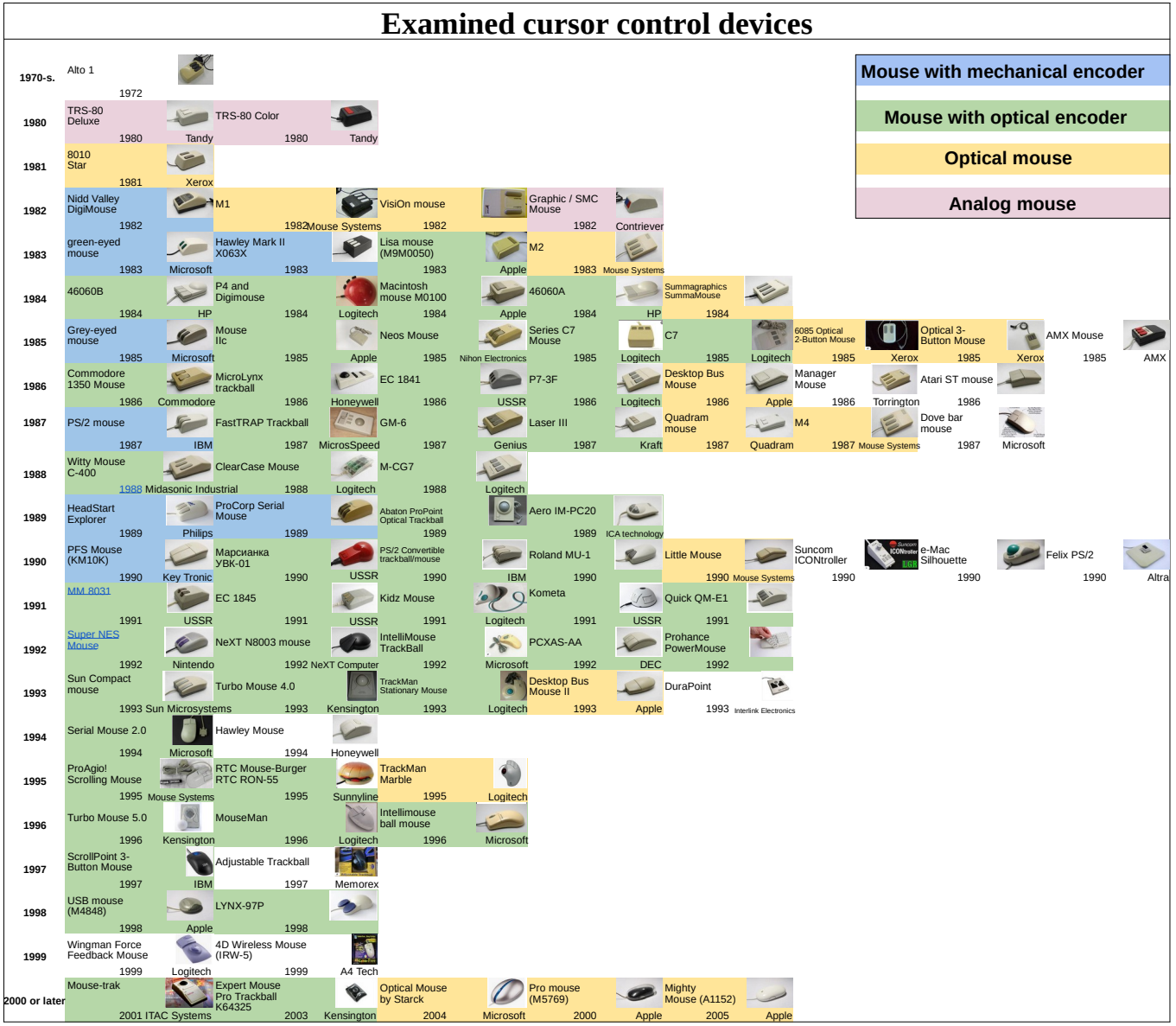
Keeping a hand on the evolution of cursor controls:

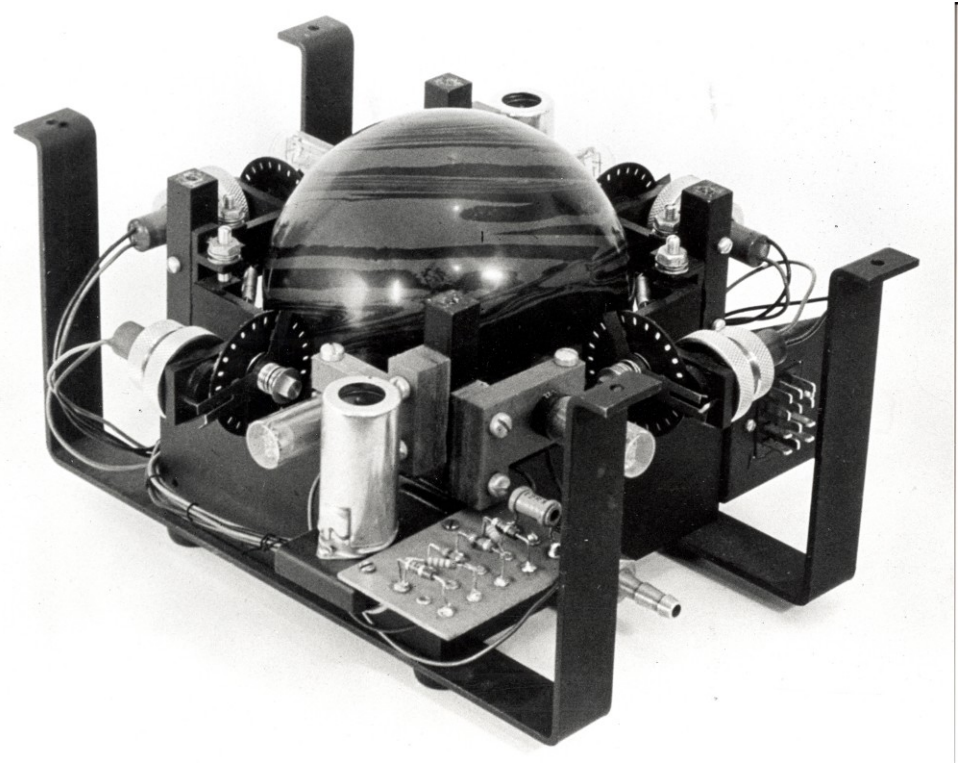
trendsetting mice of the past and what to do if you get one today



- Analysis of mice and trackballs for the period from 1970 to 2000, shown in the table on the left, allowed us to
  - draw conclusions about the evolution of the design features of cursor controls
  - highlight key devices that marked turning points in their development

1952 - trackball appearance

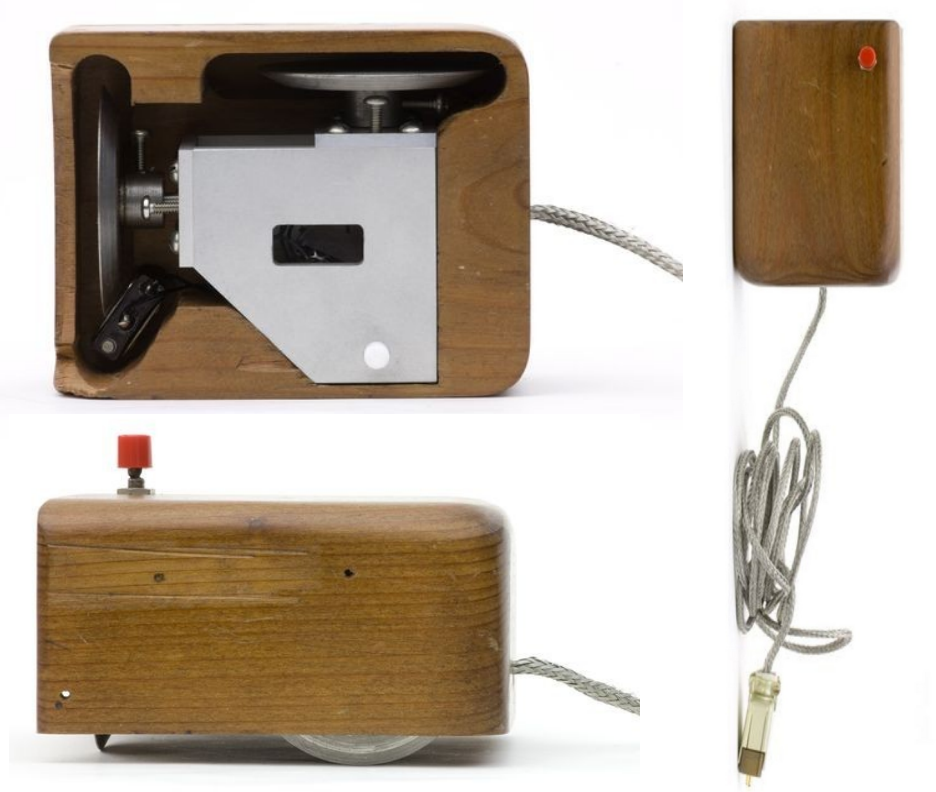
- Trackball prototype invented in 1952
- The trackball was used to interface with the Naval Tactical DATAR system developed for the Royal Canadian Navy



1966 - Douglas Engelbart's mouse

- Douglas Engelbart proposed the design of a computer mouse with wheels in 1963
- The author of the first prototype is engineer Bill English
  - It had sharp edged wheels and one button
  - When the mouse moves along one of the coordinate axes, one of the wheels rotates, transmitting changes in coordinates, while the other slides without moving
  - It is an “analog mouse”: wheels are connected to potentiometers, so coordinates are encoded by 2 analog signals

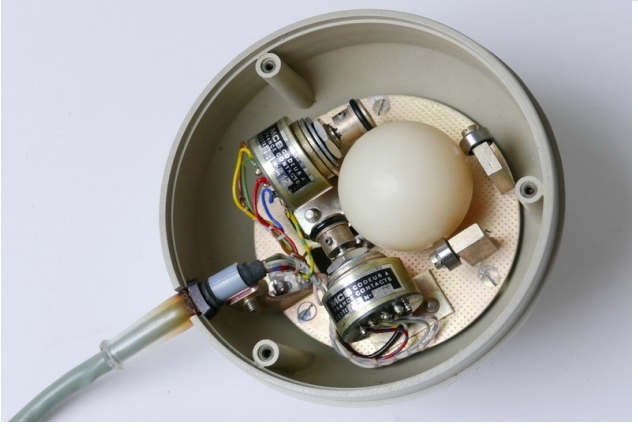
We'll see later how to **connect this mouse to USB**, if you have one – but, chances to have it are low :-)



A late replica of Engelbart's mouse on display at the California Computer History Museum

1966 - Telefunken Rollkugel

- In 1966, Telefunken engineers “inverted” the trackball
- Used a ball rolling on the table
  - actually, a ping-pong sized ball :)
- The ball's movements were tracked using two friction wheels
  - It produced 4-bit Gray code for each axis
- This is how the ball mouse was invented

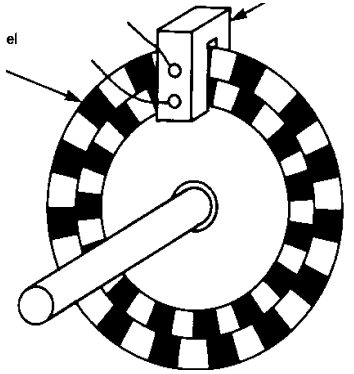


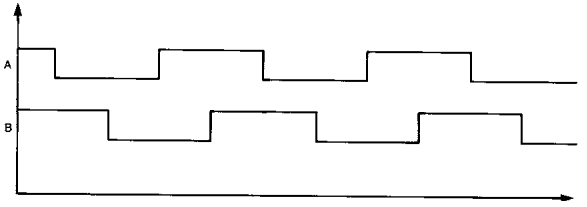
A working example from the collection of Jürgen Müller

There is even a USB converter based on ATtiny micro-controller with schematics and source code: e-basteln.de/computing/rollkugel/rollkugel

Quadrature mouse interface

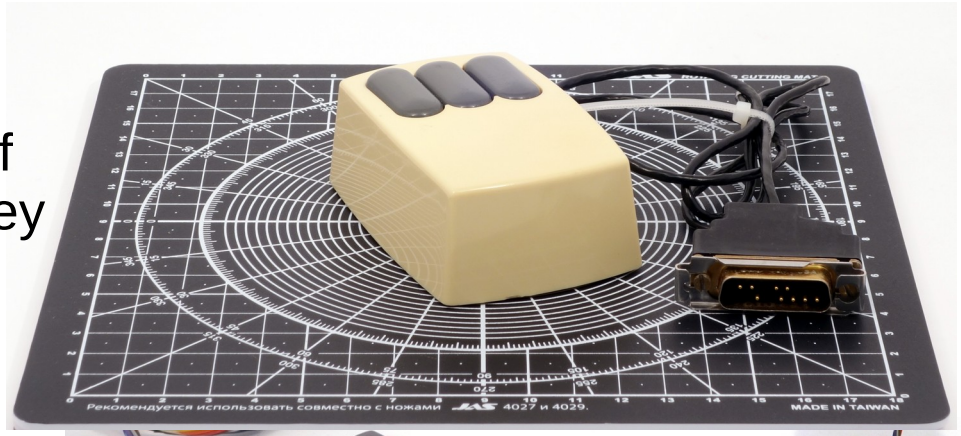
- An electrical contact is closed on the disk segments and a series of voltage pulses appears at the output
- The second contact is shifted relative to the first one by one quarter of the period, and we have a quadrature output
- As a result, the quadrature signal of each coordinate is transmitted by two values A and B
  - In total, the quadrature mouse connection interface uses ground and power lines, 4 lines for transmitting movement (X_A, X_B, Y_A, Y_B) and one line for each mouse button



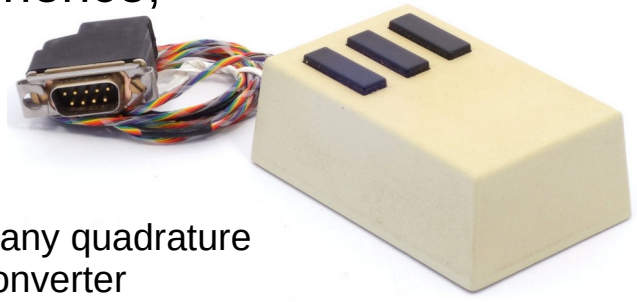


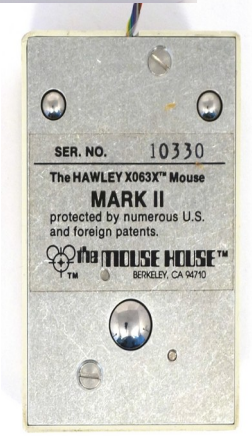
1973 - Xerox Alto mouse

- The first commercially available mouse, released in 1973 with the participation of 2 engineers: Bill English and Jack Hawley
- Jack Hawley's company continued to produce this mouse in several modifications almost until the mid-80s
- The user experience, by the way, wasn't very good :)



Hawley Mark II:

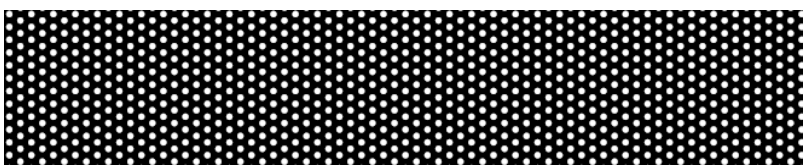




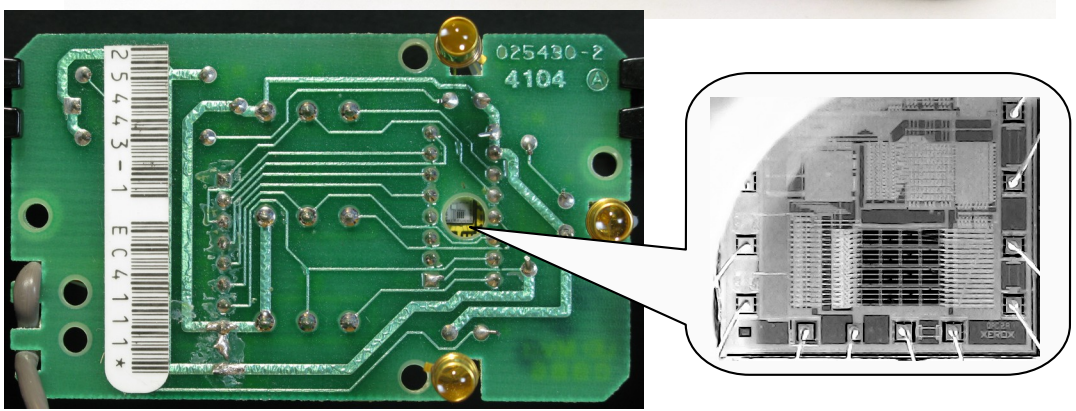
- These mice work with any quadrature Arduino-based USB converter
- We recommend one for Amiga: github.com/BleuLlama/AmigaInputToUSB License MIT
- You need a coupling connector (bitsavers.org/pdf/xerox/mouse/lyon_optical/Lyon_Mouse_Notes.txt for Alto in our case, https://www.microsoft.com/buxtoncollection/a/pdf/Mouse%20House%20MK%20II%20Brochure.pdf for Hawley Mark II)

1981 – Xerox Star mouse

- The first optical mouse in the more or less modern sense is a mouse for Xerox Star computers
- This mouse had an optical matrix and required a mouse pad with alternating black and white spots
  - The pattern looks like this:



  - Actually, any grained pattern was OK, even fabric

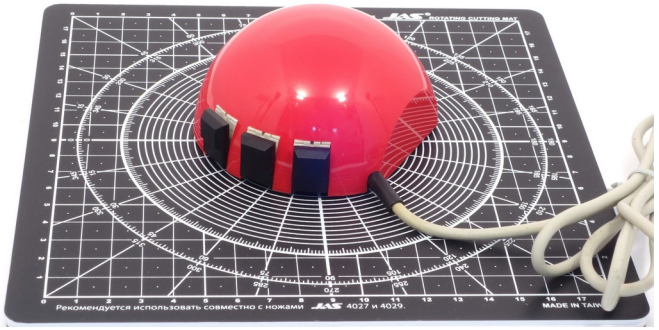


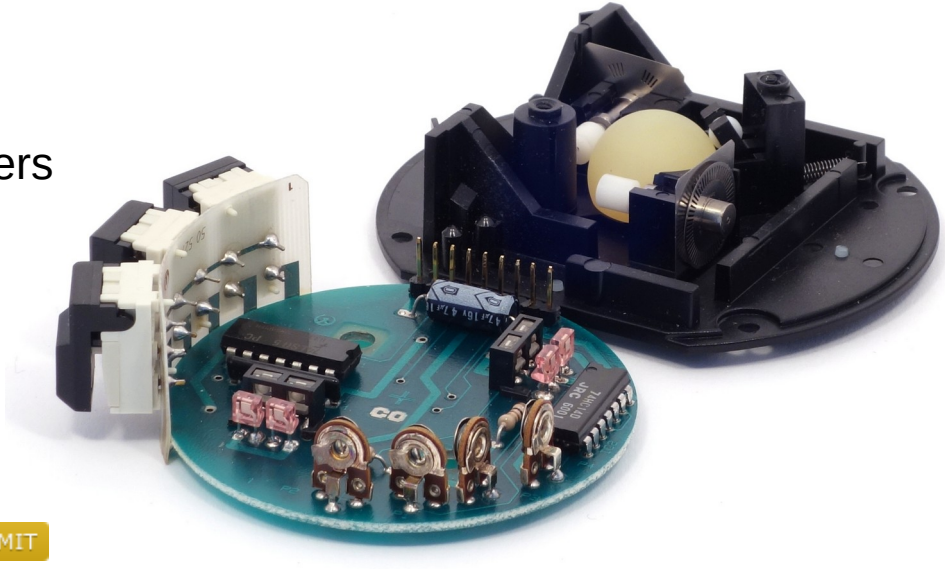
Coupling connector (for the later models like this one) is the most difficult part; aside of this it's a plain quadrature mouse

1982 – Depraz/Logitech P4 mouse

- The Swiss watch manufacturer Depraz had industrialized the mouse design from Swiss Federal Technology Institute of Lausanne, which combined the advantages of optical and mechanical mice through an optical encoder
  - it is cheaper
  - no special mouse pad required
  - no unreliable mechanical contact in the encoders
  - higher resolution is easier to achieve
- It was the first serial mouse (RS-232), but also had quadrature version...
  - ...which now has a dedicated converter:

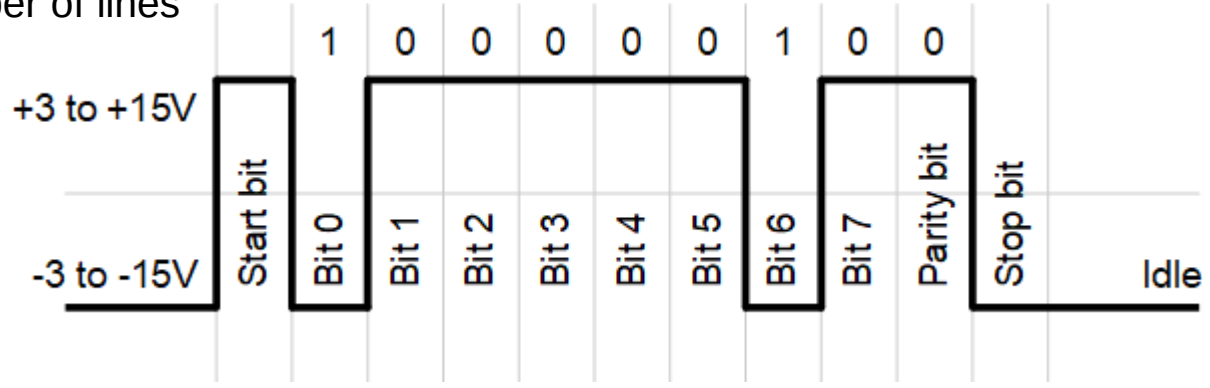
https://github.com/floren/depraz-arduino License MIT





Serial interface

- Following Depraz, Mouse Systems and Microsoft almost simultaneously developed their own versions of the protocol for connecting a serial mouse to an IBM PC
  - This allows the existing IBM PC RS-232 port to be used instead of a separate adapter that would accept the quadrature signal
- In 1986, low-power LEDs appeared, but before that, serial mice needed an additional power source
  - RS-232 has signal lines only, and you can't get much power from them
  - sometimes it's a separate power supply, sometimes it's a cut-in into the keyboard cable
  - some companies had developed a special RS-232-based bus with an additional power supply circuit for their computer architectures (SUN, DEC)
- Changes in coordinates and button presses are encoded by a sequence of pulses, which allows to reduce the number of lines



1982 – Mouse Systems M1

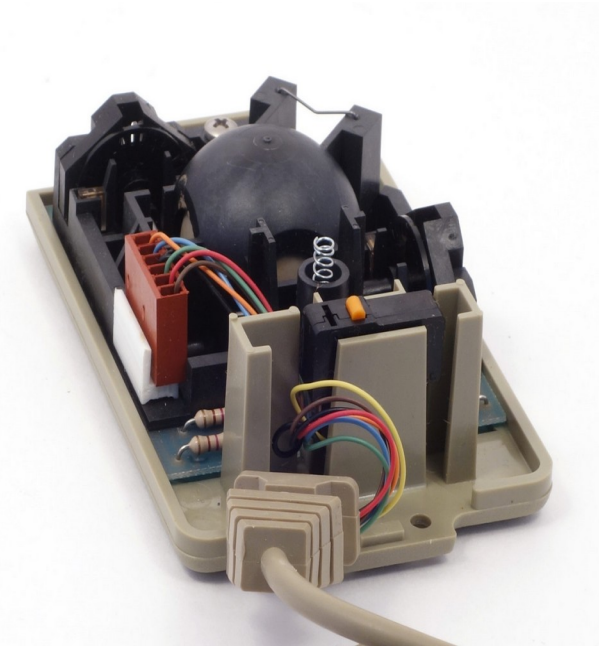
- Mouse Systems' first optical mouse set the optical mouse standard for a decade
  - From 1982 (model M1) to 1988 (model M4) the mouse remained almost unchanged

- It uses a cheaper design than Xerox and modern mice, invented by a student (Steve Kirsch)
  - A special reflective mouse pad and phototransistors are used instead of an optical matrix

Use USB–RS232 dongle and `inputattach --mousesystems /dev/ttyUSB0` in Linux

1983 – Apple Lisa mouse

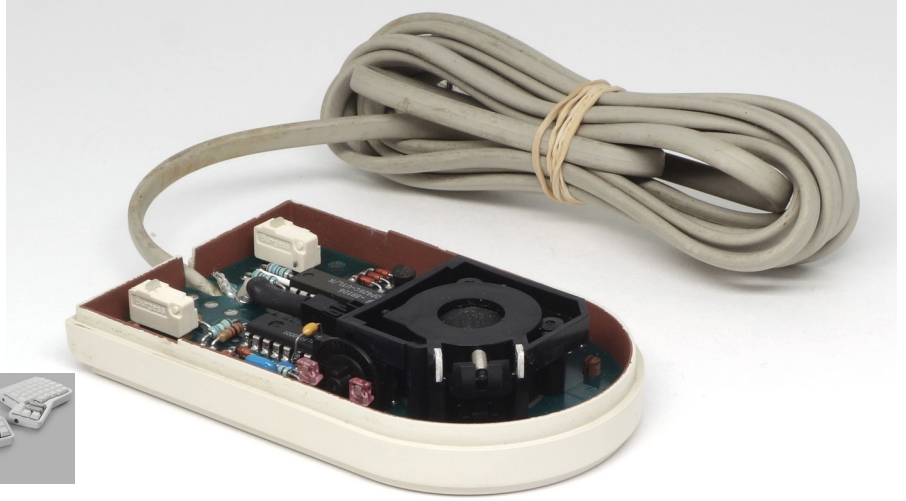
- The 1st computer mouse known to the wide audience
- Probably the 1st mouse with a rubber-coated metal ball
- Has typical optical encoder (nothing new)
- Works with any quadrature mouse converter and 9-pin D-SUB connector
  - we still prefer one for Amigas and Arduino
  - or you can use a dedicated Apple Mouse firmware and adapter from retronicdesign.com:



https://github.com/retronicdesign/USBJoystickAdapter_v3.3 License GPLv3

1984 – HP 46060A and HIL bus

- This mouse became Logitech's first major contract
- The mouse was developed for Hewlett-Packard, for HP 9000 workstations
  - All human interaction peripherals of these workstations were connected to the HIL bus
  - probably the earliest USB predecessor
- The bus had a frequency of 8 MHz and connected up to 7 devices in a daisy chain
  - keyboards, mice, trackballs, digitizers, tablets, barcode readers, rotary knobs, touch screens, etc.



HP HIL mice are supported (surprise!) by TMK and QMK firmware (an open source firmware for a variety of open keyboards like ErgoDox EZ) :)

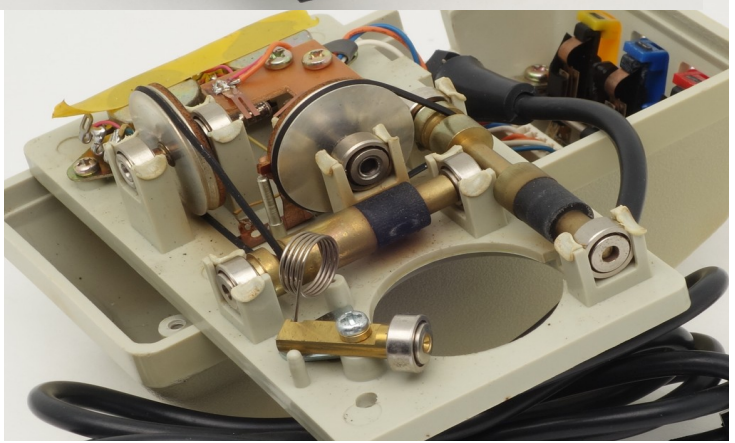
Find converter at https://github.com/tmk/tmk_keyboard/tree/hphil/converter/hphil_usb

1984 – mice imitating a joystick

- In 1984 the original Engelbart's approach to use potentiometers had a new birth
- The mouse is an imitation of an analog joystick
  - It has limited “range” of the mouse in each direction
  - still, it’s cheap and found use in home computers that only had a game port
- A number of projects allows using Arduino or similar platform’s ADC to behave as USB HID joystick or mouse:
  - e.g. github.com/option8/RetroConnector/tree/master/Joystick-Shield ...
  - ...or docs.arduino.cc/built-in-examples/usb/JoystickMouseControl/

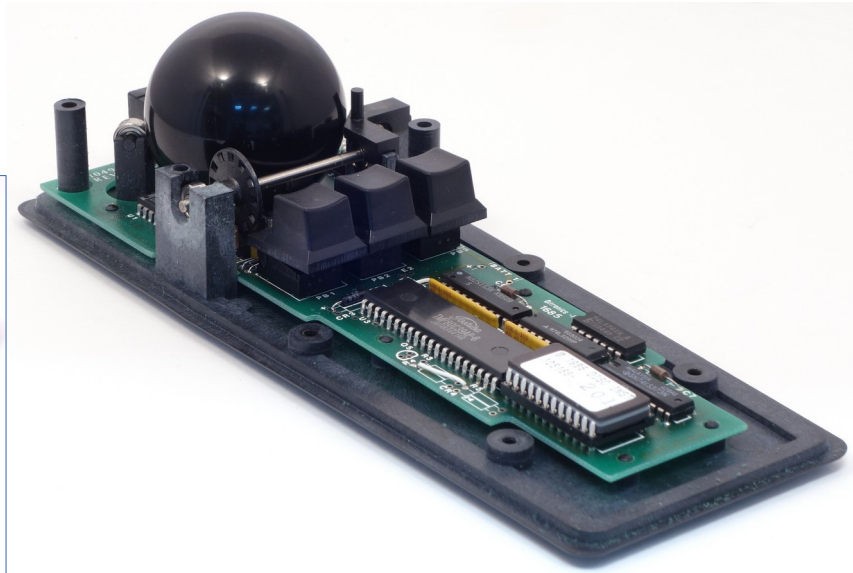
SMC Mouse for Commodore computers (1985)

Color Mouse
for TANDY TRS-80
home computers (1984)



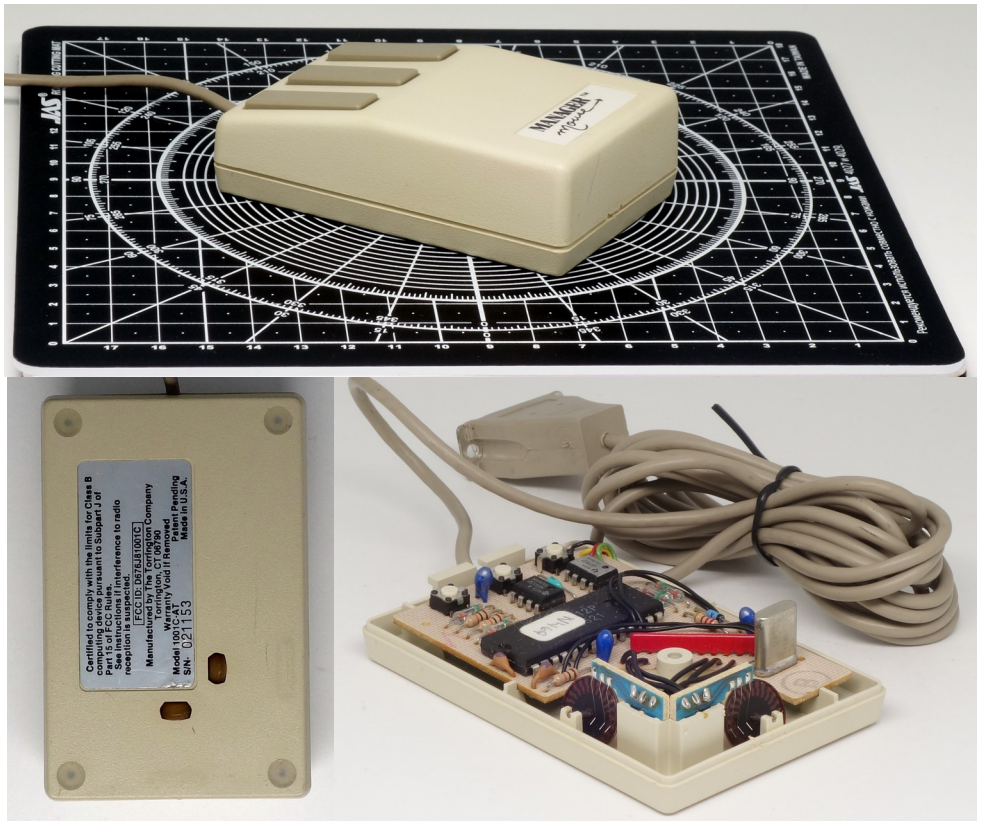
1986 – microLYNX trackball

- Some other mice for such limited connectivity computers emulated even cheaper digital joystick
  - stick just closes contact (presses one or two internal buttons) when moved – just like cursor keys :)
  - the mouse had a typical mechanical or optical encoder, and only simulated these joystick contact closures over its interface lines
- Honeywell/Disc instruments microLYNX trackball went even further, presenting itself as an additional cursor keys keyboard
  - It is inserted between the keyboard port and the normal keyboard, and imitates cursor key presses on ball rotation
  - the trackball hears everything you type, and you can chat with it via your favorite text editor
    - ask about the configuration, set options, etc.



1986 – Manager mouse

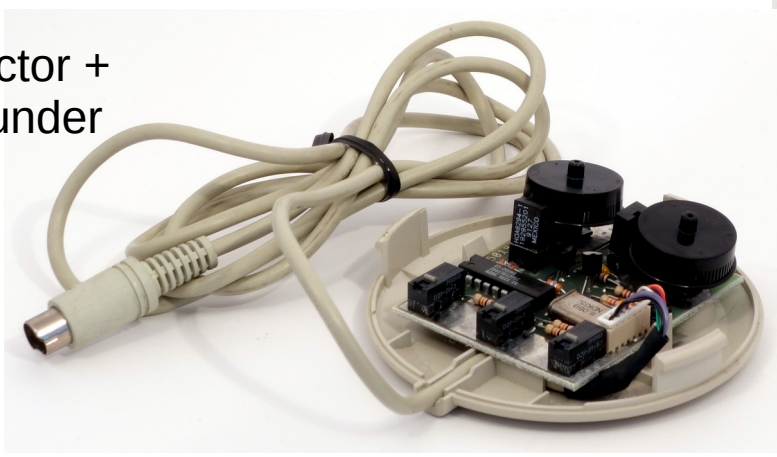
- At the same time, two companies (Torrington and Hawley Mouse House) are trying to revive the idea of using wheels instead of a ball to reduce clogging and make the mouse cheaper
- The Manager mouse option is cheaper, but a small amount of debris still gets into the case
- A plain RS-232 mouse
  - it can be connected same way as Mouse Systems mice



Use USB–RS232 dongle and `inputattach --mousesystems /dev/ttyUSB0` in Linux

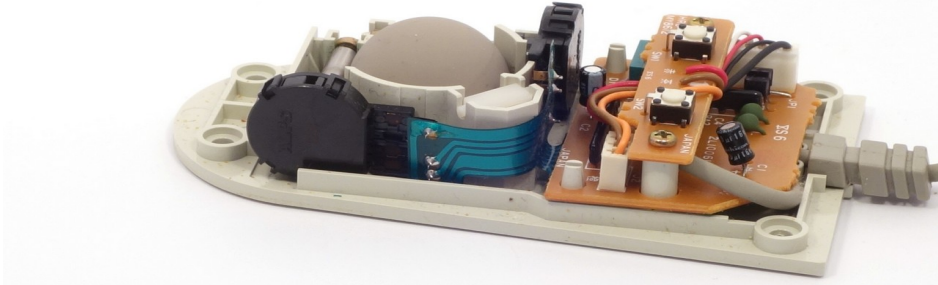
1986 – DEC Hawley

- Jack Hawley's version is more expensive, but the wheels are located outside the sealed body
  - the mouse collects no dust inside
- It works via the DEC ACCESS.bus
  - Electrically it’s like RS-232 with additional power
- USB–RS232 dongle + coupling connector + power supply should make it working under Linux
  - “attaching a serial line to an input-layer device” (C) should do the job (but we didn’t check)
  - `inputattach --vsxxx-aa /dev/ttyUSB0`



1987 – IBM PS/2 mouse

- First mouse for the PS/2 interface
- Actually made by ALPS Electric in Japan
  - Old-school closed mechanical encoders inside
- No one new yet that this interface will become so popular for computer mice, and PS/2 mice will be the easiest ones to use with the XXI century computers
  - you can find enough converters on the market, which present them as USB HID devices



1987 – Microsoft “Dove bar” mouse

- The third generation of Microsoft mice was the first model to advertise an ergonomic design
- The prototype for the shape of this mouse was a sanding block

It has either serial interface or Microsoft InPort interface - which actually is quadrature, so any good quadrature converter (we still prefer Amigas!) with the connector coupler works

1995 – Logitech Trackman

- This model was the first optical trackball, based on the principle previously used only in computer mice
- The pattern on the ball acts as a special mouse pad, allowing the optical sensor matrix to read alternating light and dark spots as it rotates
- The use of an optical method for registering the rotation of the ball made it possible to replace the rollers with a low-friction point supports for easier rotation of the ball
- It was discovered that the design of the optical trackball is less sensitive to clogging and requires cleaning less often
- Fortunately, PS/2 mice are simpler than everything before, you can find enough converters on the market, which present them as USB HID devices

1995 – Mouse Systems scroll mouse

- ...or “ProAgio scroll mouse” - the first mouse with a scroll wheel
  - Although it would be more correct to call it a scroll roller :)
- The wheel was originally intended for zooming in spreadsheets
- But it quickly turned out to be ideal for scrolling documents
- For scrolling, a separate optical encoder and a belt drive were used
  - people didn’t yet know that scrolling needs much lower resolution than cursor movements

- This made all already existing mice obsolete
- Any further attempts to re-invent scrolling (i.e. with a tiny joystick) had not much success

Possibly, the scroll wheel is so comfortable, because we inherited the adaptation to the finger movement used for scrolling from our distant tree-climbing ancestors :)

Conclusions

- Surprisingly, most of the significant mice can be easily connected to nowadays PC and used under GNU/Linux
  - Open source converters are doing an opposite task more often (use contemporary mice with old computer), but plugging a vintage mouse to USB-only PC or smartphone also works :)
  - Difficult mice with a dedicated system adapter are actually parallel quadrature devices
    - so they are the most easy to be revitalized
  - Mice imitating analog or digital joysticks are also easy because the idea of connecting a vintage joystick to a modern PC had brought into life enough converters projects :)
  - Some serial devices have both old converters, and modern open hardware ones (e.g. ADB-USB)
  - Some serial devices are also not very difficult cases because of the existing Linux port for their platforms
  - Hewlett-Packard compatible HIL mice was a tough case for a long time, until its appearance in TMK and QMK firmwares (in addition to ADB, serial, SUN mice)
- Connecting vintage mouse to the computer running an emulator of the old system helps to reproduce UX (user experience) much better than just dealing with today regular controls

Useful links

- L'histoire de la souris – smaky.ch: https://smaky.ch/chapitre-7-souris-douglas-engelbart/
- Converters, supported by the TMK Keyboard Firmware: https://github.com/tmk/tmk_keyboard/tree/hphil/converter
- The inputattach manual with the list of supported serial mouse protocols: https://linux.die.net/man/1/inputattach
- More on the above mice (and a number of other “mouses”): https://mouses.info :)