Historical Milestones Enabling Driverless Vehicles

A Survey of Historical Innovation Milestones Driving Next-Generation Transportation and their Accelerating Pace of Occurrence

Intraduce

Autonomous Vehicle Symbol

News

- 70m iPads Sold, 3rd Gen iPads Introduced
- Google Driverless Car Licensed in Nevada
- 25b iPhone Apps Dl'd, 500k iPhone Apps Created, 220m iPhones Sold
- Apple CEO Steve Jobs Dies
- zipcar Initial Public Offering
- 20b iTunes Songs Dl'd, 250m iPods Sold
- SPRIDE, Getaround, RelayRides, mint — Venture Capital Investment in Peer-to-Peer Car-Sharing
- 500m iPhone Apps Dl'd, 10k iPhone Apps Created, 10m iPhones Sold, 10b iTunes Songs Dl'd, 150m iPods Sold
- >2b Computers!
- zimride
- 5b iTunes Songs Dl'd, 65m iPods Sold
- iROBOT
- >1b Computers!
- MINORITY REPORT
- >200m Internet Users
- >100m Internet Users
- OnStar
- 4m Internet Users
- DEMOLITION MAN
- TOTAL RECALL
- Batman
- Macintosh
- KNIGHT RIDER
- MADD
- Star Wars
- EXXON, Microsoft, Amtrak, intel, HYUNDAI
- The Love Bug
- 2001: A Space Odyssey

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- TATA MOTORS, NISSAN, CHRYSLER, VOLVO, GMAC, TRB, Mobil, GM, IBM, Ford, FIAT, BOSCH, Continental
- The term, *Robotics*, and the future robotics industry are defined and outlined.
- DRIVE-IN Movies
- The term *Robot* is coined
- Oil Price Plummets
- Hildebrand-Wolfmueller Motorcycle
- Penny-Farthing Bicycle
- Transcontinental Railroad Completed
- Col J.Stevens Predicts 100Mph Railways
- Middleton Railway in Leeds, UK
- First Steam Engine Arrives in America

Mobility

Efficiency

- Trexa Enertube EV Chassis
- Trexa Modular EV
- Tesla EV Roadster
- GM Hy-wire AUTOnomy
- Natural Gas Powered
- Zero Emission
- CVT Introduced
- Catalytic Converter
- Turbocharger
- 12v Auto Electrical
- 4x4 4-Wheel Drive
- A/C
- Super-charger
- Spark Plug
- Limited Access Highway
- Internal Combustion Engine
- 2-Cylinder Engine
- Steam Engine

Accessibility & Convenience

- On P2P Rental Support
- Augmented Reality Car Windows
- GM EN-V
- Google Driverless Car
- CITY CAR SHARE.org
- GM PUMA
- Automatic Parking
- SEGWAY
- zipcar
- Push-Button Ignition
- Remote Assist
- GPS Vehicle Navigation
- Adaptive Cruise Control
- Remote Keyless Entry
- Keyless Entry
- Remote Garage Door
- Power Steering
- Power Windows
- Auto Trans
- Car Radio
- Front-Wheel Drive
- Antifreeze
- Electric Starter Motor
- Steering Wheel
- Automobile Invented
- Draisienne Velocipede Bicycle
- Wire-Cable Suspension Bridge
- Passenger Locomotive

Safety

- Pedestrian Detection
- Automatic Braking
- Night Vision
- AI Seatbelts
- Lane Departure Warning
- Hybrid Electric
- Curtain Airbags
- Daytime Headlamps
- Electronic Stability Control
- Side Airbags
- Traction Control
- Heads-Up Display
- Seatbelt Tensioner
- Airbags
- Ignition Interlock
- Antilock Brakes
- Seatbelt Interlock
- Head Restraints
- Side-Impact Guard Beam
- Radial Tires
- All-Wheel Disc Brakes
- Turn Signals
- Windshield Wipers
- Safety Glass
- Speedometer
- Shock Absorber

Technology

Supporting Innovations

- Digital Camera
- Pocket Calculator
- OOP
- CCD
- VCR
- CAD
- LED
- Kalman Filter
- Laser
- Hard Drive
- Artificial Intelligence
- Transistor
- Color TV
- Broadcast Television
- RADAR
- Broadcast Radio
- Public Phone
- Electric Lightbulb
- Tele-phone
- Phonograph
- Microphone
- Typewriter
- Electric Motor
- Mechanical Adding Machine
- Dynamite
- Nature of Magnetism
- Portland Cement
- Telegraph
- Photography
- Battery
- Nature of Electricity
- Glass Mirrors
- Universal Joint
- Leaded Glass
- Slide Rule
- Calculus $\int_a^b f(x)dx$
- 3 Laws of Motion $F=ma$
- Universal Gravitation $F=G\frac{m_1m_2}{r^2}$
- Logarithm $\log_b(x)$
- Cartesian Coordinate System

Communication & Automation

- Google Glass
- Light-field Camera
- KINECT, XBOX 360
- iPad
- Bionic Contact Lens
- Retinal Implants
- Augmented Reality
- iPhone
- Bendable Concrete
- YouTube
- Facebook
- SIRIUS SATELLITE RADIO
- iPod
- Google
- Smart Phone
- iRobot
- CISCO
- Cellular Phone
- Personal Computer
- Microprocessor
- Relational Database
- Robotics
- Computer Vision
- Touchtone
- Integrated Circuit
- Computer Modem
- Atomic Clock
- Broadcast Radio
- Interchangeable Parts
- Complex Automata
- Gutenberg Printing Press
- Pocket Watch
- Perspective Drawing
- Mechanical Clock
- Sheet Glass
- Belt / Chain Drive
- Moveable Type
- Cast Window Glass
- Differential Gear System
- Postal System
- Greek Alphabet
- Structural Arch
- Abacus
- Oxen Domesticated
- Writing
- Money

Open Standards

- open hardware
- ROS.org Robot Operating System
- creative commons
- open source, OpenCV, WiFi 802.11b
- 6σ Six Sigma Adoption
- Java
- MOSAIC Graphical Browser
- GPS Global Positioning System
- World Wide Web
- Linux
- GNU License
- BSD License
- Domain Name System
- TCP/IP Internet Protocol Suite Std.
- IBM ISA: Industry Standard Architecture
- Ethernet
- Email
- Arpanet The Internet
- LEAN Lean Mfg

Society

- NEVADA MI-L8 — Nevada Licenses Robot Drivers
- Nevada Legalizes Robot Drivers
- AZ, CA, FL, HA & OK Debate Robot Driver Licences
- AB-1871 — California Passes Car-Sharing Law
- Tire Pressure Sensors Regulated
- DARPA Urban Challenge
- DARPA Grand Challenge II
- DARPA Grand Challenge I
- DARPA Grand Challenge Funded & Announced
- US DOD Funded Demos
- NAHSC PATH Demo '97
- Dual Airbags Regulated
- National Seatbelt Mandate
- HOT High-Occupancy Toll Lanes
- SRS Passive Restraints Regulated
- EZ Pass Open-Road Tolling
- Center High-Mounted Stop Lamp Regulated
- Rear Passenger Seatbelts Regulated
- Side-Impact Protection Regulated
- 5 MPH Bumpers
- Child Seats Regulated
- HOV LANE High-Occupancy Vehicle Lanes
- fars Fatality Analysis Reporting
- Seatbelt Regulated
- Environmental Protection Agency
- U.S. Dept of Trans
- National Transportation Safety Board
- Head Restraints Mandated
- FHWA Federal Highway Administration
- Auto Emissions Regulated
- SALE Auto Sticker-Price Standard Regulated
- Interstate Highway System Funded
- Brake-Fluid Regulated
- Air Pollution Regulated
- Drivers Ed Regulated
- DRIVE THRU Drive Thru Services Regulated
- Macroeconomics
- Car-Rental Available Nationally
- Motels Service Begins
- 87 Octane Regulated
- Auto Insurance Mandated
- Parking Meters
- Federal Radio Commission
- Fed. Comm. Commission
- SPEED LIMIT 5 Vehicle Speeds Regulated
- Drunk Driving Laws
- Driver Licensing
- Crash Testing
- STOP Stop Signs Regulated
- Traffic Signal
- US Rail Gauge Standardized
- Microeconomic Theory
- Gregorian Calendar
- Copyright Protection Begins
- Bank Notes
- VOTE Athenian Democracy
- Minted Coin Currency
- Iron Age
- Bronze Age
- Stone Age

Log Scale — e^x log-based timescale — AIM Autonomy Innovation Metric

Era	Year	AIM
Digital Era	2013 AD	29.0
	2012 AD e^{0} – 1	9.0
	2009 AD e^{1} – 3 years prior	8.5
	2005 AD e^{2} – 7 years prior	6.5
	2000 AD $e^{2.5}$ – 12 years prior	3.6
	1992 AD e^{3} – 20 years prior	3.6
	1979 AD $e^{3.5}$ – 32 years prior	1.8
	1957 AD e^{4} – 54 years prior	1.8
Print Era	1921 AD $e^{4.5}$ – 90 years prior	1.5
	1860 AD e^{5} – 150 years prior	0.6
	1760 AD $e^{5.5}$ – 250 years prior	0.9
	1600 AD e^{6} – 400 years prior	0.9
Pre-Print Era	1000 AD e^{7} – 1000 years prior	0.02
	0 AD/BC	
	1000 BC e^{8} – 3000 years prior	0.01
	6000 BC e^{9} – 8000	0.003

Linear Scale | Log Scale

Newsworthy & Media Events, Product Announcements & Corporate Activities | **Critical-Path Invention & Development Milestones in Mobility** | **Key Technology Discoveries & Innovation Milestones** | **Landmark and Democracy Driven Societal Milestones**

A partially modified log-scale (above & right) uses the logarithmic base **e**, also known as the natural log. The timeline along this scale, reveals a sweeping span with a broad perspective of historical innovation, all within a highly compact area.

All milestone events are mapped to the ***Log Scale***, shown on the right-side of the left column, and on the far right side of the page. A reference ***Linear Scale***, (far left) shows the full 8000 year timespan with convential linear (even) spacing. This reference helps expose the long-term and accelerating pace of innovation.

- The earliest timeline period, or ***pre-print era***, spans 7600 years (6000 BC to 1600 AD.) This is ~***95%*** of the total span, & yet yields merely ***15%*** of the milestones.
- The ***print era*** is the middle period, spanning 1600 AD -1956 AD. It begins after the ***Gutenberg Press*** & continues until the ***Integrated Circuit*** & Computer Modem are introduced. This period accounts for more than ***one-third*** of innovation milestones, yet requires less than ***5%*** of the 8000 year timespan to be developed.
- The current period is the ***digital era***, which begins in 1956. ~***50%*** of all innovation, across 8000 years, occurs in this short period. In total, these 56 most recent years comprise less than ***1%*** of the total 8000 year timeframe. People in the U.S. will live 33% longer than the time taken to manifest these milestones.

Autonomy Innovation Metric:

$$\frac{\text{(\# of Events / Period)}}{\text{(\# of Years in the Period)}}$$

The selection of events is qualitative, and therefore somewhat arbitrary. When the occurrence of these events is mapped over time, however, a relatively steady, geometric growth of this metric is shown to exist.

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