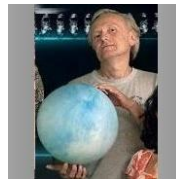


Humankind 2.0: The Technologies of the Future

10. Space Technology

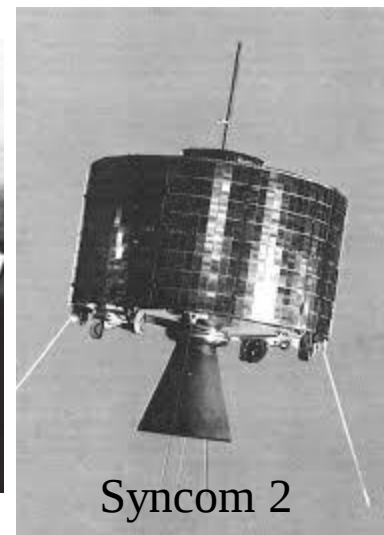
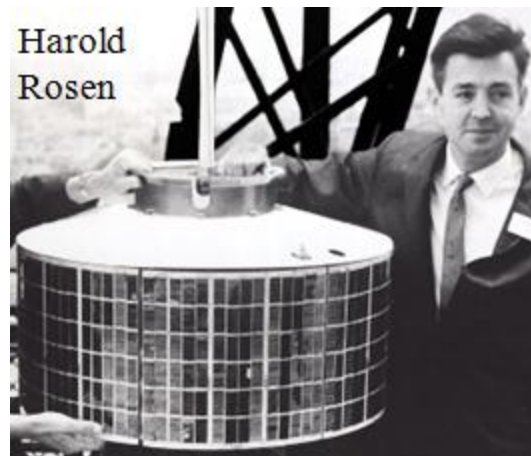
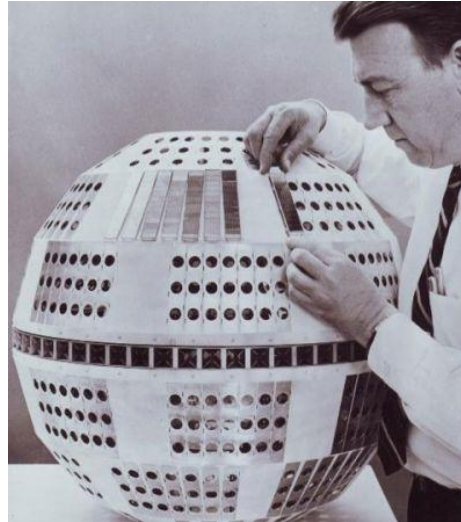
Piero Scaruffi, 2016



See <http://www.scaruffi.com/singular/human20.html>
for the full text of this discussion

Space

- Telstar (1962)
- Syncom 2 (1963)



Syncom 2

Space



BLUE ORIGIN

- Space exploration and technology market estimated to be worth \$314 billion
- Q1-2 of 2015: space startups raise more than \$1.76 billion in the USA
- Space services or rocket technology (46% of all space startups)
- Satellite operations and technology (35%)

SpaceX
Blue Origin
Virgin Galactic

Kymeta
Planet Labs
One Web
Mapbox
Spire



Space

- The space billionaires
 - Elon Musk (SpaceX)
 - Jeff Bezos (Blue Origin)
 - Richard Branson
 - Robert Bigelow
 - Yuri Milner (Starshot)



Space

- Nov 2015: Jeff Bezos' Blue Origin becomes the first private company to land a reusable rocket
- Dec 2015: Elon Musk's SpaceX lands a rocket upright



Musk's Triumph: A Falcon 9 Rocket Lands Upright in Florida

At long last, SpaceX has vertically launched and landed an orbital rocket.



Battle of the Billionaires: How Jeff Bezos and Blue Origin Just Trumped Elon Musk's SpaceX

Don't look now, but Blue Origin's New Shepard just leapfrogged SpaceX's vaunted Falcon 9R in the reusable spacecraft race.



Rich Smith (TMFDitty)
Nov 30, 2015 at 7:00PM

Space

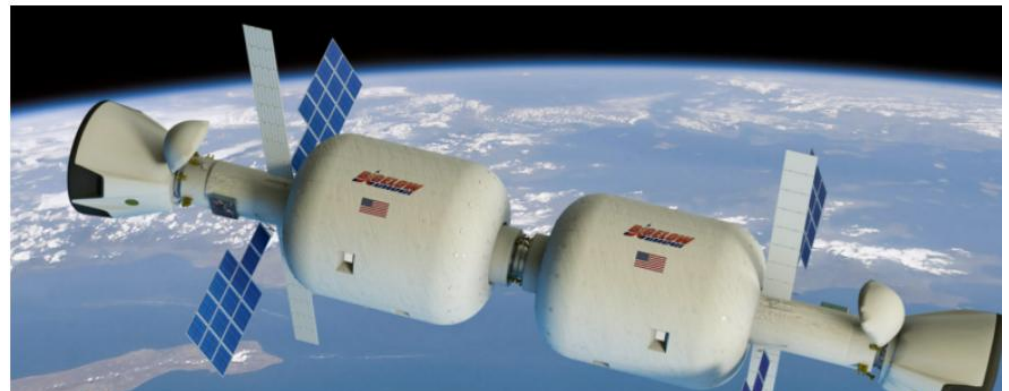
- 2016: SpaceX's CRS-8 lands vertically on an ocean platform
- 2016: Bigelow's inflatable space room BEAM (Bigelow Expandable Activity Module)



Space Companies Promise Full Inflatable Space Stations in Orbit by 2020

Jamie Condliffe
4/12/16 7:05am · Filed to: SPACE

6.2K 68



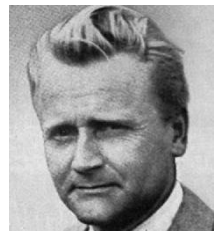
Space

- 2016: Yuri Milner's "Breakthrough Starshot" project to send millions of tiny "spacechips" to Alpha Centauri



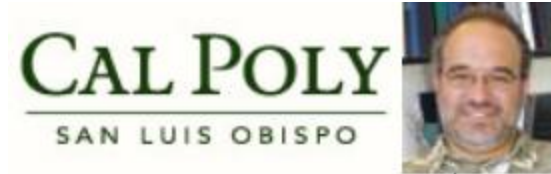
Space

- How to defeat gravity
 - Antimatter gravity (if repulsive)
 - Matter-antimatter annihilation (Eugen Sanger, 1953)
 - Vacuum energy
 - Photonic energy (Philip Lubin)
 - Space elevator (Bradley Edwards, 2003)



Space

- Tiny satellites
 - 1999: CubeSat specs (Jordi Puig-Suari of California's Polytechnic State University and Bob Twiggs of Stanford University)
 - A CubeSat is a small satellite of exactly one cubic liter
 - Rocket Lab (Los Angeles): send small satellites into orbit around the Earth
 - Planet Labs (San Francisco) and Nanosat-1/Spire (San Francisco): affordable satellites



Space

- Tiny satellites
 - Orbital Sciences (Virginia) launched 29 satellites (2013)
 - Kosmotras (Russia) launched 32 satellites (2013)
 - Google Skybox Imaging is planning to launch an army of mini-satellites so that some day we will be able to see any spot on Earth



Hyper-transportation

- The hyperloop

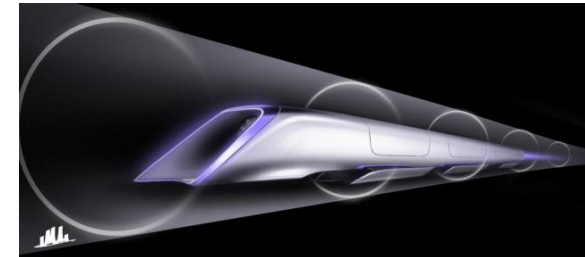


Hyper-transportation

- Elon Musk's white paper (2013): the hyperloop

Hyperloop Preliminary Design Study Technical Section

Elon Musk (2013)



1. Abstract

Existing conventional modes of transportation of people consists of four unique types: rail, road, water, and air. These modes of transport tend to be either relatively slow (e.g. of relatively slow transport that seem inexpensive for people design concept, simulation can help advance the

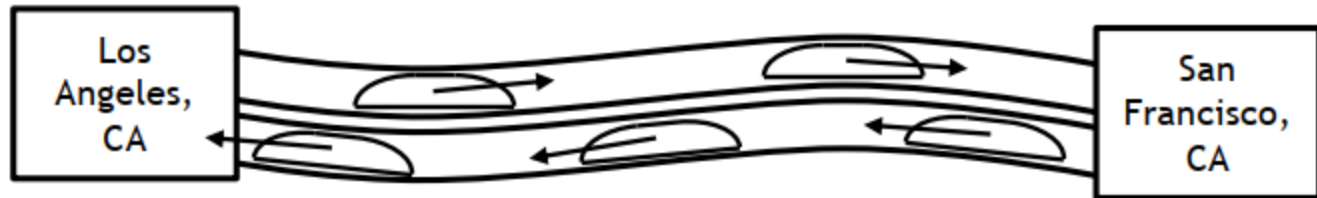


Figure 2. Hyperloop conceptual diagram.

Hyperloop consists of a low pressure tube with capsules both low and high speeds throughout the length of the tube supported on a cushion of air, featuring pressurized air. The capsules are accelerated via a magnetic linear motor at various stations on the low pressure tube with rotors and stators. Passengers may enter and exit Hyperloop at stations located at the ends of the tube, or branches along the tube length.

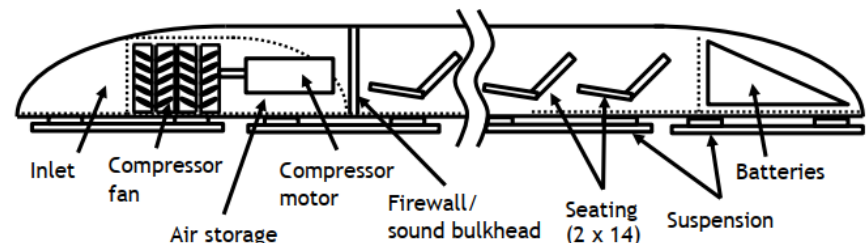


Figure 4. Hyperloop passenger capsule subsystem notional locations (not to scale).

Hyper-transportation

- SpaceX (Elon Musk - Los Angeles)
- Hyperloop Tech/One (Shervin Pishevar - Los Angeles, 2014)
 - Test tube in Nevada (2017)
 - cargo in 2019
 - passengers in 2021



Hyper-transportation

- Hyperloop TT (Dirk Ahlborn - Los Angeles, 2014)

HYPERLOOP
TRANSPORTATION TECHNOLOGIES

Hyperloop Transportation Technologies to Build China's First Hyperloop System

| Jul 19, 2018

HyperloopTT to open Chinese entity and begin work on China's first Hyperloop starting with an initial 10 km commercial agreement at Tongren in Guizhou Province.



Sep 6, 2017



HTT signs agreement to develop a Hyperloop in India

Hyper-transportation

- SpaceX Hyperloop Pod Competition

2019 SpaceX Hyperloop Pod Competition Rules and Requirements

August 23, 2018

VTOL

- VTOLs - Vertical Take Off and Landing vehicles
- EVTOLs - Electric VTOLs
- Mark Moore (NASA): white paper “Personal Air Vehicles” (2003) and concept VTOL (2010)
- Volocopter (Germany, 2011)

AIAA Paper 2003-2646

PERSONAL AIR VEHICLES: A RURAL/ REGIONAL AND INTRA-URBAN ON-DEMAND TRANSPORTATION SYSTEM

Mark D. Moore[†]
NASA Langley Research Center
Hampton, VA 23681-2199



THE VERGE

Nov 2, 2011

Four quadrocopters propel a real live human into aviation history



VTOL

- EVTOLs - Electric VTOLs
 - E-volo's air taxi Volocopter VC200 (Germany)
 - Lilium (Germany): the first electric vertical take-off and landing jet (first test in April 2017)



 LILIUM

The world's first electric vertical take-off and landing jet.



300 km range
Travel from London to Paris in
one hour.



300 km/h speed
Fly as fast as a Formula One
car.



All-electric



On-Demand

VTOI

- EVTOLs - Electric VTOLs
 - Kitty Hawk (California): flying car Flyer (unveiled in 2017) and autonomous flying taxi Cora (unveiled in March 2018)
 - Cora = electric power + self-piloting software + vertical take-off

Bloomberg

June 9, 2016

Hyperdrive

Welcome to Larry Page's Secret Flying-Car Factories

With Zee.Aero and Kitty Hawk, the Google co-founder looks to the skies.



Kitty Hawk Conducts Flying Car Trials in Las Vegas

BUSINESS
INSIDER

Jun. 6, 2018,

The flying car backed by Google's cofounder just got a big update, and people can pilot it with less than an hour's training



VTOL

- EVTOLs - Electric VTOLs
 - A³ (Airbus in Silicon Valley): Vahana (first tested in January 2018)



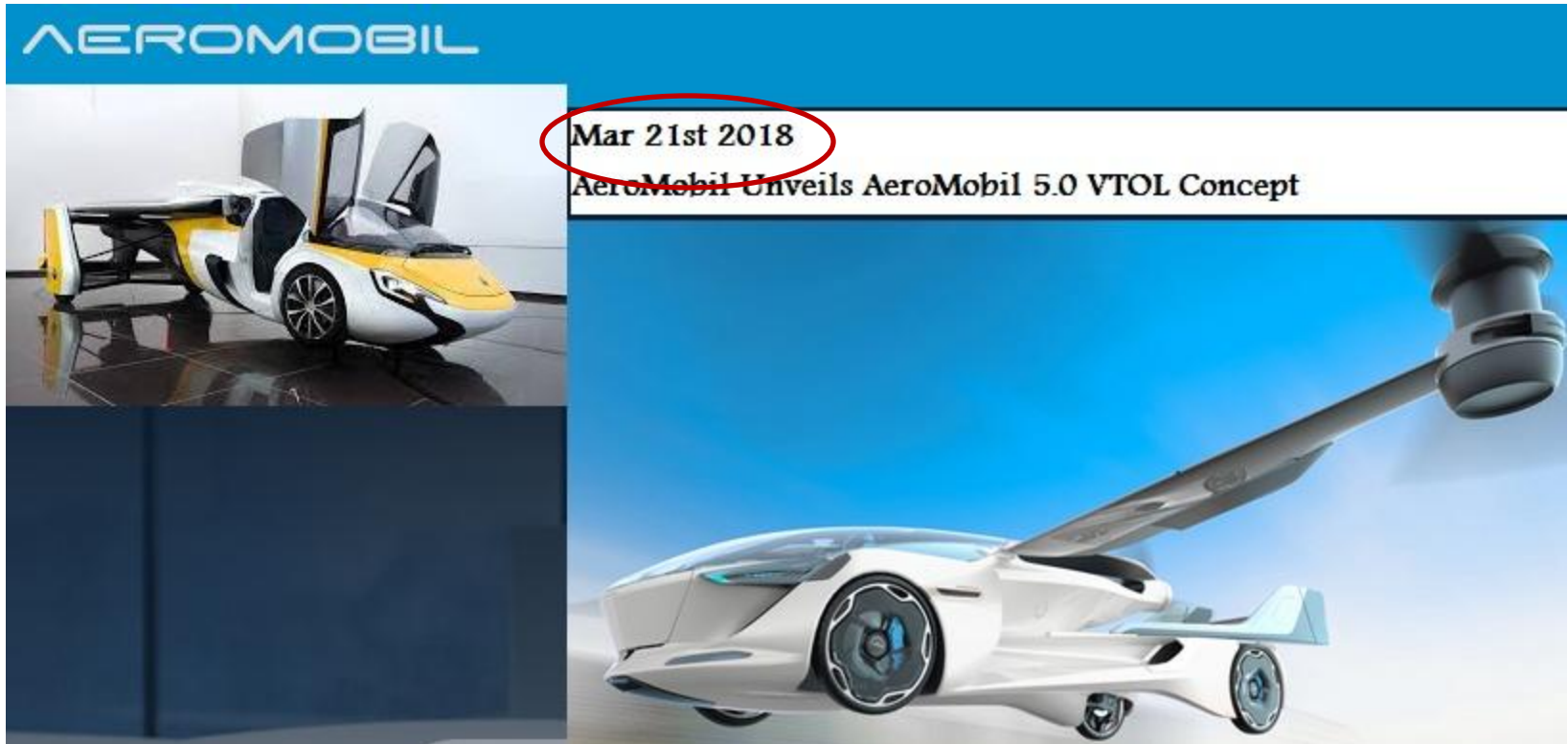
**Vahana, the Self-Piloted,
eVTOL aircraft from A³ by
Airbus, Successfully
Completes First Full-Scale
Test Flight**

January 2018



VTOL

- EVTOLs
 - Aeromobil 5.0 (Slovakia): door-to-door flying-taxi (electric VTOL that can also drive on roads)



VTOL

- VTOLs - Vertical Take Off and Landing vehicles
 - Joby (California): air taxi (\$100m in February



Bloomberg Businessweek

February 1, 2018

Air-Taxi Startup Has a Working Prototype and a Fresh \$100 Million

- Joby Aviation hides its craft at a secretive private airfield.

Flying Car

- Flying cars
 - Terrafugia (Boston, acquired by Zhejiang Geely in 2018)
 - Paul Moller: Skycar (California, never demoed)
 - EHang 184 (China, demoed in 2016)
 - Chris Malloy's Hoverbike (Britain)

SEPTEMBER 02, 2018

With a new Chinese owner, Terrafugia says its flying car is getting closer to takeoff



Flying Car

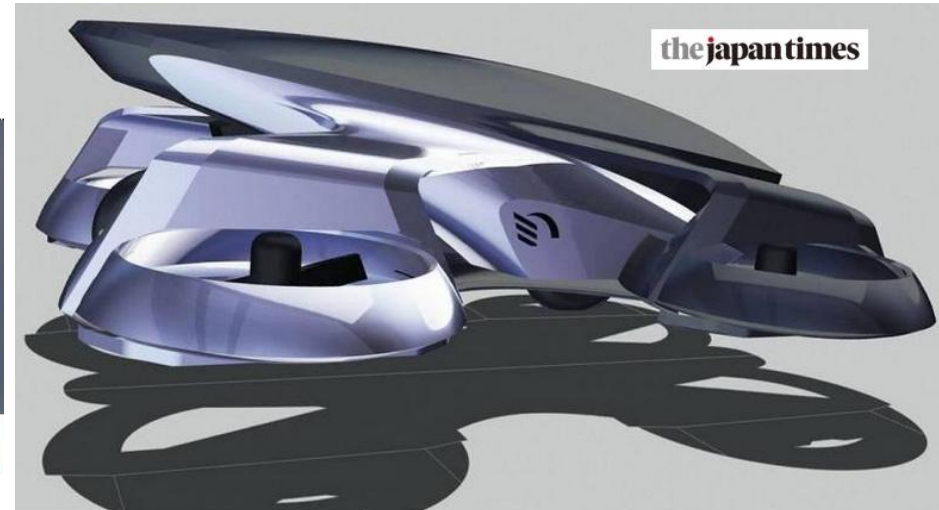
- Flying cars
 - Boeing
 - Japan: Boeing, Airbus, Japan Airlines, NEC , ANA Holdings, Yamato Holdings, Toyota's startup Cartivator, etc

March 1, 2018,

Bloomberg



Boeing Is Getting Ready to Sell Flying Taxis



Flying Car

- Flying cars
 - Uber

Bloomberg

February 6, 2017,

Technology

Uber Hires Veteran NASA Engineer to Develop Flying Cars

The man who inspired Google's co-founder



Uber Is Opening a Flying-Car Lab in Paris

Bloomberg

May 24, 2018,



Uber Elevate Concept Air Taxi Source: Uber

Hyper-transportation

- Flying cars
 - Terrafugia (Boston)
 - Moller's Skycar (UC Davis)
 - China's EHang 184 (2016): a single passenger for 23 minutes at a maximum speed of 100 km/h



Hyper-transportation

- Flying cars
 - E-volo's Volocopter VC200 (Germany)
 - Chris Malloy's Hoverbike (Britain)
 - Google: Zee.Aero and Kitty Hawk



Hyper-transportation

- Flying cars of 2018
 - Google Kitty Hawk
 - Boeing
 - Uber

March 1, 2018,

Bloomberg



Boeing Is Getting Ready to Sell Flying Taxis

Kitty Hawk Conducts Flying Car Trials in Las Vegas

Jul 28, 2018 1:30 PM PT



Uber Is Opening a Flying-Car Lab in Paris

Bloomberg

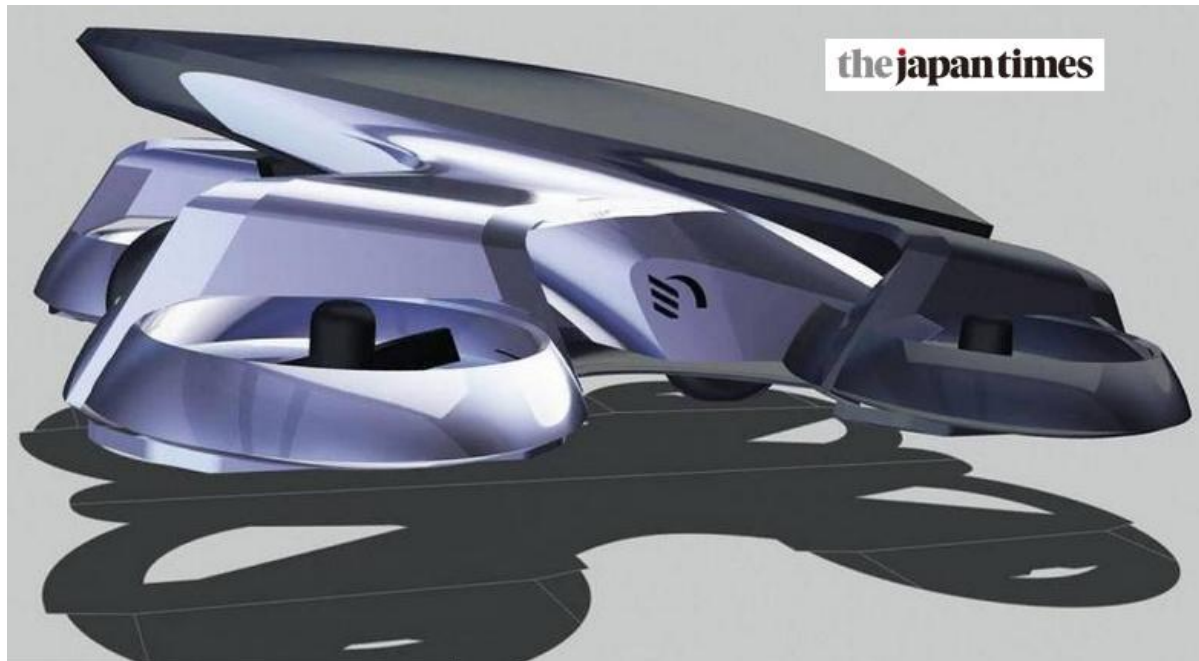
May 24, 2018,



Uber Elevate Concept Air Taxi Source: Uber

Hyper-transportation

- Flying cars of 2018
 - Japan: Boeing, Airbus, Japan Airlines, NEC , ANA Holdings, Yamato Holdings, Toyota's startup Cartivator, etc



Hyper-transportation

- Flying cars of 2019
 - Japan: NEC & Cartivator

Bloomberg

August 5, 2019

Hyperdrive

New Japanese Flying Car Gets Off the Ground, for About a Minute



Hyper-transportation

- Flying cars of 2018
 - Airbus Vahana

Airbus' autonomous 'air taxi' Vahana completes its first test flight

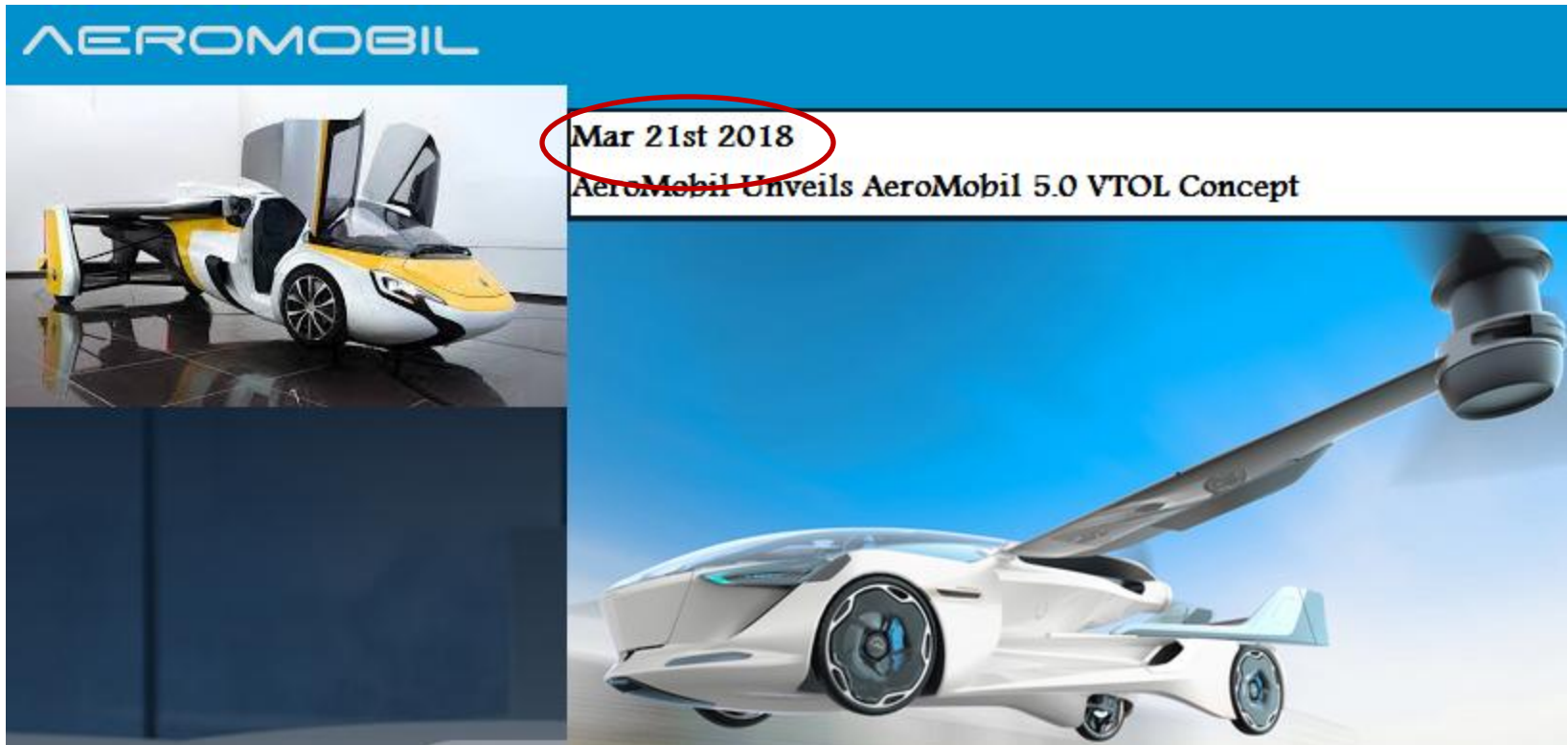
Fifty-three seconds of glory

By [Andrew J. Hawkins](#) | [@andyjayhawk](#) | Feb 1, 2018, 5:01pm EST



Hyper-transportation

- Flying cars of 2018
 - Aeromobil 5.0: door-to-door flying-taxi (electric VTOL that can also drive on roads)



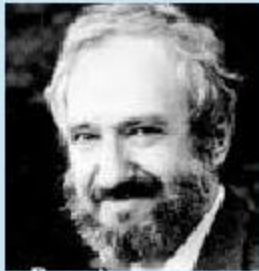
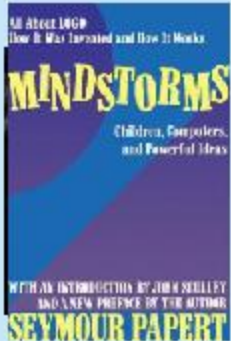
Drones

- Unmanned Combat Aerial Vehicles



Drones

- From Mindstorms to DIYDrones





Drones



- Open Source
 - Paparazzi (ENAC, 2003)
 - DIYDrones (Berkeley, 2007)
 - PX4 (ETH, 2009)
 - Dronecode (Linux Foundation, 2014)

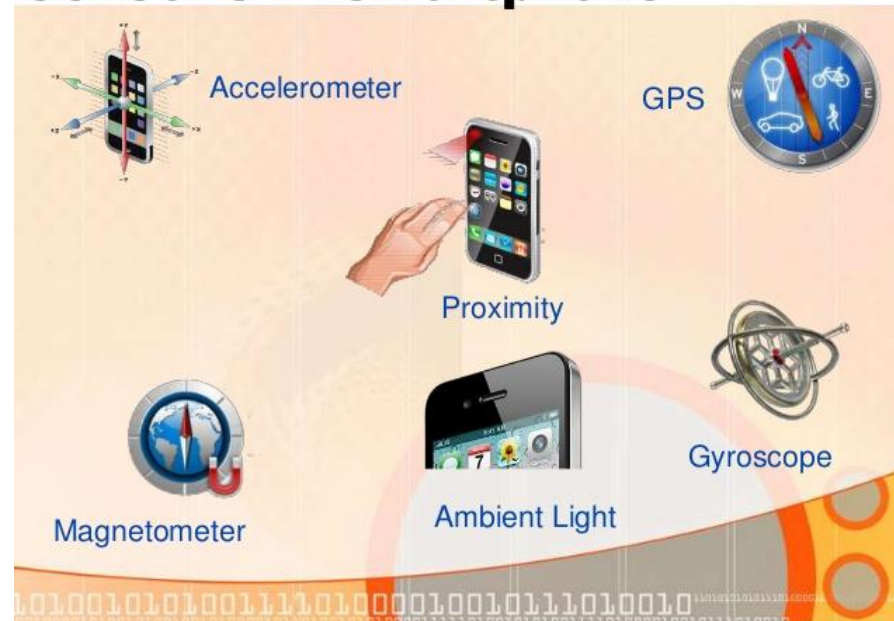


Drones

- The boom of the 2010s
 - Thank the smartphone industry
 - A drone is a flying robot if you think of its function, but it looks more like a flying smartphone if you open it and look at its components.
 - The components are the same: embedded processors, sensors (gyroscopes, magnetometers, accelerometers), GPS chips, wireless communications, memory chips, cameras and batteries.



Sensor's in Smartphone



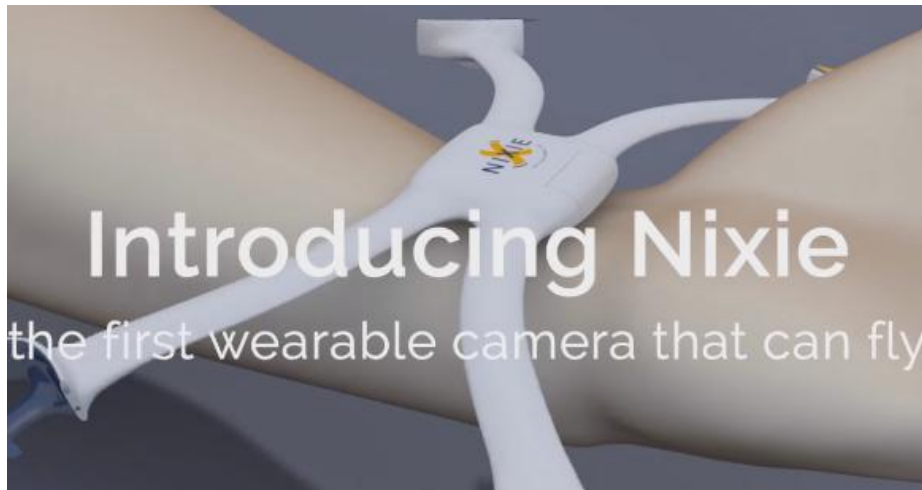
Drones

- Hobbyist market
 - Hoverfly
 - DJI Innovations
 - MikroKopter
 - 3D Robotics



Drones

- Camera drones
 - DJI Phantom (China)
 - Parrot AR Drone (France)
- Nixie, a wrist-worn camera drone



Drones

- Drone for industrial inspection (Flyability, Switzerland)
- Drone without sensors (Gimball): small ultralight insect-like flying spheroid (EPFL, Switzerland)
- Self-assembly drone (ETH, Switzerland): Distribution Flight Array



Drones

- Airware (San Francisco): operating system for drones
- Tensegrity (UC Berkeley & NASA)



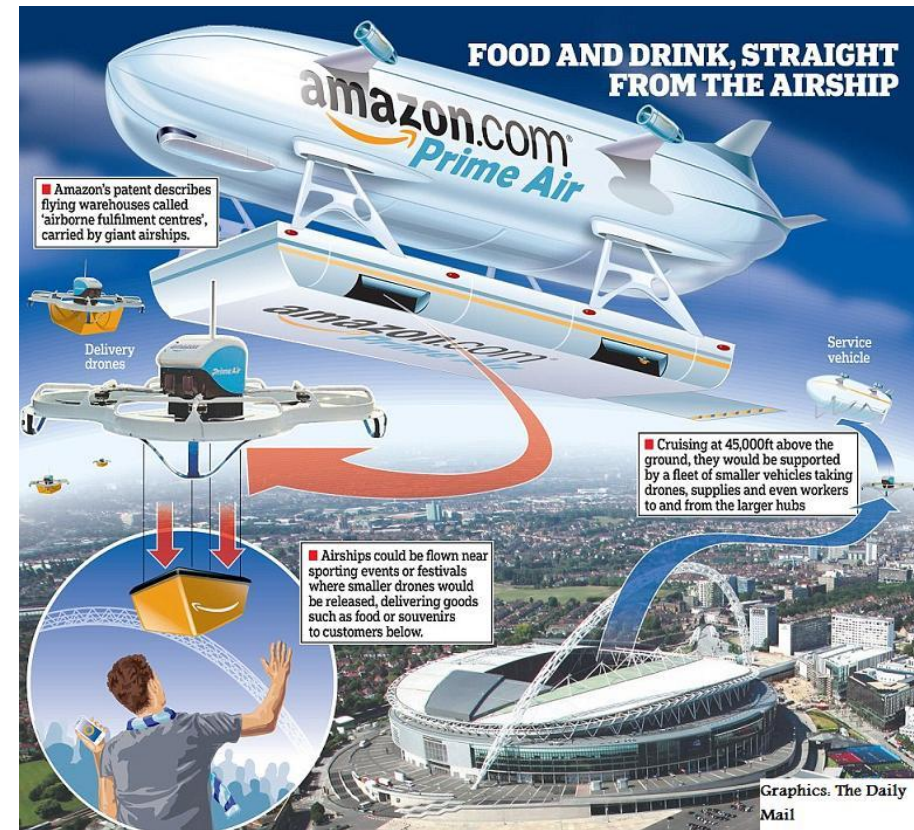
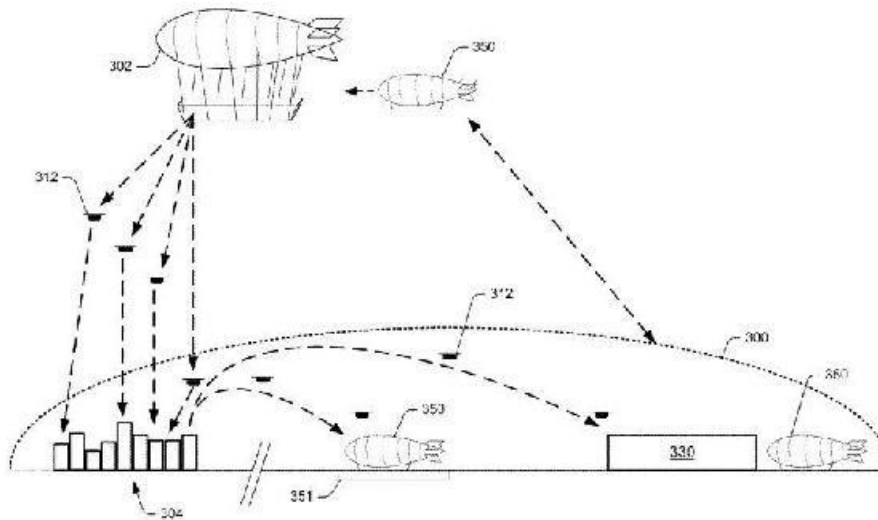
Drones

- Delivery drones



Drones

Amazon wins patent for a flying warehouse that will deploy drones to deliver parcels in minutes



Drones

- Mothership, Walmart



Bloomberg
Technology

August 18, 2017, 10:56 AM PDT

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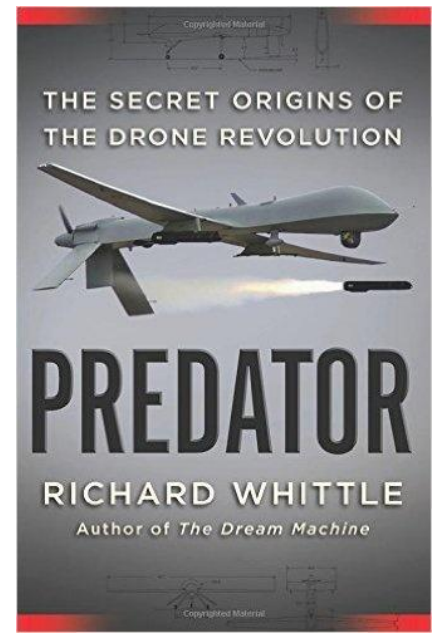
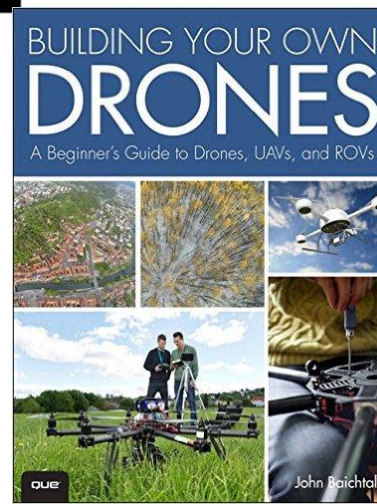
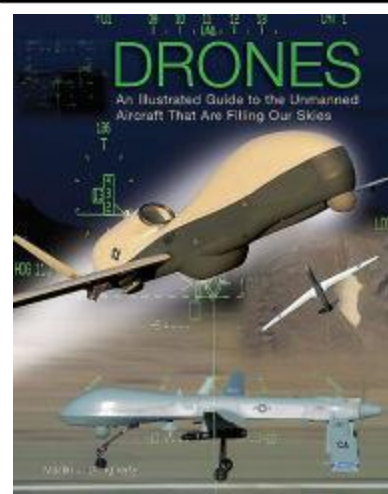
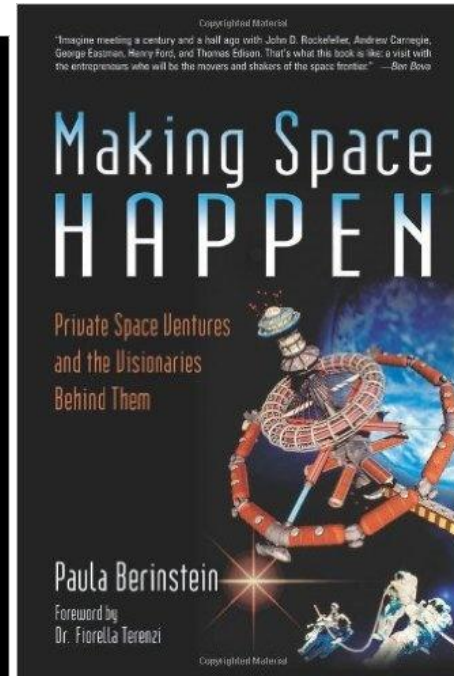
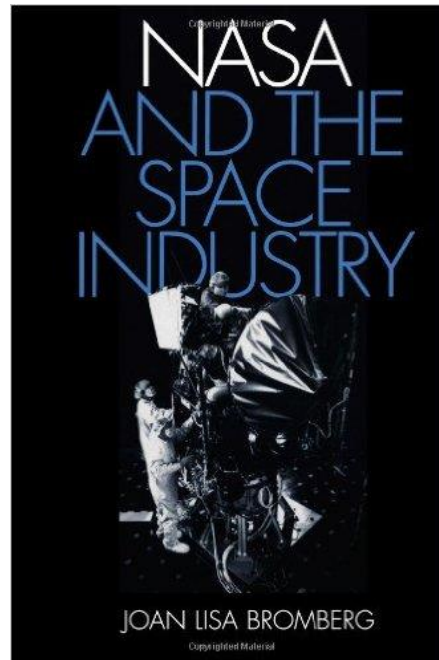
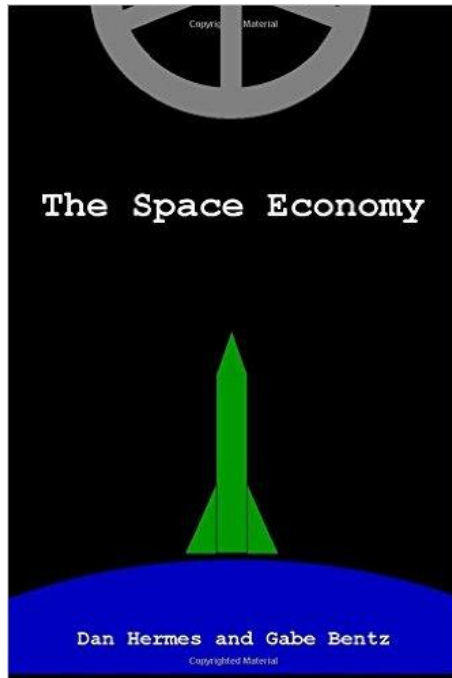
Wal-Mart Applies for Patent
for Blimp-Style Floating
Warehouse

Art



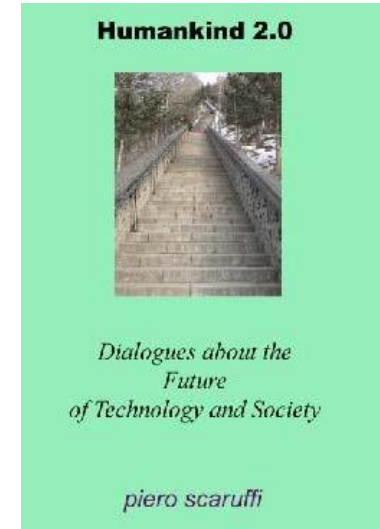
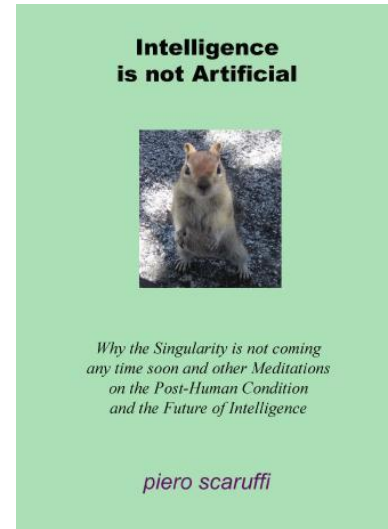
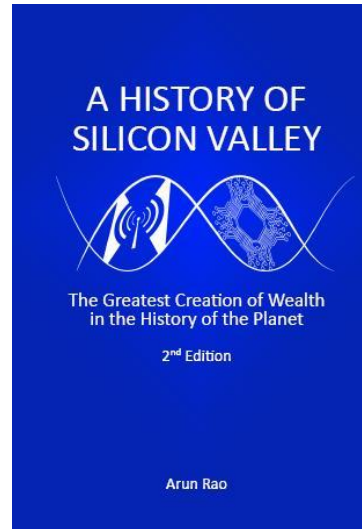
Heather Layton and Brian Bailey

Bibliography



Contact

- www.scaruffi.com



See <http://www.scaruffi.com/singular/human20.html>
for the full text of this discussion