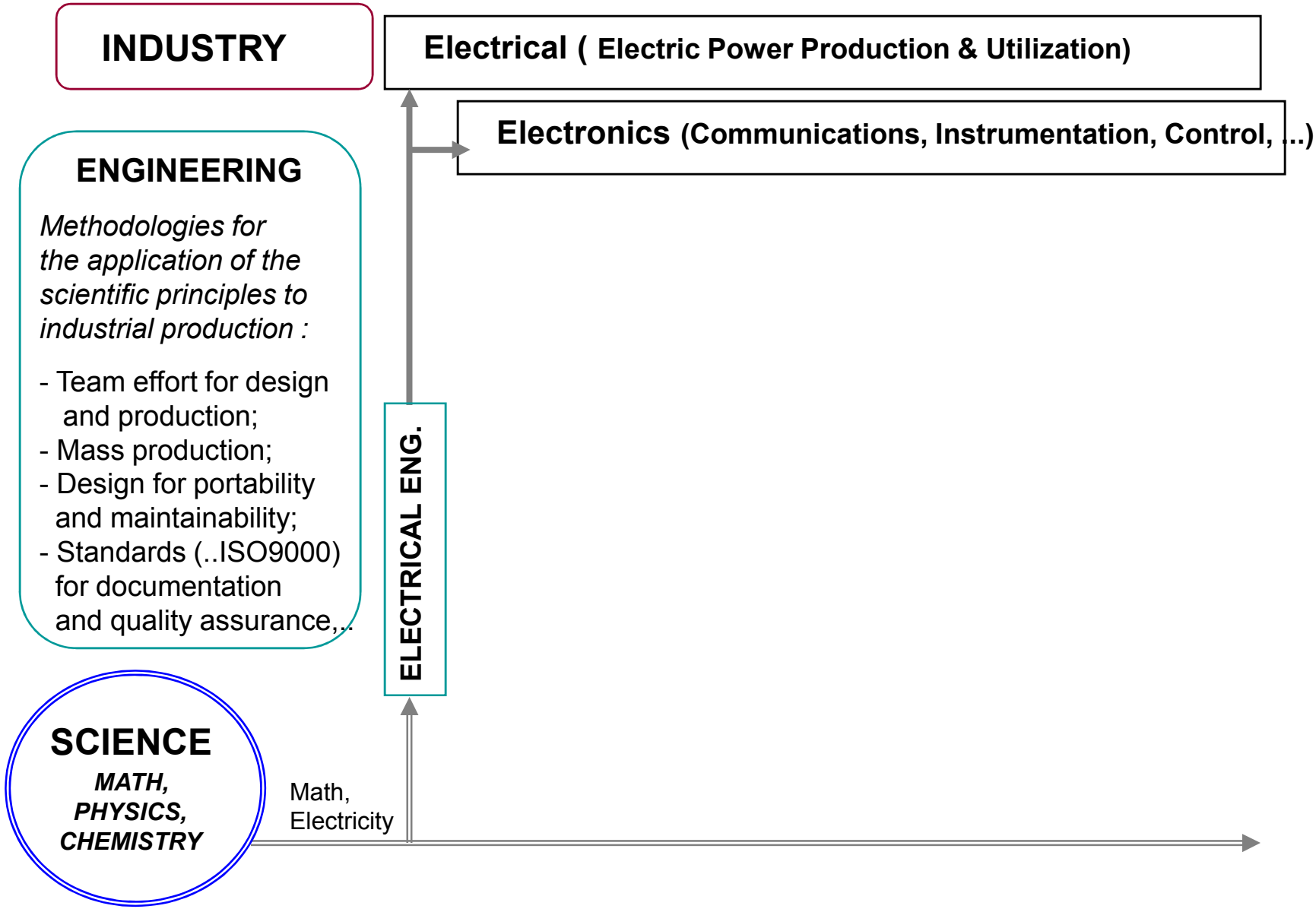
❑ **Electrical Eng.**.

ELG, CEG, SEG

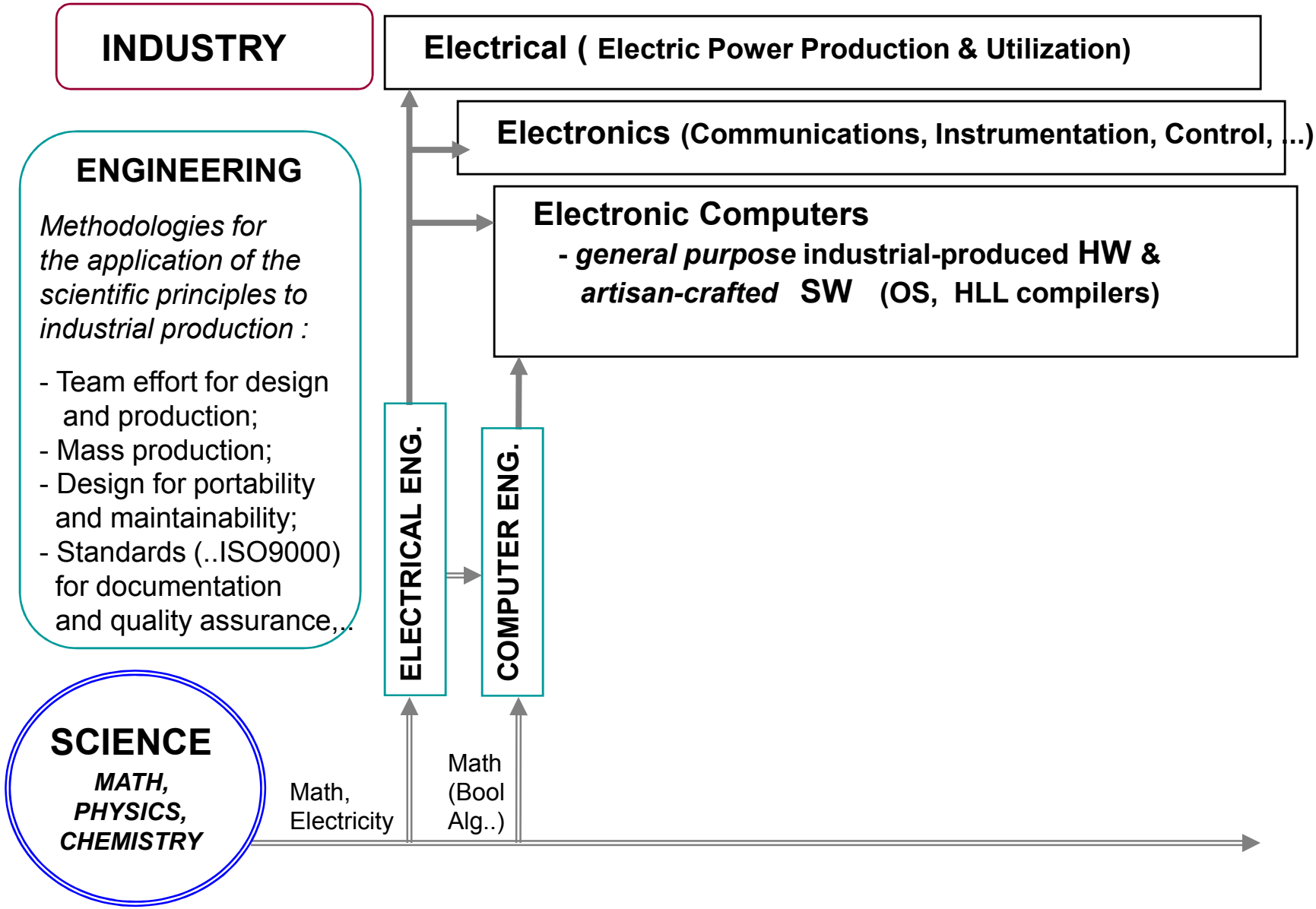
© *Emil M. Petriu*



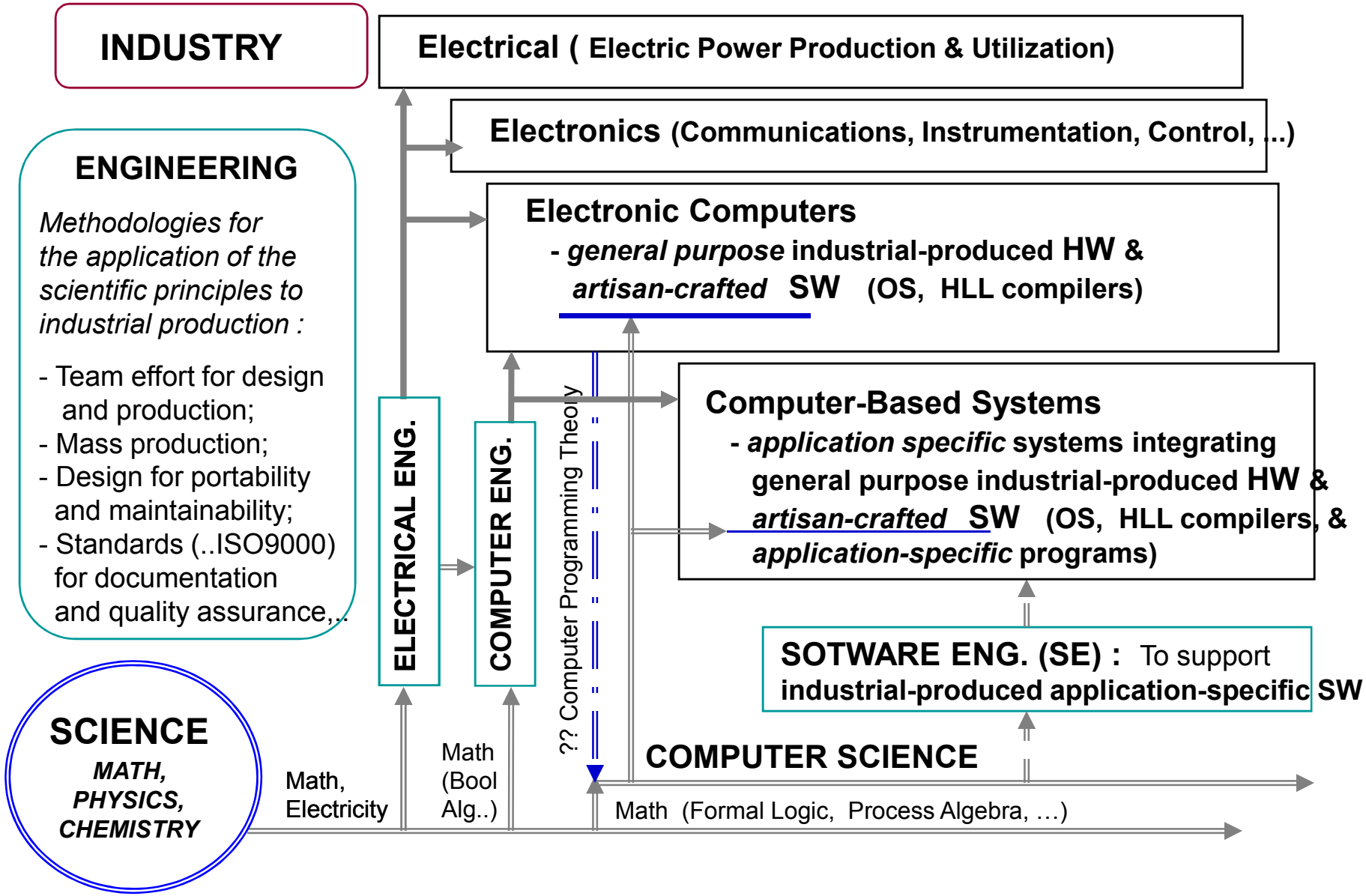
© *Emil M. Petriu*



© *Emil M. Petriu*



© *Emil M. Petriu*



© *Emil M. Petriu*

Electrical Engineering

What do electrical engineers do?

• Electrical engineers design and build electrical systems ranging from electrical generating stations to CD players, telephones, televisions and computers.

• They also help to design and produce the computer chips that are the foundation of today's high-technology industry. Finally, electrical engineers work in the space industry, in robotics, in cellular telephone and digital television design, and in the production of aids for the handicapped.

• Electrical engineers apply their knowledge, for example, to building an integrated circuit that allows a handicapped person to communicate, to designing an algorithm that analyses radar signals, to ensuring accurate and efficient transmission of information on the Internet.

Where Do Electrical Engineers Typically Work?

* Mobile and wireless communications
* Electronics and chip design
* Telecommunications and signal processing
* Computer technology
* Control systems
* Microwave circuit design for telecommunications
* Information processing

Computer Engineering

What do computer engineers do?

• Computer engineers solve a wide range of problems using computers; they design the microprocessors along with the hardware that goes in the computer and develop the software that controls the system. They also ensure computers communicate properly with one another.

• Computer engineers are equally at ease designing the hardware of systems powerful enough to execute complex tasks efficiently and developing the software to perform given tasks reliably.

Where Do Computer Engineers Typically Work?

* Hardware design
* Software development
* Information processing technology
* High-speed communication networks
* VLSI and ASIC chip design
* Control systems
* Robotics

Software Engineering

What do software engineers do?

Software engineers design, develop, and maitain software systems for information processing through the structuring, representing, transforming and transmitting of information.They apply engineering principles in the design of large-scale and embedded software systems to ensure public safety, quality and optimal cost of products.

While software engineers have some background in hardware, they specialize in the design, maintenance and evolution of software systems. Typically, they are responsible for the development and management of large-scale software projects where issues of public safety and the maintenance and evolution of software systems are of paramount importance.

Where Do Software Engineers Typically Work?

* The information technology field continues to grow at an incredible pace, and there is a definite demand for software engineers in all branches of our economy.
* Software engineers are needed in telecommunications, information processing, banking, government institutions and many other sectors. Graduates of one of the first programs in software engineering will have a broad choice of career options and can look forward to a challenging career in a constantly evolving field.

Computer Science

What do computer scientists do?

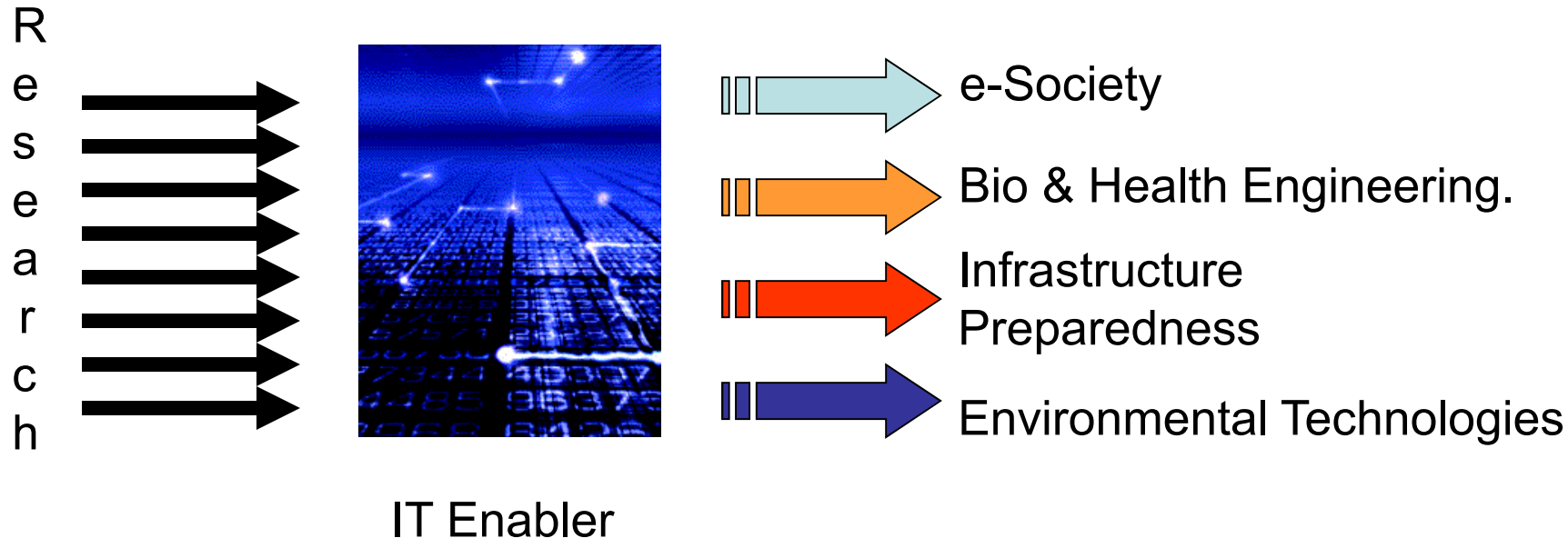
- Computer scientists specialize in the design and development of software systems; their work is concerned with information processing through the structuring, representing, transforming and transmitting of information. Computers allow user-friendly human-machine interfaces which have found applications in all spheres of human activity.

- The fundamentals of computer science include programming systems and languages, computer architecture, data structures, algorithm design, operating systems, databases, computer networks, image processing and recognition and artificial intelligence.

Where Do Computer Science Graduates Typically Work?

* There are two main types of employers: the software industry, and software users.
* In the first category, employers include industries that develop software products (e.g. databases, graphics), those that develop products including embedded software, and those that develop software services.
* In the second category, employers include companies and institutions of all types: banks, government, industry, financial institutions, etc.

IT as an Enabler



e-Society

Telecom Systems And Networks

Wireless Technologies

Information Security and Privacy

Multimedia, Virtual Environments and Haptics

Bio and Health Engineering

IT in Health

Biomedical Engineering

Infrastructure Preparedness

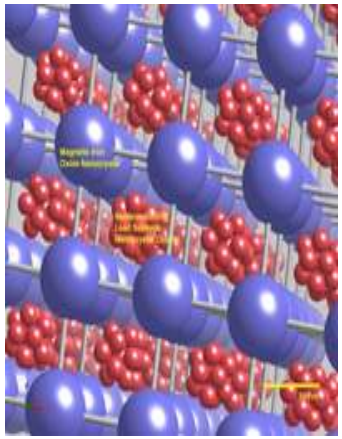
Robotics
and
Automation

Mobile and
Sensor
Networks

Infrastructure
Protection and
Emergency
Preparedness

Environmental Technologies

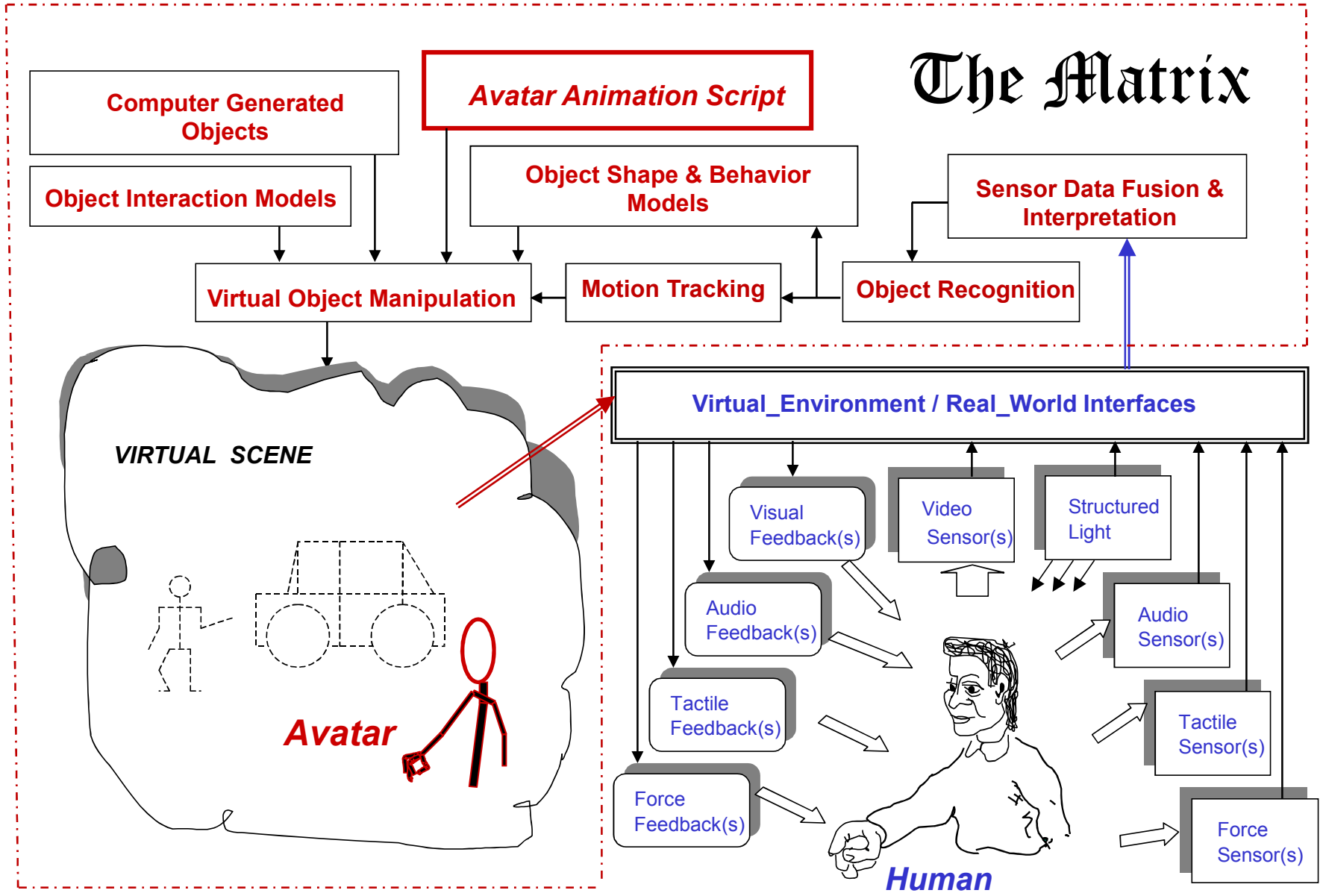
Environmental Technologies

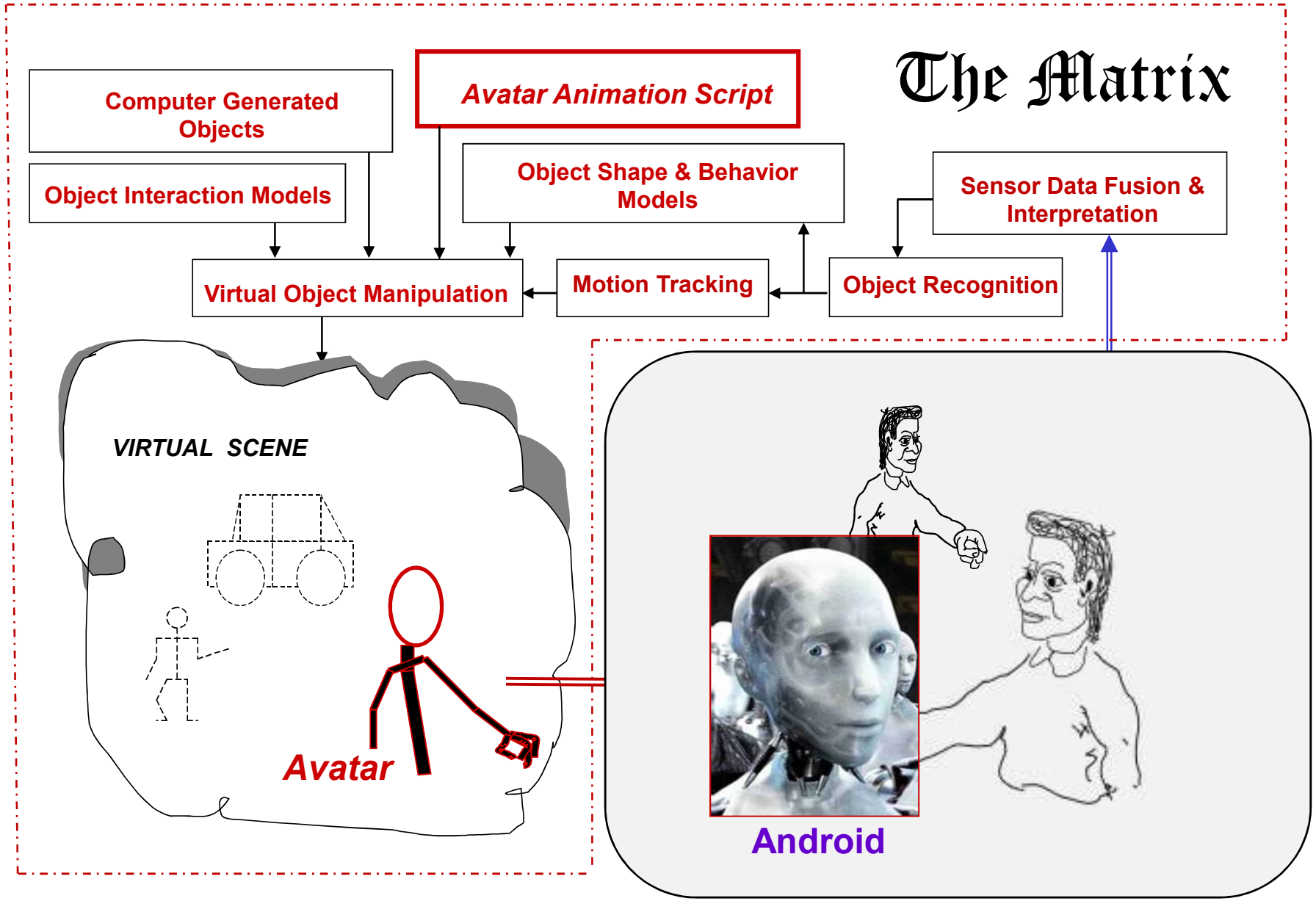


Advanced Materials

For many centuries, engineers were building upon **mathematics** and **natural science principles from mechanics, electricity, and chemistry** in order to develop an ever growing variety of more efficient and smarter industrial artefacts and machines.

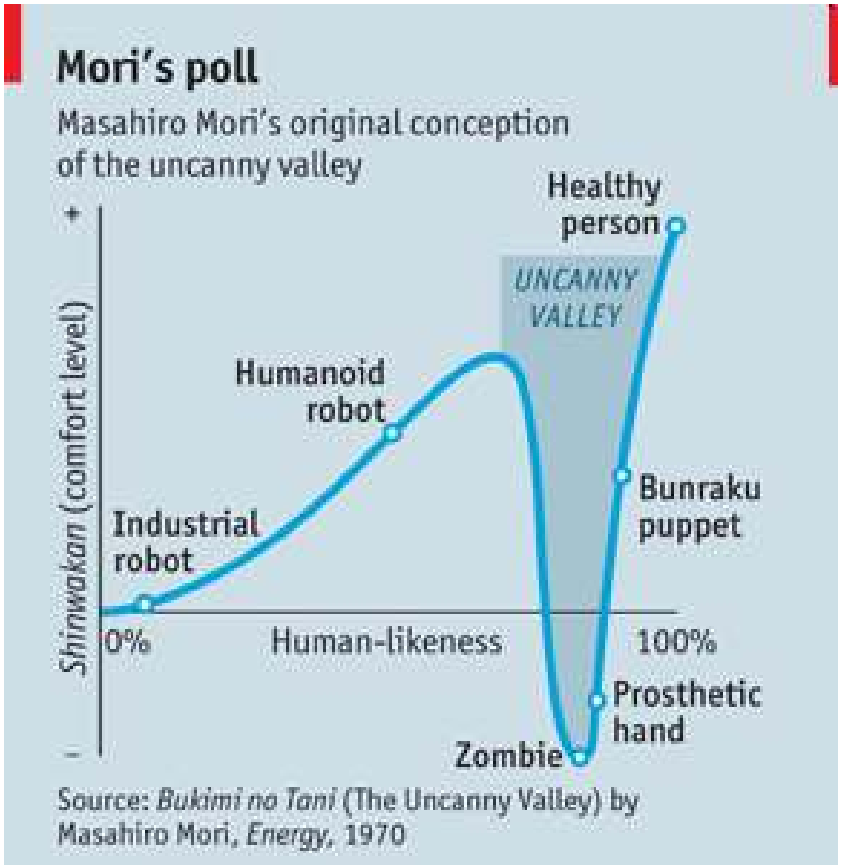
The time has now arrived to **add biology -** and more specifically, **human anatomy, physiology and psychology – to the scientific sources of knowledge** for engineers to develop **a new generation of bio-inspired intelligent machines**.


The Matrix
Computer Generated Objects
Avatar Animation Script
Object Interaction Models
Object Shape & Behavior Models
Sensor Data Fusion & Interpretation
Virtual Object Manipulation
Motion Tracking
Object Recognition
VIRTUAL SCENE
Avatar
Virtual_Environment / Real_World Interfaces
Visual Feedback(s)
Video Sensor(s)
Structured Light
Audio Feedback(s)
Audio Sensor(s)
Tactile Feedback(s)
Tactile Sensor(s)
Force Feedback(s)
Force Sensor(s)
Human


The Matrix
Computer Generated Objects
Avatar Animation Script
Object Interaction Models
Object Shape & Behavior Models
Sensor Data Fusion & Interpretation
Virtual Object Manipulation
Motion Tracking
Object Recognition
VIRTUAL SCENE
Avatar
Android

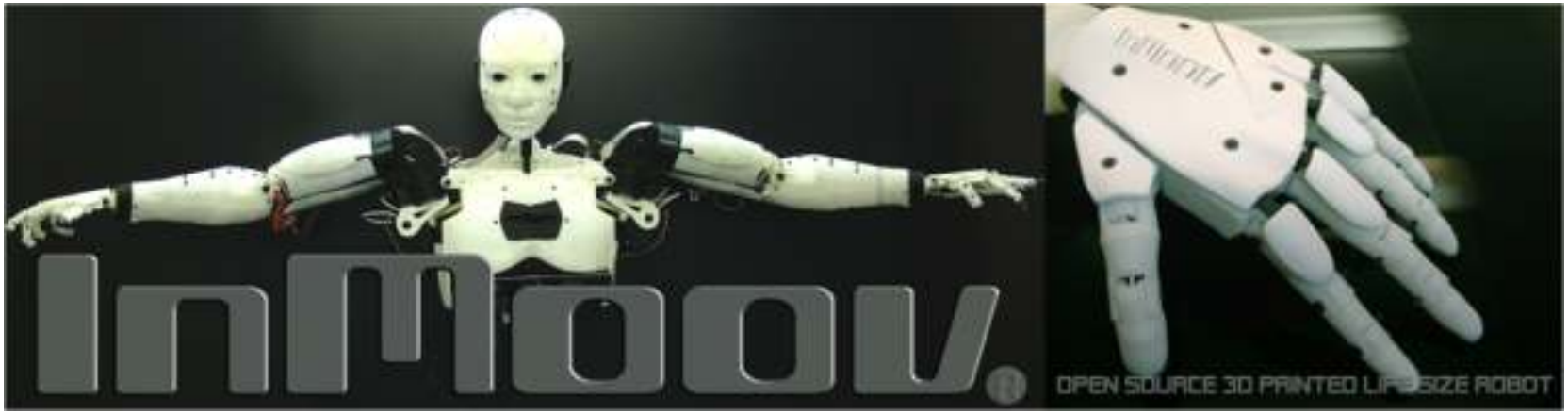
Crossing the uncanny valley: As computer graphics and robots get more human, they often seem more surreal

[*The Economist, Nov 18th 2010* , http://www.economist.com/node/17519716]



"The idea of the **uncanny valley** was proposed by Masahiro Mori in 1970. His idea was that **increasing humanness in a robot was positive only up to a certain point** …. beyond which, the not-quite-human object strikes people as creepy."


ASIMO
The Honda Humanoid Robot ASIMO
"While we were sleeping"
1986
1991
1993
2000
History
Robot Development Process



“InMoov”, the first Open Source life size humanoid robot you can 3D print and animate, ***Gael Langevin’s project, January 2012***
http://www.inmoov.fr/project/

“Gael Langevin is a French modelmaker and sculptor. He works for the biggest brands since more than 25 years. InMoov is his personal project, it was initiated in January 2012
InMoov is the first Open Source 3D printed life-size robot. Replicable on any home 3D printer with a 12x12x12cm area, it is conceived as a development platform for Universities, Laboratories, Hobbyist, but first of all for Makers. It’s concept, based on sharing and community, gives him the honor to be reproduced for countless projects through out the world.”

Human & Android & Cyborg
Hyper-Society

HUMAN

Heart +
Pacemaker

Eye +
Artificial Cornea

eye glasses, binoculars, IR night vision, HMD for augmented VR,...

Ear +
Hearing Aid
Implant

Nose +
Artificial Smell

Tongue +
Artificial Taste

Hand +
Artificial Hand

gloves (baseball glove), hand tools

Knee Joint +
Artificial Knee Joint

footwear, skates, bike, exoskeleton,..

TECHNOLOGICALLY ENHNCED HUMAN - *CYBORG*

Brain Prosthesis

"**Immortality by 2045 or bust: Russian tycoon wants to transfer minds to machines**
Russian billionaire Dmitry Itskov speaks to the Global Future 2045 Congress, Saturday, June 15, 2013 at Lincoln Center in New York. Some of humanity's best brains are gathering in New York to discuss how our minds can outlive our bodies." [Ottawa Citizen, June 15, 2013, http://www.ottawacitizen.com/business/Immortality+2045+bust+Russian+tycoon+wants+transfer+minds/8531949/story.html]

Brain Prosthesis which learns/models with an ever increasing fidelity the behaviour of the natural brain so it can be used as *behavioural-memory prosthesis* (**BMP**) to make up for the loss in the natural brain's functions due to dementia, Alzheimer disease, etc. It is quite conceivable that such a BMP could arrive in extremis to complete replace the functions of the natural brain.

***Asimov's laws of the robotics*:**

1st law: "A robot must not harm a human being or, through inaction allow one to come to harm".

2nd law: "A robot must always obey human beings unless that is in conflict with the 1st law".

3rd law: "A robot must protect itself from harm unless that is in conflict with the 1st and 2nd law".

Cyber/Machine
Society/World
{**Intelligent Androids**}

Human
Society/World
{**Human Beings**}

***Asimov's laws of the robotics*:**

0th law: "A robot may not injure humanity or, through inaction, allow humanity to come to harm."

1st law- updated: "A robot must not harm a human being or, through inaction allow one to come to harm, unless this would violate the 0th law."

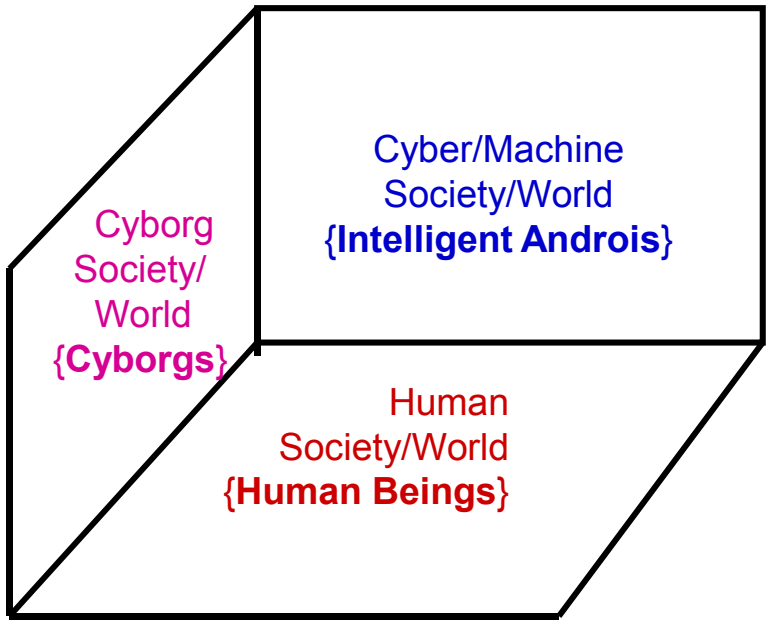
2nd law: "A robot must always obey human beings unless that is in conflict with the 1st law".

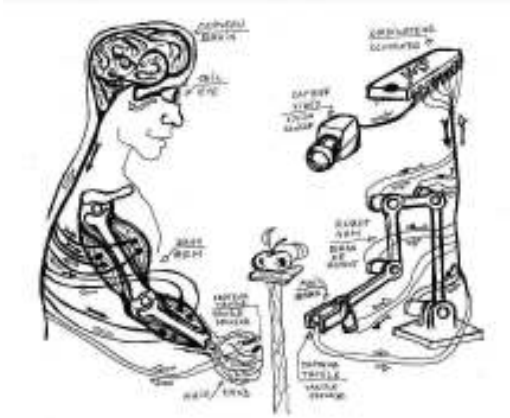
3rd law: "A robot must protect itself from harm unless that is in conflict with the 1st and 2nd law".

---

[*] I. Asimov, Robots and Empire, Doubleday & Co., NY 1985, p.291

Moral, Ethical, Theological, Legal, Biological, Psychological Social, Economic Challenges





Thank You!