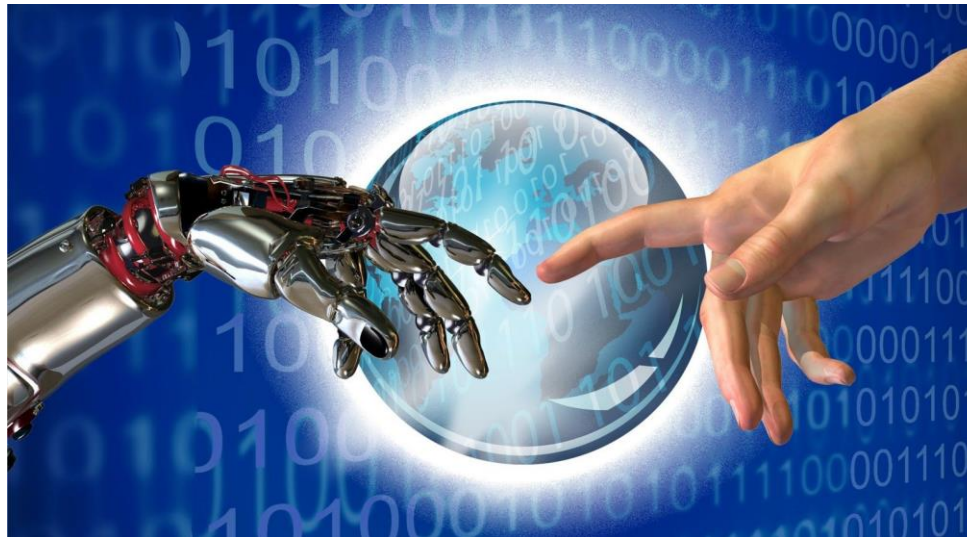


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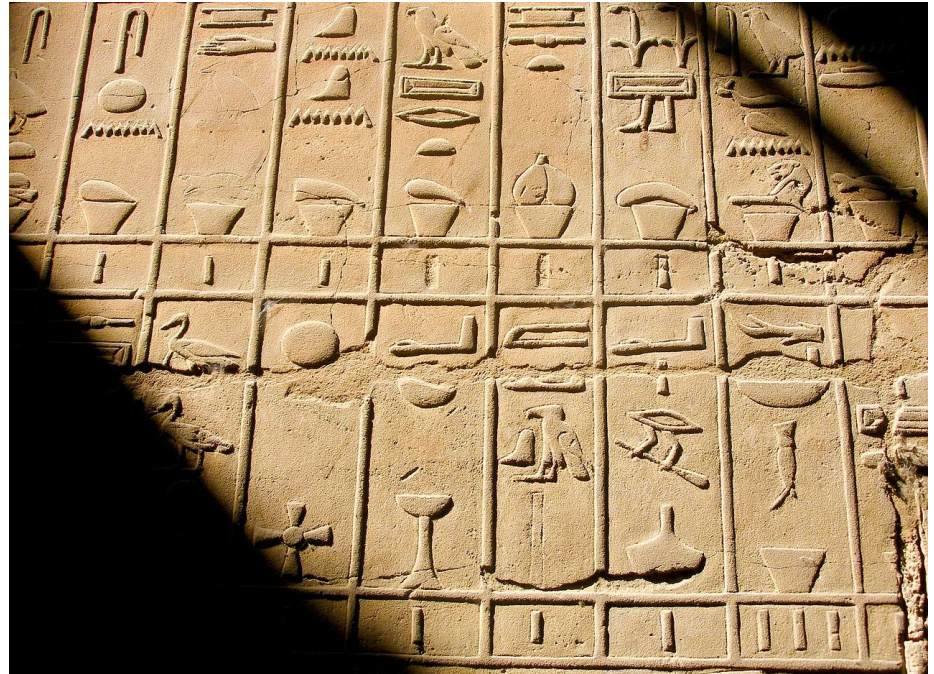
“Impresión funcional-Oportunidades y Areas de Impacto”



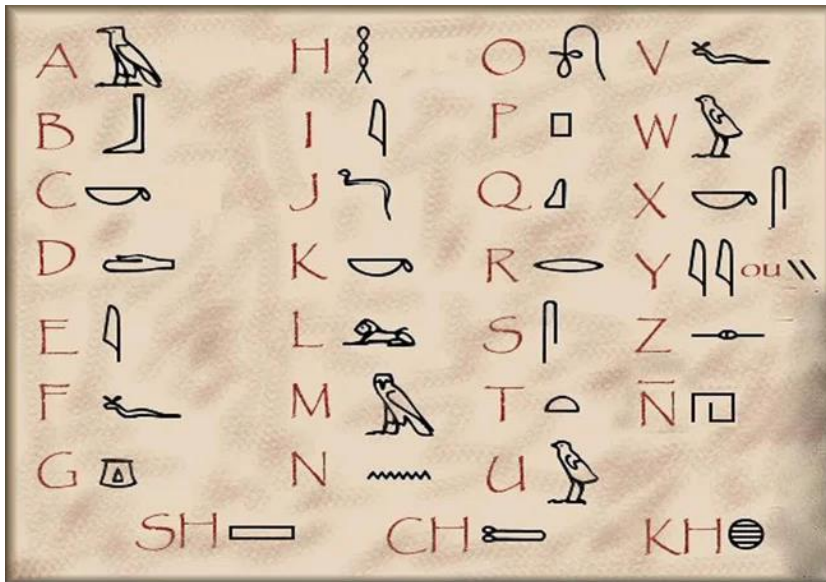
**Active and smart materials....
.... for a better life!**



- The **beginning of writing**... Bronze Era (end of the IV millennia a. C.- 3100 a.C), simultaneously in Mesopotamia and Egypt.
- The **beginning of History**, through written registers.



- The **first alphabet**: around 2000 aC, as adaptation of the Egyptian hieroglyphs.
Example for the rest. **Simplification of writing.**



NOMBRE Y SIGNIFICADO	FENICIO ANT.	FENICIO	GRIEGO ANT.	GRIEGO	LATÍN
ALEF buey					A
BETH construcción					B
GIMEL esquina					G
MEM agua					M
NUN cobra					N
AYIN ojo					O
RESH cabeza					R
TAU cruz					T
SHIN diente					S



Johannes Gutenberg ca. 1398-1468

**The printing press (approx. 1450 b.C.):
One of the most important
inventions in history**

30000 books in Europe

to...

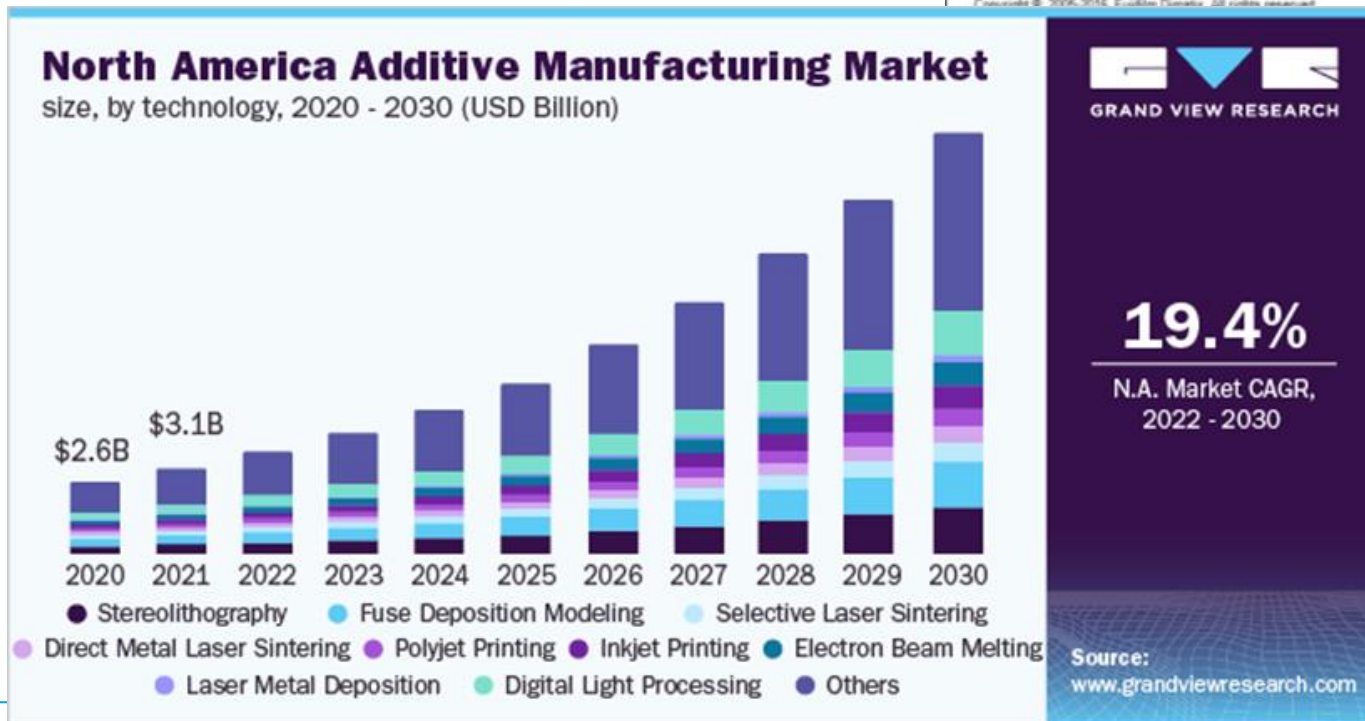
10 to 12 million by 1500

(for approx. 60 million population)



- The **first additive manufacturing** system appeared in the **1980s**
- In the early 1980s, Dr. Hideo Kodama.
- In **1984, Charles Hull** developed the material **Stereolithography** Apparatus known as SLA. He went on to establish the first 3D printing company in 1986.

Additive manufacturing technologies



Printing technologies are strongly evolving due to...

- The **variety of materials** that can be printed
- **Flexibility** of developing different kind of objects or **patterns**
- **Simple fabrication** and/or integration into devices

One of the most interesting areas are **flexible printed electronics**

- ✓ Low cost functional flexible sensors
- ✓ Communication devices
- ✓ Wearable smart systems

Can be produced in **large areas, conformable shapes** in **mass production**

Printed Electronics

*... is (mainly) based on soluble polymers or metallic **nano-material** based powders that become fluid in special solvents and can be transformed into printable inks.*

Components & technologies involved:

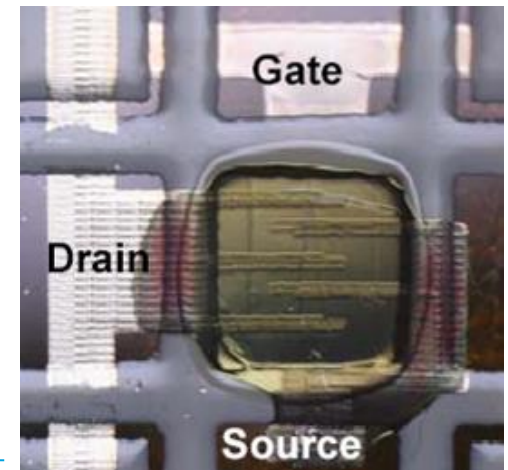
◆ **Materials (inks/pastes):**

- conductor
- semiconductor
- dielectric
- resistive
- functional...



◆ **Printing technologies**

- ◆ Substrates: flexible plastic film or paper, glass or wherever the functional solutions can be printed.



Technology benefits & drawbacks

Printed & Organic electronics

Low mobility (10^{-3} - $5 \text{ cm}^2/\text{V}\cdot\text{s}$)

Low performance & low speed (range of KHz)

Low degree of integration (10^1 ... 3 FETs / cm^2)

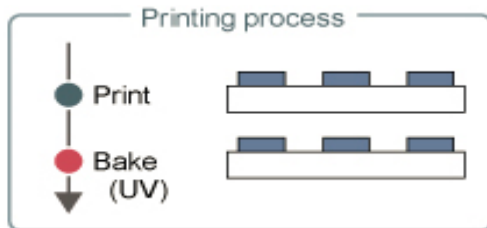
Simple fabrication

Very flexible interfaces to environment

Low fabrication costs

Typical applications:

Large areas, low-end, single-use & disposable products



Silicon-based electronics

High mobility ($\sim 1000 \text{ cm}^2/\text{V}\cdot\text{s}$)

High performance (speed, power)

High degree of integration (10^8 FETs / cm^2)

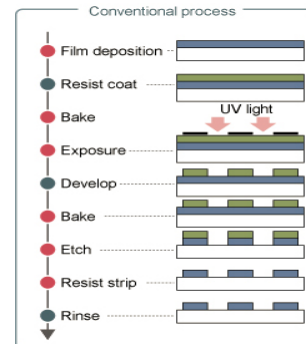
Sophisticated fabrication

Complex chip/environment interfaces

High fabrication costs

Typical applications:

high-end; usage over a long period



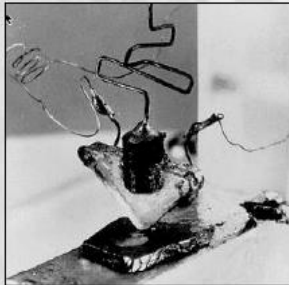
↓ **Steps**

↓ **Cost**

↓ **Materials**

Electronics by mass printing

1947 first transistor



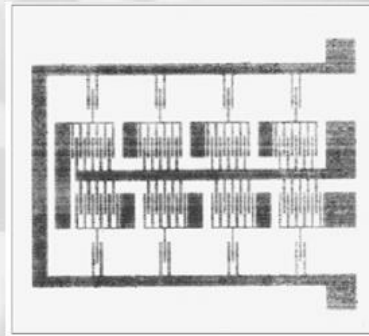
1958 first integrated circuit



2005 a billion of transistors on a wafer



2003 first organic transistor with mass printing techniques at pmTUC



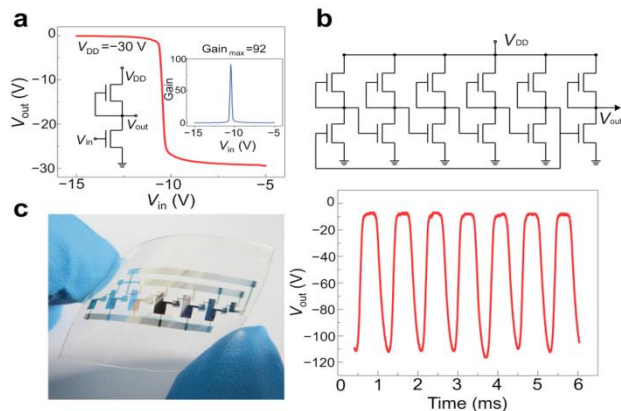
2005 first organic circuit with mass printing techniques



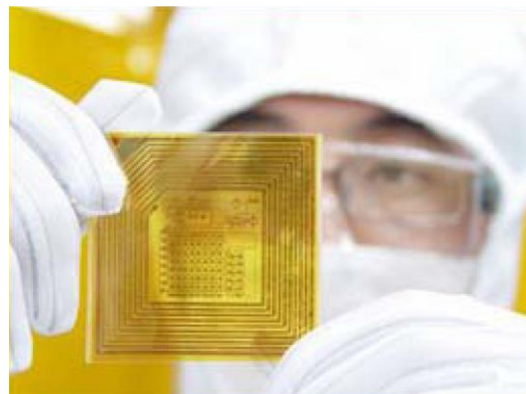
mass printing of electronics is on a good track towards its first applications. logic devices are under development

Applications

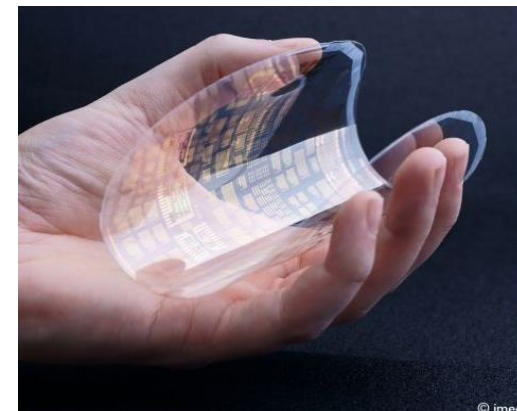
Systems & components



Organic 5-stages oscillator.
T&R, Singapore (2012)



Sunchon University
16-bit 13.56 MHz RFID tag
gravure R2R, 20m/min



8-bit organic processor @ 8Hz
IMEC (2011)- lytho



Rollable OLEDs

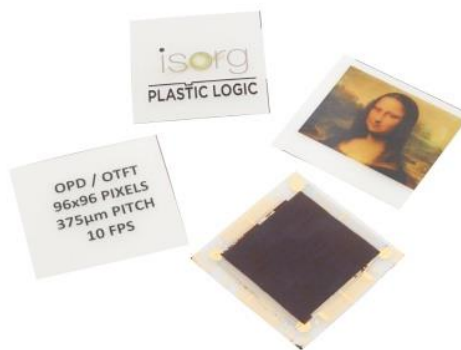
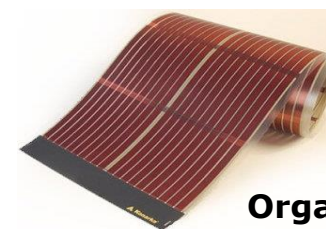


Image sensor
IMEC, Holst Center,
ISORG and Plastic Logics
(2012)



Organic PV



Batteries

The Context

On-going revolutions and needs:

-Biomedicine



**-Green deal
(Materials, processes,
Energy)**



-Digitalization





The Context

On-going revolutions and needs:

-Biomedicine



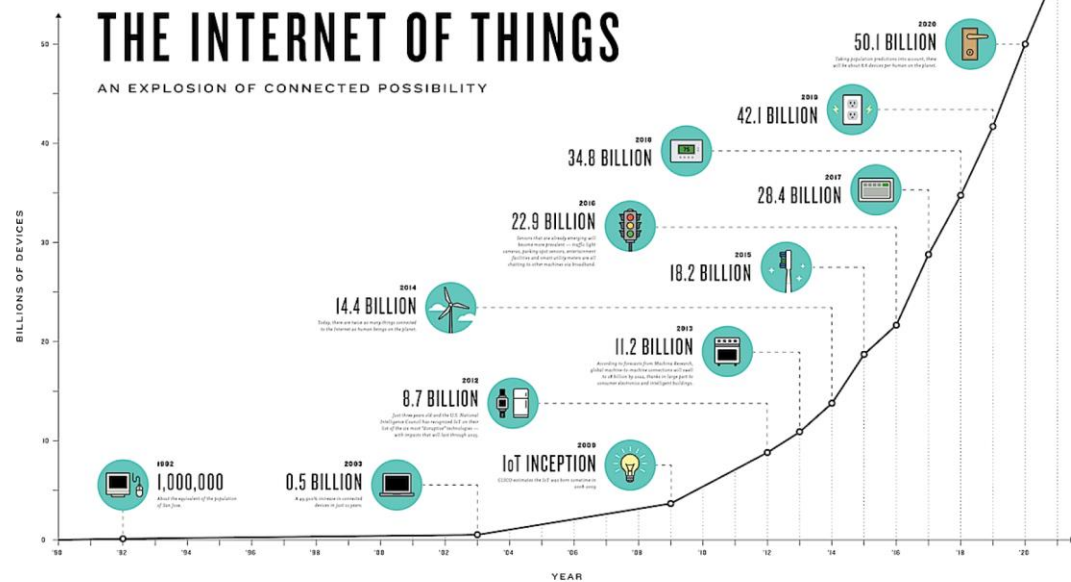
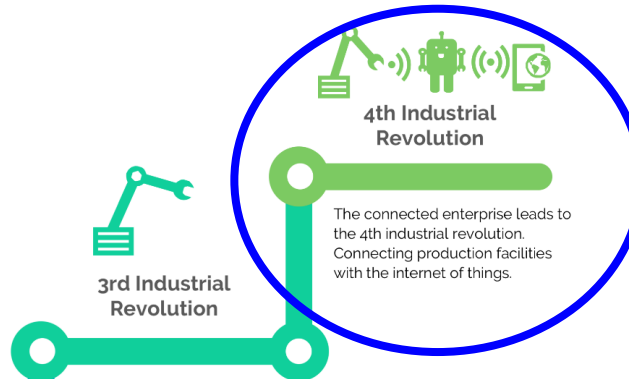
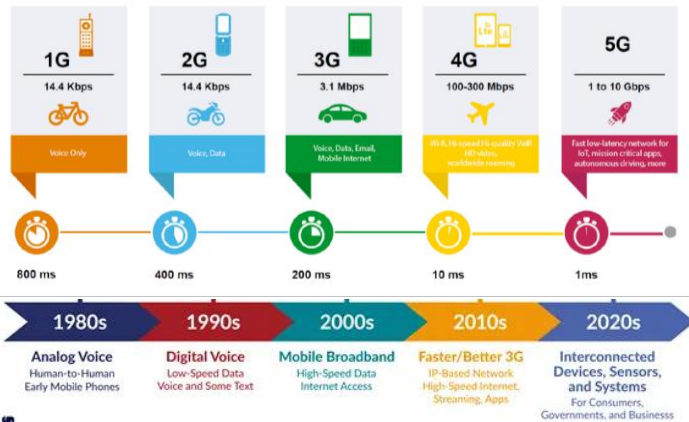
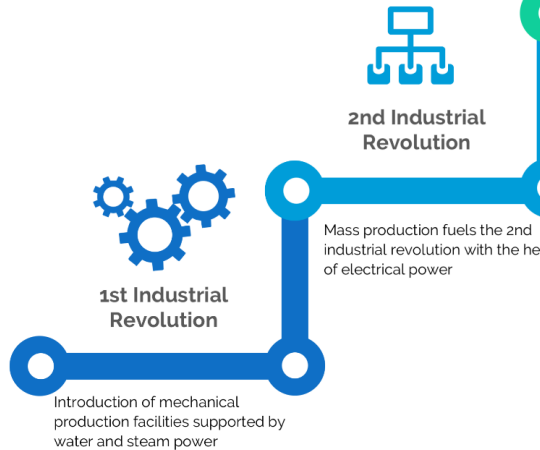
-Green deal (Materials, processes, Energy)



-Digitalization

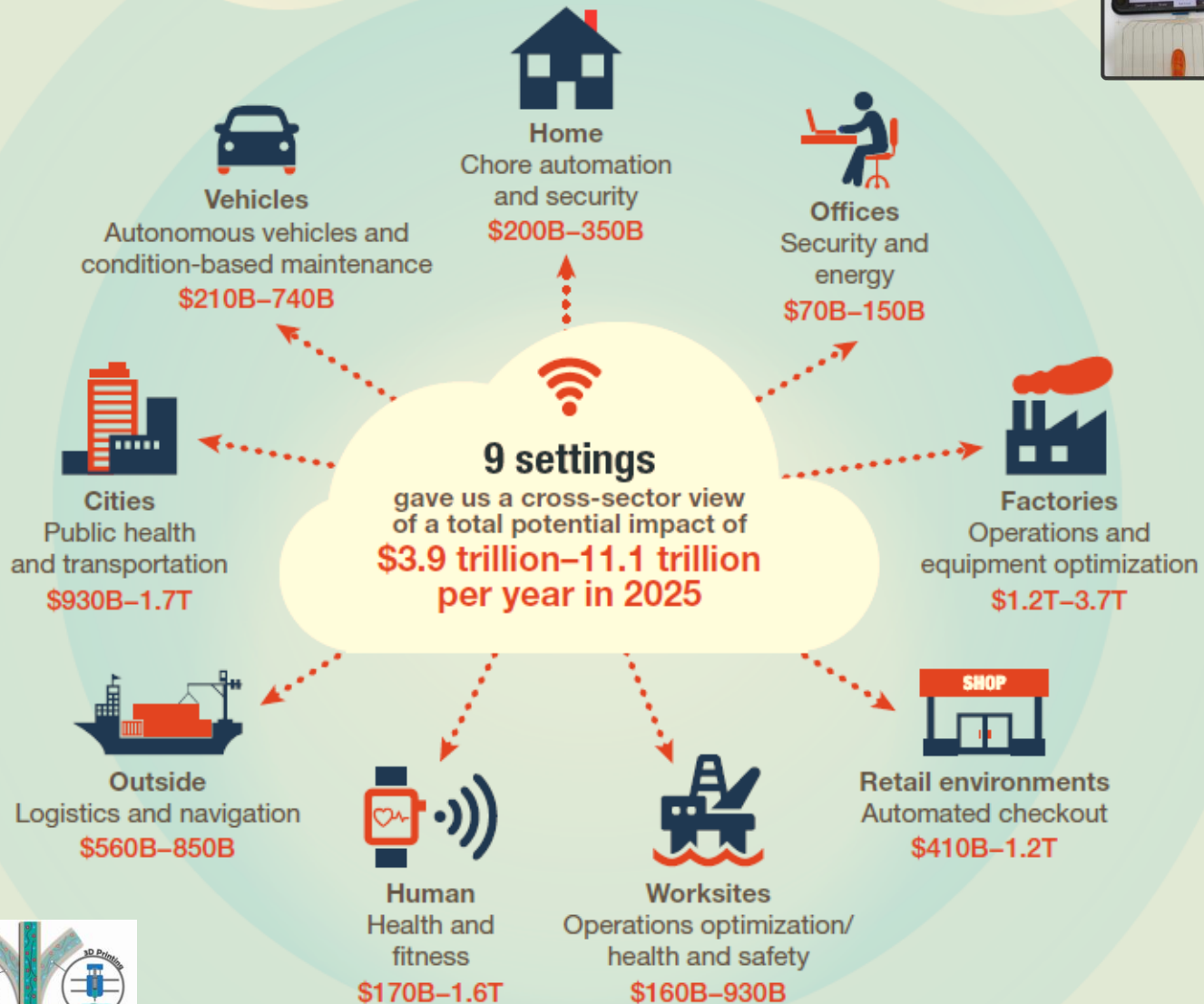
- First report on *networking* [J. C. R. Licklider](#) (MIT) 1962 **Galactic Network** concept
- Practical implementations **in the 80's** and the **90's**.
- In the **90's** introduction of the [World Wide Web](#) (WWW).

- 1984 1000 interconnected computers.**
- 1987 10000 interconnected computers
- 1989 100000 interconnected computers**
- 1991 Public introduction of the World Wide Web
- 1992 1 million interconnected computers**
- 1996 10 million interconnected computers**
- 1998 Google is born
- 2001 Wikipedia.
- 2004 Facebook.
- 2005 1000 millions users**

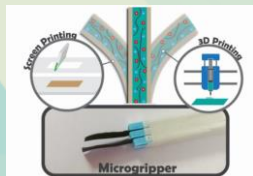


THE INTERNET OF THINGS

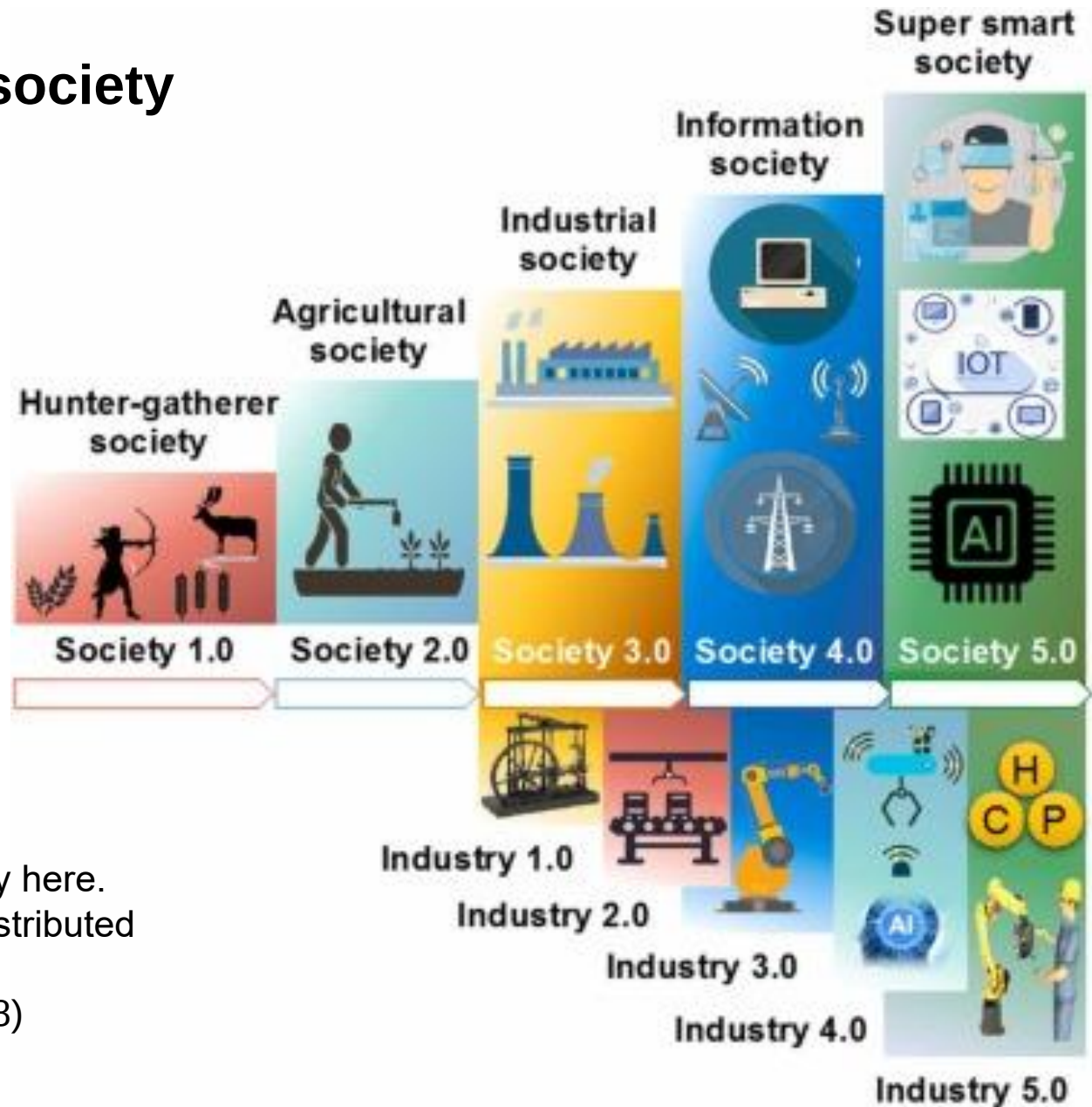
Sensors



Actuators



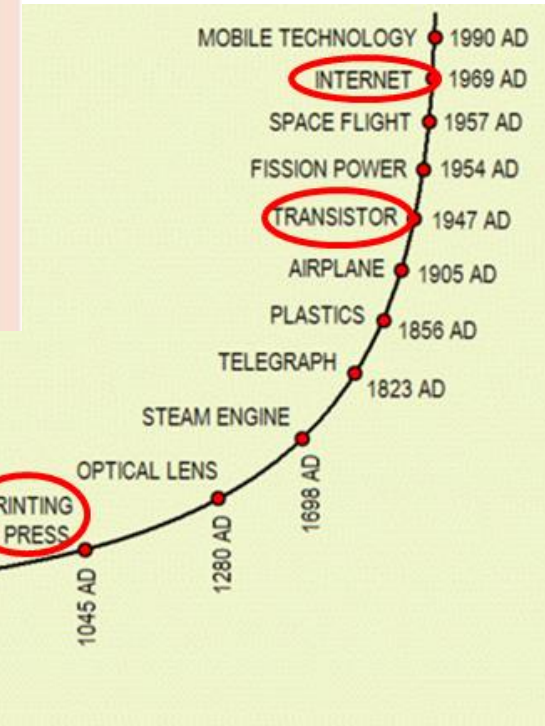
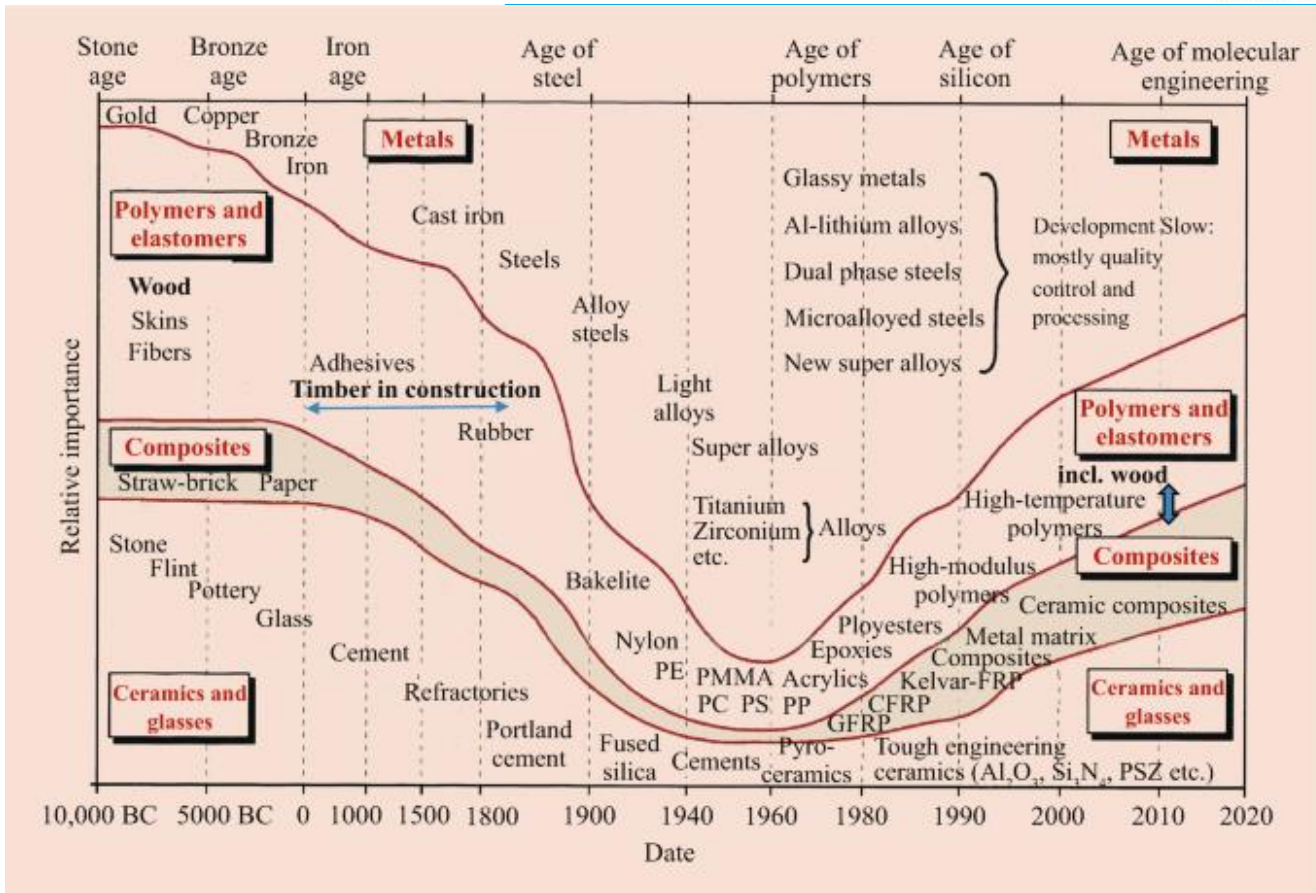
Industry and society



“The future’s already here.
It’s just not evenly distributed
yet.”

William Gibson (1948)

- **Four messages**
- Materials
- Time
- Sustainability
- Printability - Information

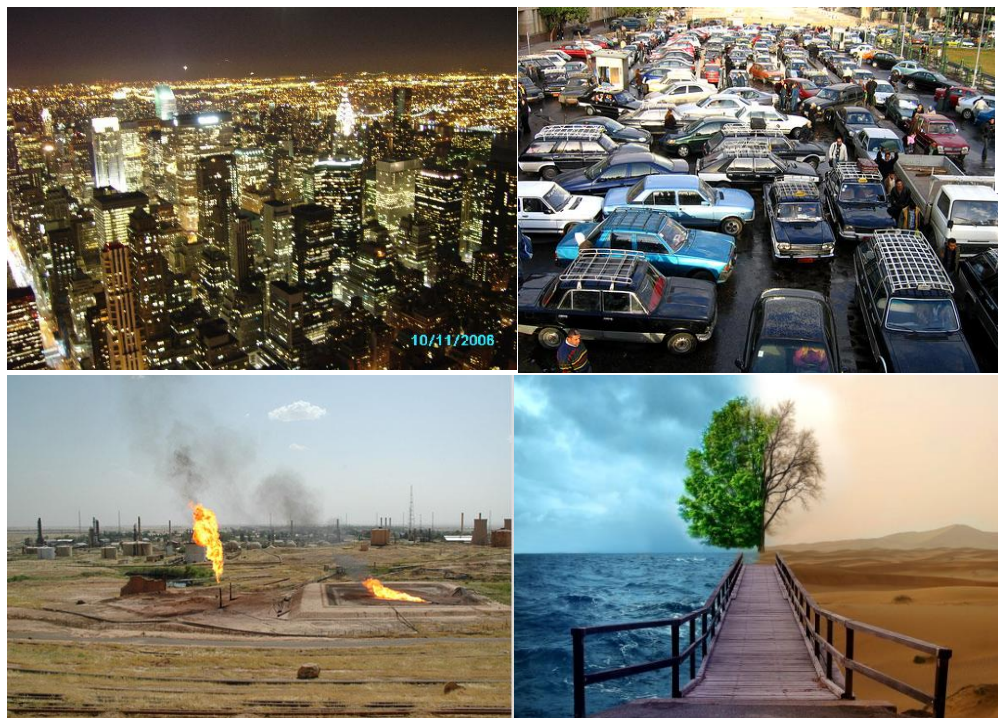


Sustainable digitalization

Digitalization

Interactive

Efficient

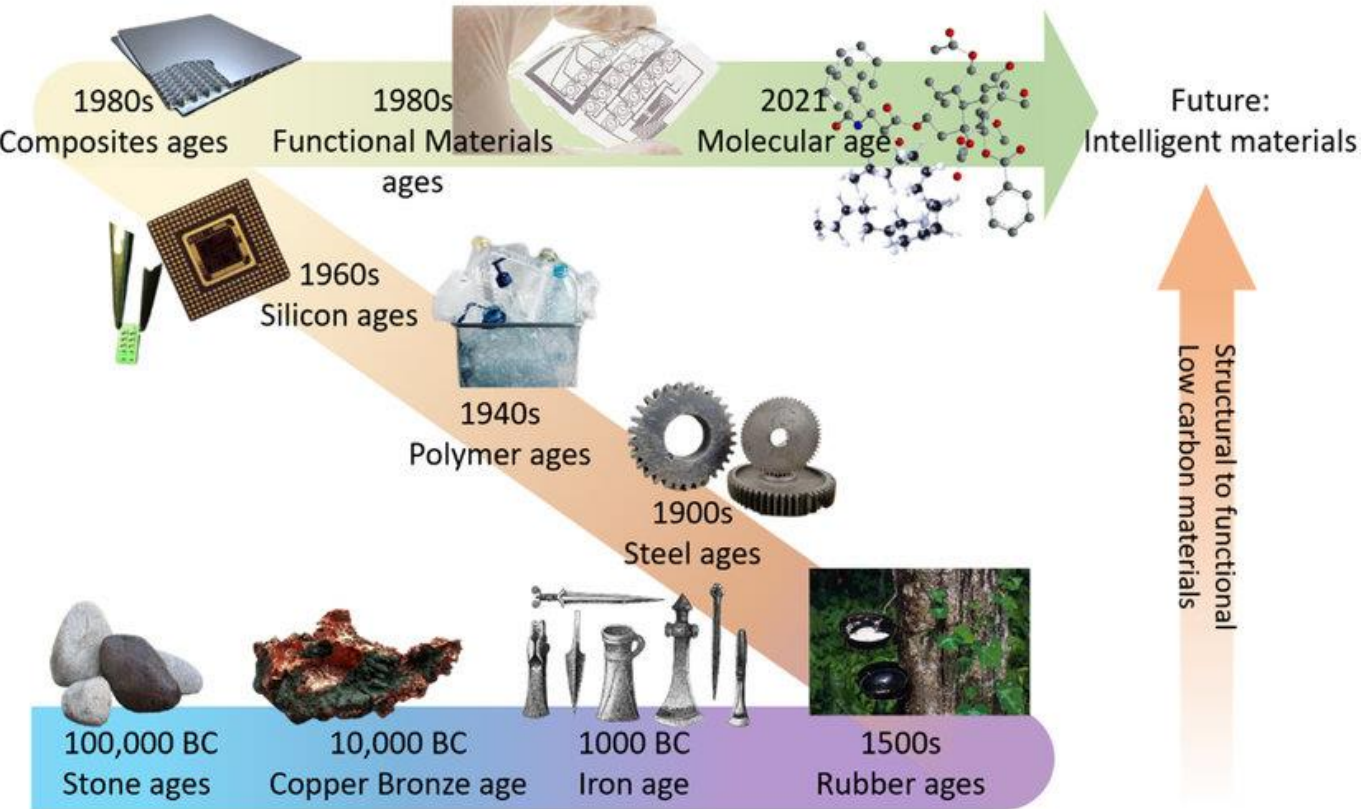


Sustainable

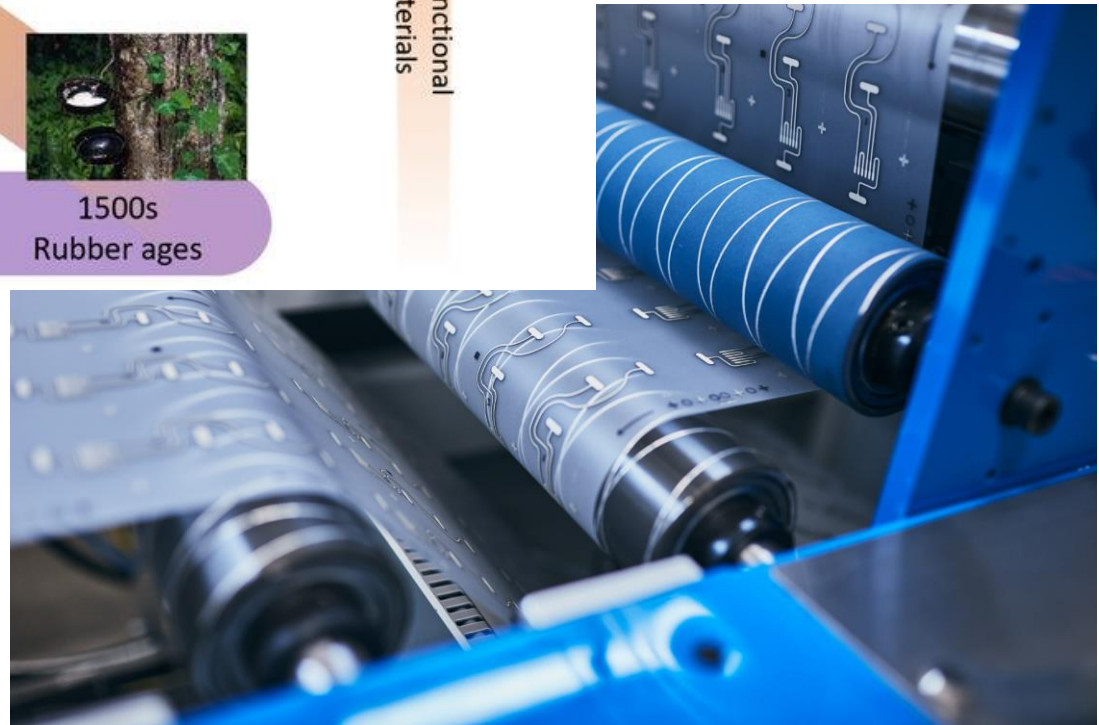


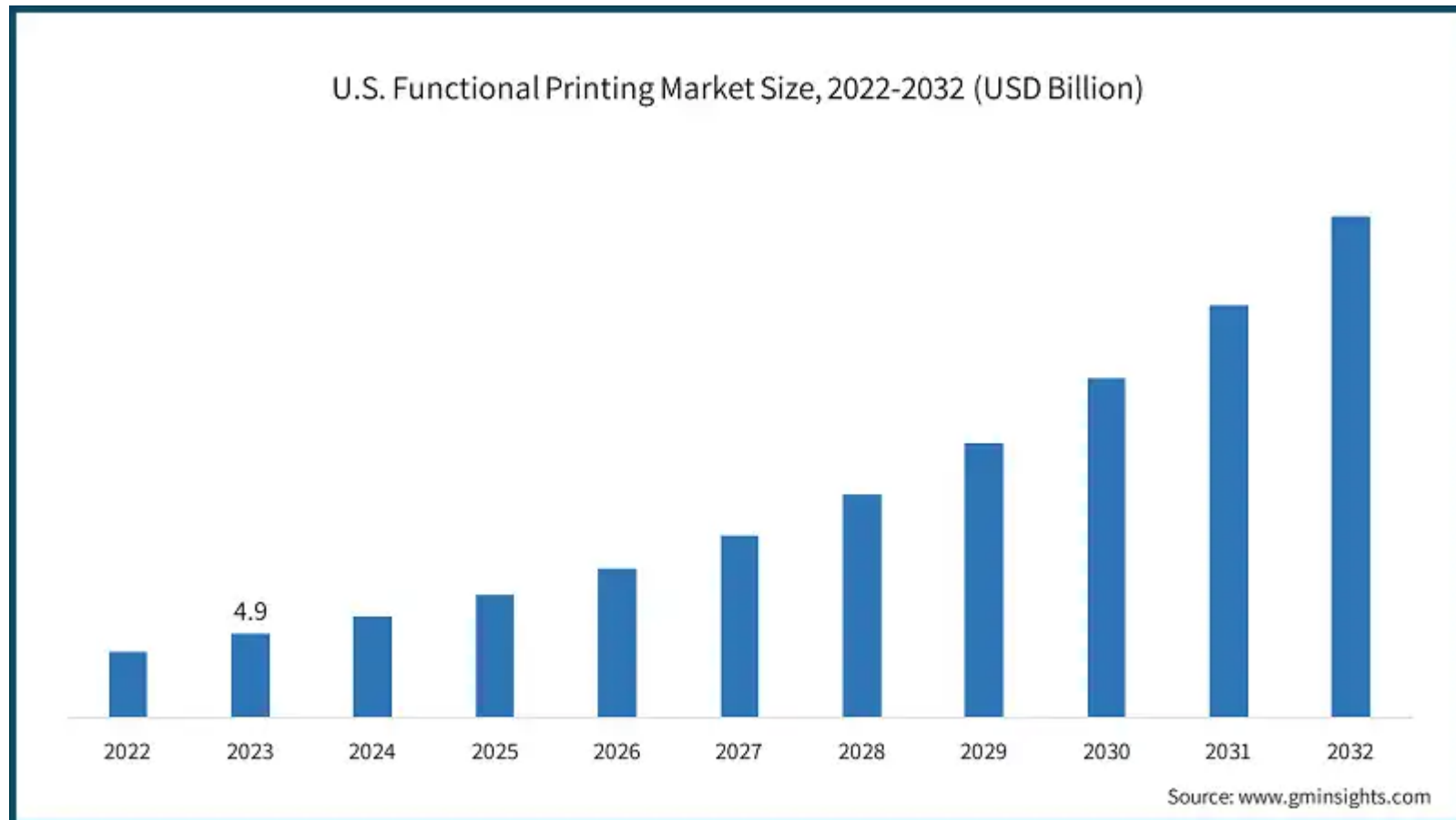
....new materials.....
for a better life!

Green deal



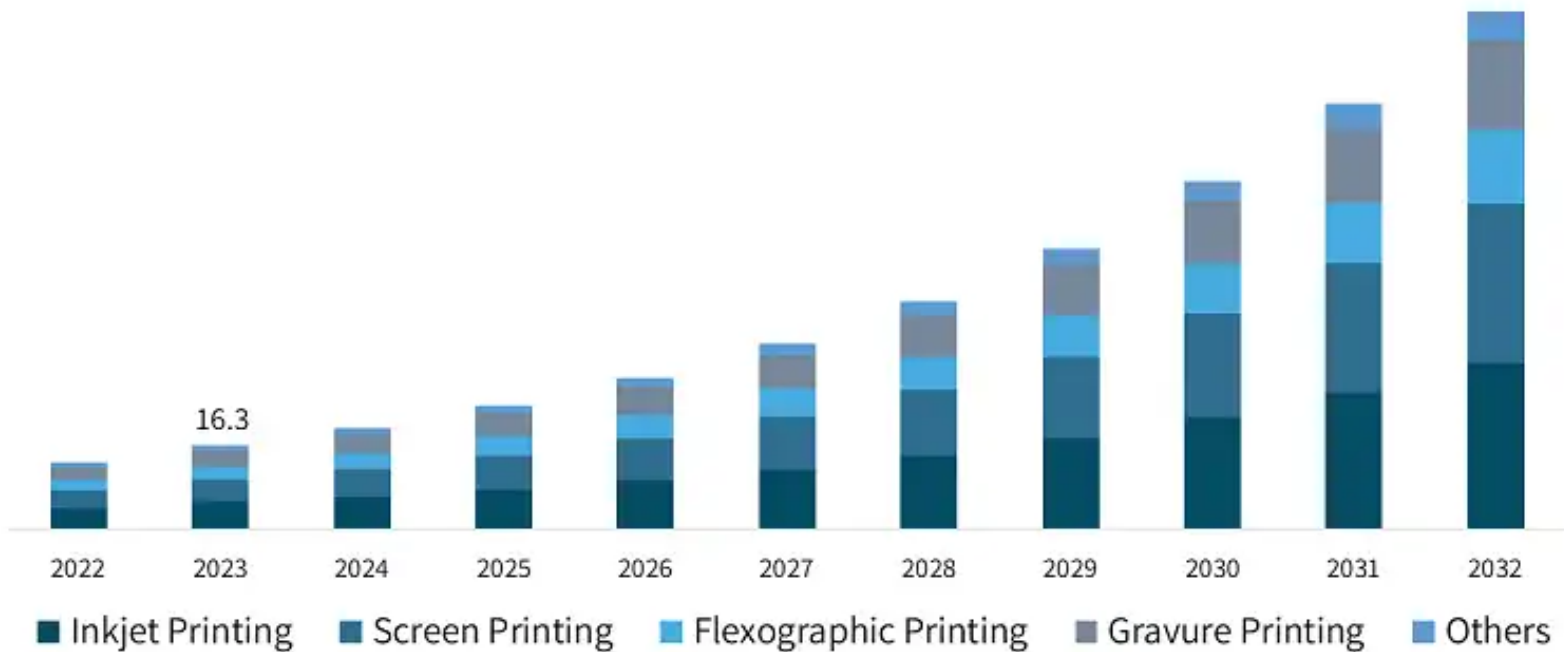
Functional printing



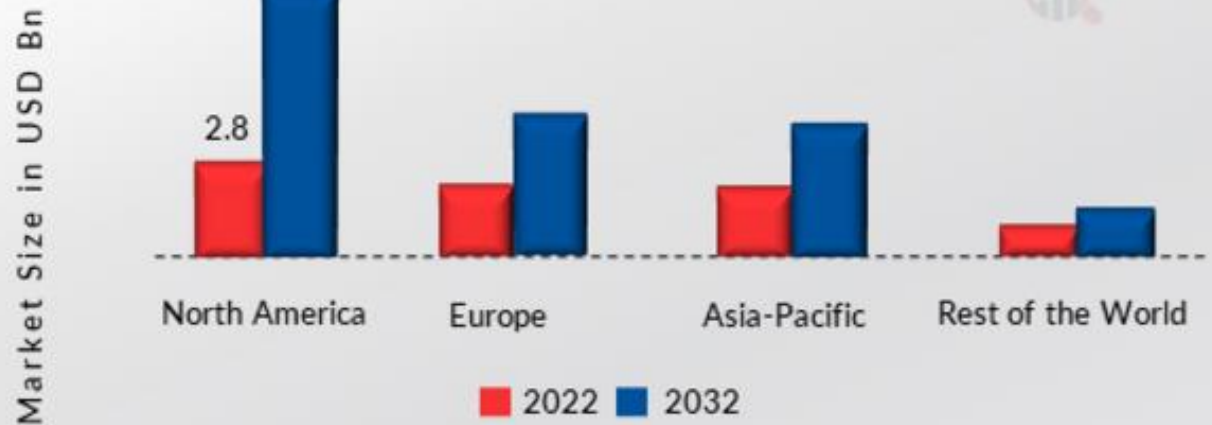
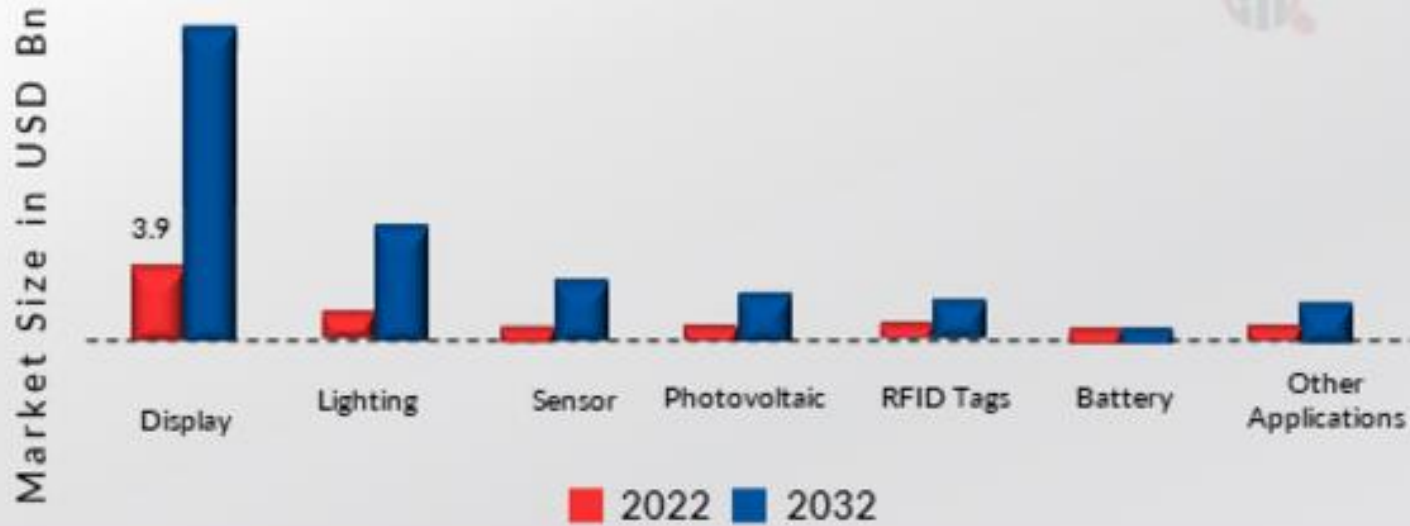


Market análisis report. Report ID: 978-1-68038-180-1

Global Functional Printing Market Size, By Technology, 2022-2032 (USD Billion)



Source: www.gminsights.com



Functional Printing Market

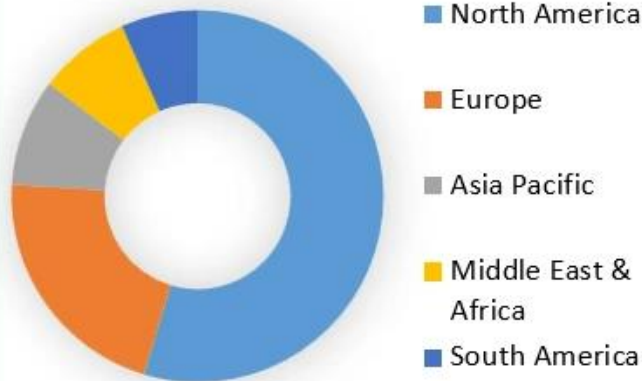


Key Players

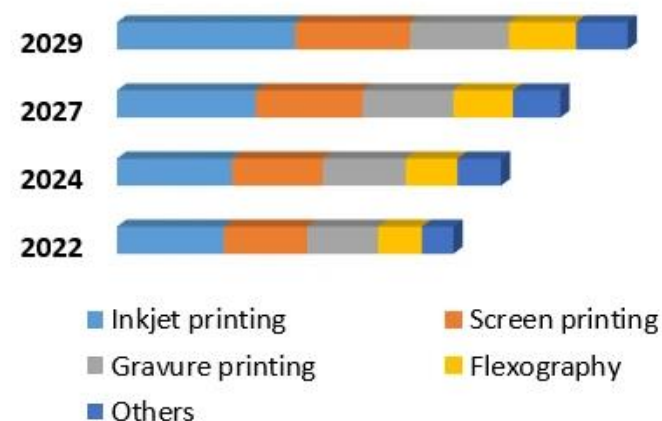
HP Development Company, L.P.
Haiku Tech
Avery Dennison Corporation
BASF SE
Blue Spark Technologies
Display Corporation
E Ink Holdings Inc.
Eastman Kodak Company

EnfucellOy
GSI Technologies LLC
Isorg
Mark Andy Inc.
Nanosolar Inc.
Novaled AG
Optomec Inc.
Toppan Forms Co. Ltd
Toyo Ink Sc Holding Co.
Vorbeck Materials

Regional Analysis in 2022 (%)



Technology Segment Overview

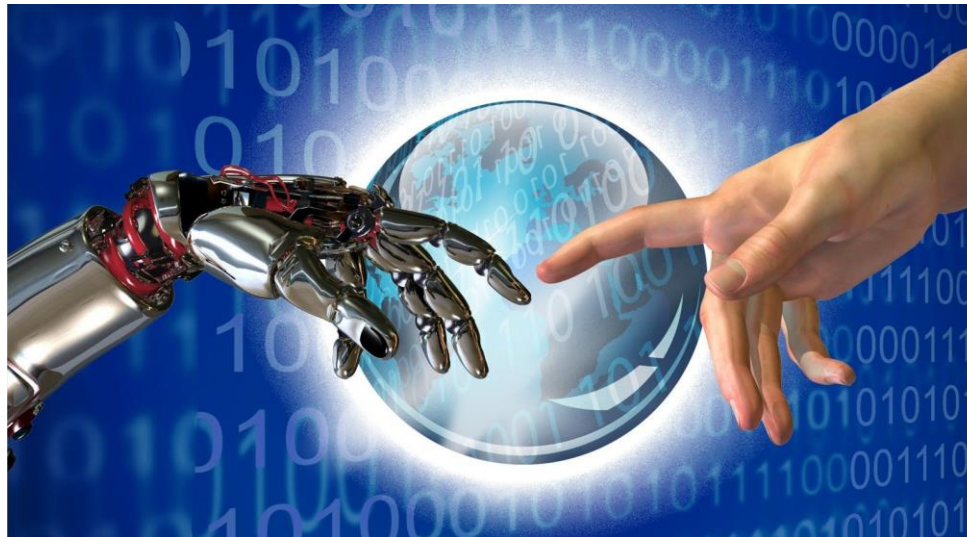


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“Impresión funcional-Oportunidades y Areas de Impacto”



**Active and smart materials....
.... for a better life!**

