

### Ignored Disposed of Revived

#### Four Decades of Apple's Lisa



Michael Engel, VCFB, October 15th, 2023

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### How It Began ...from the Garage to a UFO

- 1976 Apple I
- 1977 Apple ][ / ][+
- 1980 Apple ///
- 1983 Apple //e

- All use a 6502 CPU
  - 8 bit, 1–1.8 MHz





#### The famous Xerox visits of 1979 UserView workspace XEROX - Learning Research Group This is a resurrected version of the Smalltalk-78 system running on the Notetaker computer in 1979. It has been extended from the original, mainly by fixing bugs (because the Notetakér néver went beyond a demo), and by restoring features from Smalltalk-76 that had to be stripped out (because of the Notetaker's limited hardware resources). Other features have been added taking advantage of modern machines speed. Enjou! Bert, Dan, Ted, Yoshiki, Alan Operation kons 2014 CON BILLO X Hex Representation 57FFFFFFA A8000015 5000000A 5200004A 8200004D 5200004A 820 8200804D 5200804A 200004A B204204D 5203C04A 820 5200004A BIFFFED 5000000A BD 5000000A B000000D 5000000A 5800001A A8000015 5800001A AFFFFF5

#### 1973: Xerox Alto innovations

A Walk in the PARC

- Bitmapped display
- GUI, windows, mouse
- 1979: Xerox Star
  - also: Ethernet, laser printing
- **Smalltalk**: inspiration for early UI experiments at Apple [1,2]



**3333 COYOTE HILL ROAD** 

### **Something New** ...the Apple ][ was sooo old!

- 1978: New projects at Apple
  - Sara: successor to the Apple II, using the same CPU, an 80column display, additional memory, intended for small businesses I Apple ///
  - Lisa: ambitious, more expensive, easy-to-use, next generation office computer featuring a "revolutionary "graphical user interface (GUI)



#### The Lisa is born ...January 19, 1983: Lisa 1



- Uses the "new" Motorola 68000, 5 MHZ
  - So far only used in "Unix-y" micros (Sun 1, SGI Iris, Apollo)
- Memory: 1 MB RAM, 16 kB ROM
- Screen: 12" b/w, *rectangular pixels*, 720x364
- "Twiggy" floppy drives: 5.25", 871,424 bytes
- 5 MB ProFile hard disk
- Price: US\$ 9,995 (!)





### Lisa Hardware ....evolution

- Twiggy drives were unreliable
- 1984: Lisa 2 introduced
  - Two Twiggys replaced by a single 400kB 3.5" Sony floppy
  - Same drive as in Mac 128/512k
- Variants:
  - Lisa 2/5 with 5 MB ProFile
  - Lisa 2/10 internal 10 MB Widget

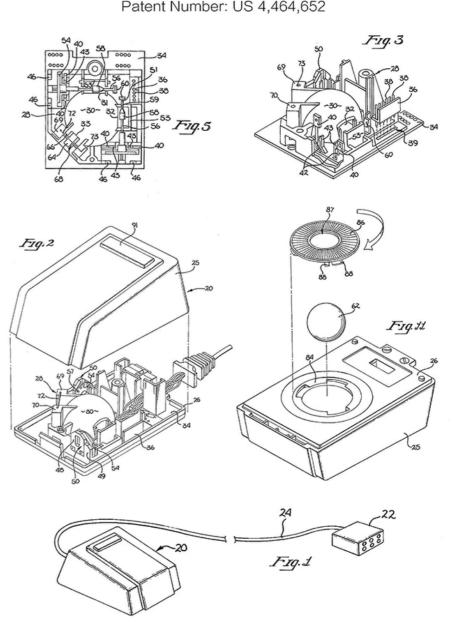


### **Mouse!** ...Apple's own way





- Xerox mouse uses three buttons
  - "Too complicated" which button for which function?
- Apple implements **single button mouse** 
  - Uses a roller ball, quadrature encoding
- Later Lisas were delivered with the M0100 Mac mouse
  - Protocol and connector identical



## Lisa Hard Disks

#### ... ProFile vs. Widget

#### ProFile

- Seagate ST-506 stepper motor drive and mechanism
- Without usual Seagate electronics
- Digital and analog circuit board designed & manufactured by Apple
- Also used for the Apple ///
- Proprietary parallel interface
- Widget
  - 10 MB, Apple internally developed
  - Uses three Z8 microcontrollers



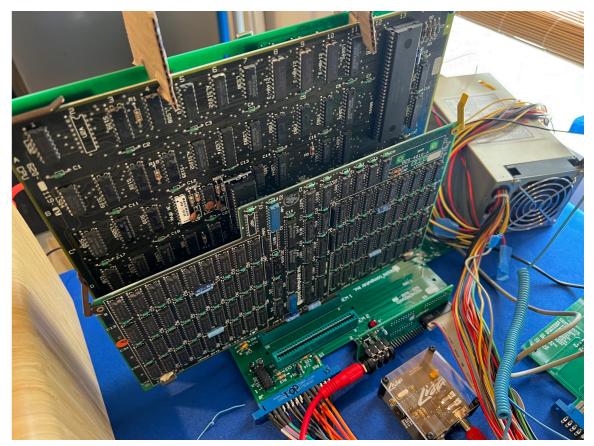


### A Modular System

...wish we had this today...

- Modular construction
  - Easy service
- Thumbscrews
- Safety interlock switches
- Expandable
  - Two RAM slots
  - Three I/O expansion slots





### Lisa PCBs

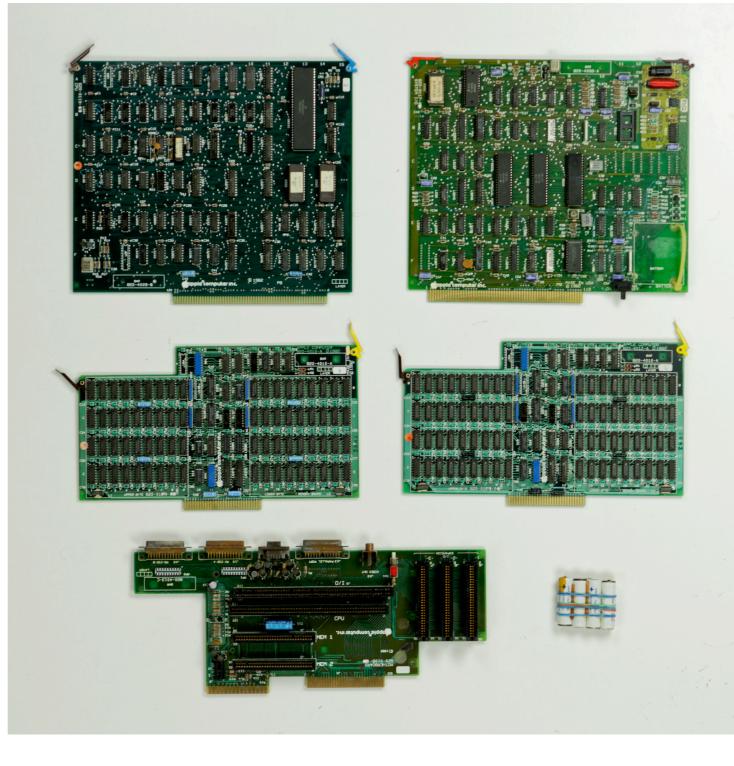
#### ...modularity!

#### CPU board

- 68000 Processor + ROM
- MMU, video

#### I/O board

- Parallel and serial interfaces
- Floppy, keyboard, mouse
- Power management
- Memory board(s)
  - Lots of 4164 DRAMs...
- "Mainboard" (backplane)



Logical Address (24 bits)

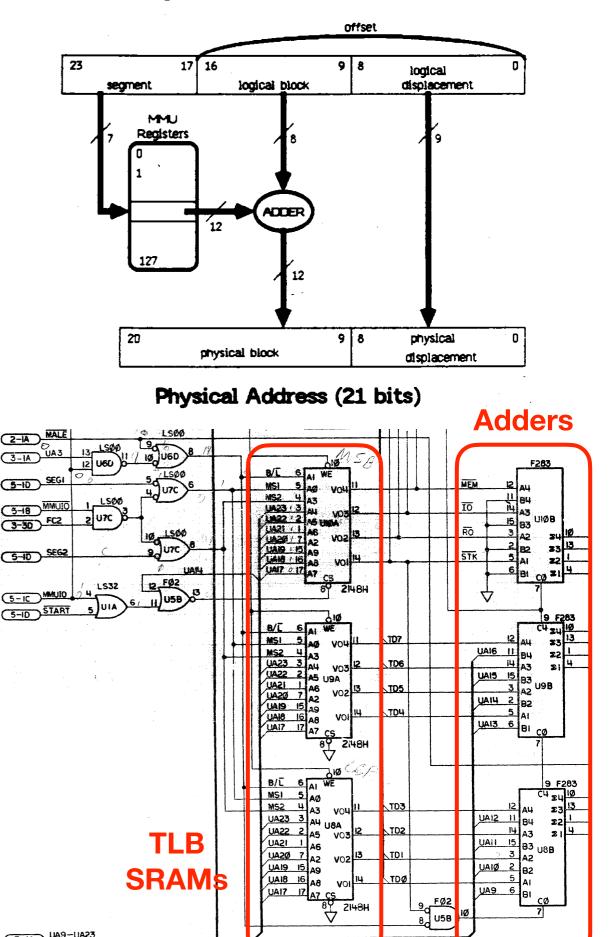
### **Hardware Details**

...advanced features!

- No custom ASICs used [6]
  - Mostly 74-series TTL logic
  - VLSI chips: 68000, 6522, Z8530
  - Two bipolar 256x8 bit PROMs
- MMU uses discrete components [4]
  - SRAMs (2148, 1k x 4 bits)
  - fast adders (74F283)
- I/O coprocessors
  - 6504 a tiny Apple ][ subset

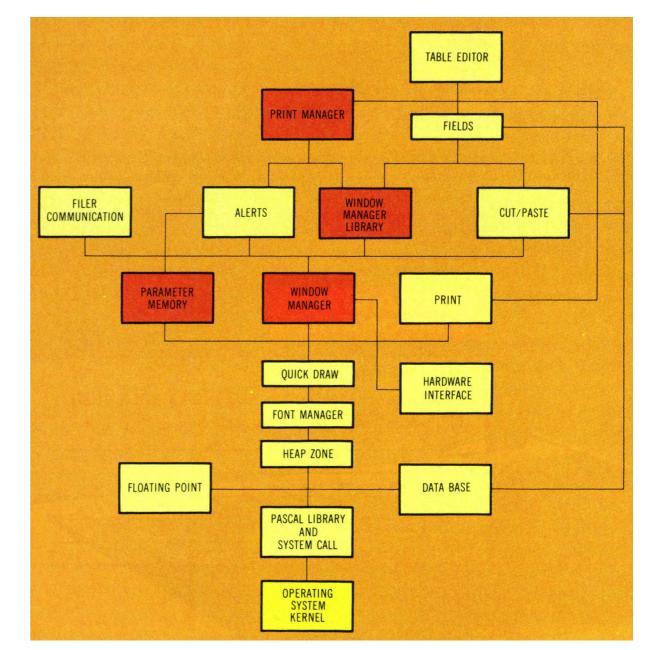
11

COPS421 4-bit controller



#### ...operating system

- LOS: Lisa Office System / OS [5]
  - "Local Integrated Software Architecture"
  - Idea: build an office system
- OS and apps written in Pascal
- Cooperative multitasking
- Protected virtual memory
- Hierarchical file management

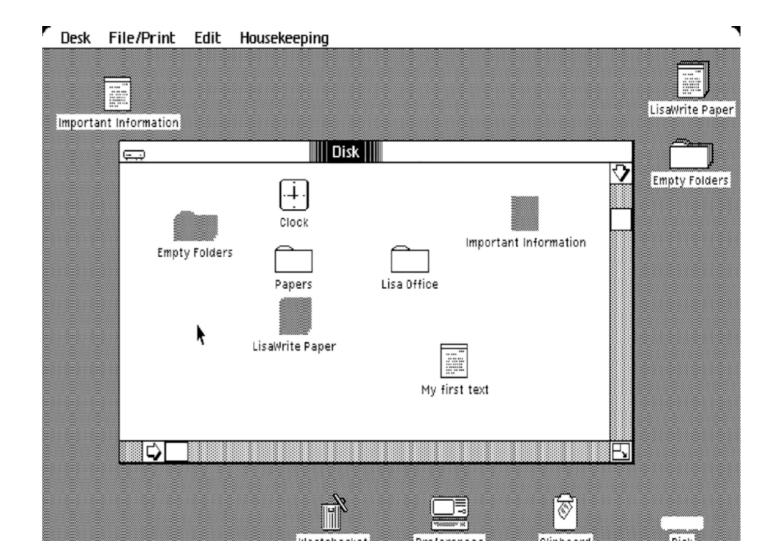


#### ...innovations

- Introduction of the menu bar
- Task-oriented workflow
  - Uses "stationery": document templates
- Internationalization
  - OS and applications in US and British English, French, German, Italian, Spanish, Scandinavian languages
- Regions:

efficient handling of overlapping windows [7]

- Atkinson thought he reimplemented stuff the way Xerox did it
  - ...turned out they did not



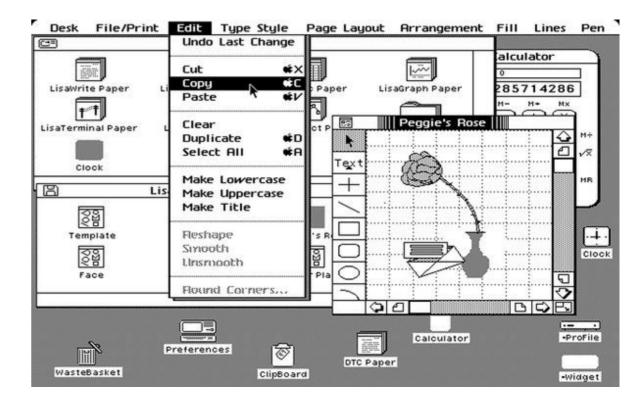
# Window Manager calculates visible region of each window

#### ...applications

{V3.0} WORKSHOP: FILE-MGR, SYSTEM-MGR, Edit, Run, Debug, Pascal, Basic, Quit, ?

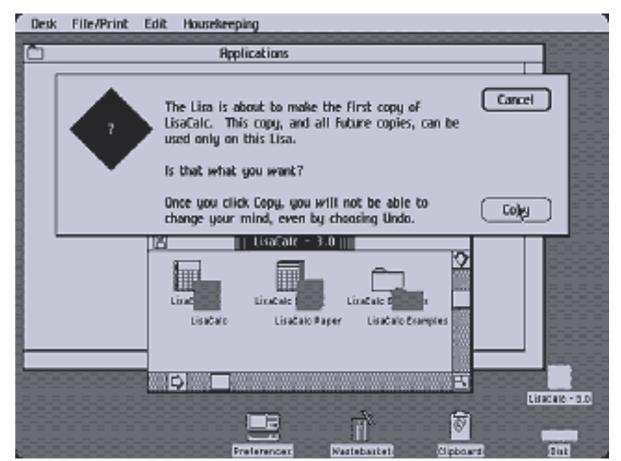
Workshop Copyright 1983, 1984 Apple Computer Inc.

- Lisa came with **seven applications** ("7/7 office system")
  - LisaWrite, LisaCalc, LisaDraw, LisaGraph, LisaProject, LisaList, and LisaTerminal
- Lisa Office System could not be used to write programs for itself:
  - a separate development OS was required – Lisa Workshop
  - similar to UCSD Pascal
- Third-party software initially poor
  - new paradigms
  - inexperienced programmers
  - Programming languages: BASIC, Cobol



#### ...atrocities

- Lisa used simple copy protection
  - Floppy disks were serialized during software installation to hard disk
- Serial number was stored in video state PROM
  - Well hidden, took long to find
  - Deserialization tools available today...



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...alternative OSes

#### SCO XENIX V3.0

Copyright Microsoft Corporation and The Santa Cruz Operation Inc, 1983. All rights reserved. Use, duplication, and disclosure are subject to the terms stated in the customer license agreement.

XENIX is a trademark of Microsoft Corporation.

Lisa II/5 (s): ROM 00A8 Slot 1 Empty Slot 2 Empty Slot 3 Empty rootdev 0 0 swapdev 0 0 System 136k User 792k Root 3872k Swap 992k

Type CONTROL-d to proceed with normal startup, (or give root password for system maintenance): Current System Time is Thu May 17 16:53:27 PDT 1984 Enter new time (Cyymmdd]hhmm):

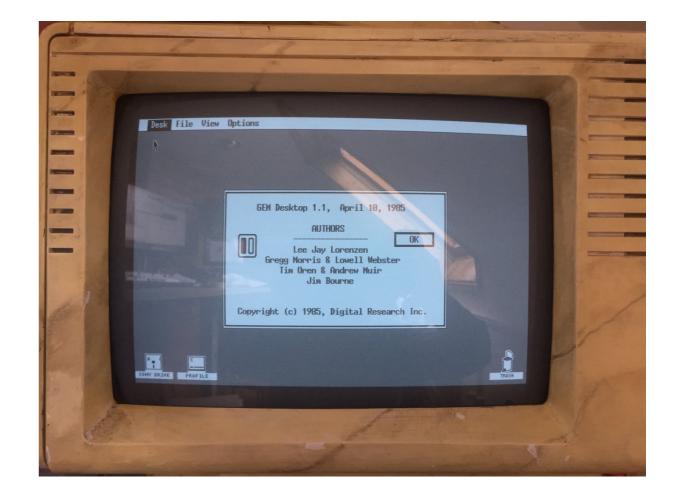
lisa!login: 📕

- SCO Xenix 3.0 [8]
- Unisoft UniPlus Unix
- Smalltalk-80 [9]
- CP/M 68k

	1		
	Project	Project	System Workspace
	Examples	System	Smalltalk-80 of March 17, 1982
		Browser	Copyright (c) 1981, 1982 Xerox Corp. All rights reserved.
E LISA UNIX SYSTEM V	with a different set of are two project windo project, first select th clicking it. Keep the	n alternate desktop, t windows on it. There ws above. To enter a e project window by coursor in the project and hold the yellow the promotion of the project	Italics are used below to indicate info not applicable to this release. The text in this window was received from Xerox. Inquiry InputState browseAllAccessesTo: 'deltaTime'. Smalltalk browseAllCallsOn: #opendabel: Smalltalk browseAllImplementorsOf: #emphasis:
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warranty expressed or implied!			
ease refer to the User Guide for basic assistance.			
NIX Release: unix ulisa 5.0 rl m68000 istro Version: 20180427			and and have been been the same agent. And
et to control-H t to control-X			

# Lisa Software ....GEM?!?

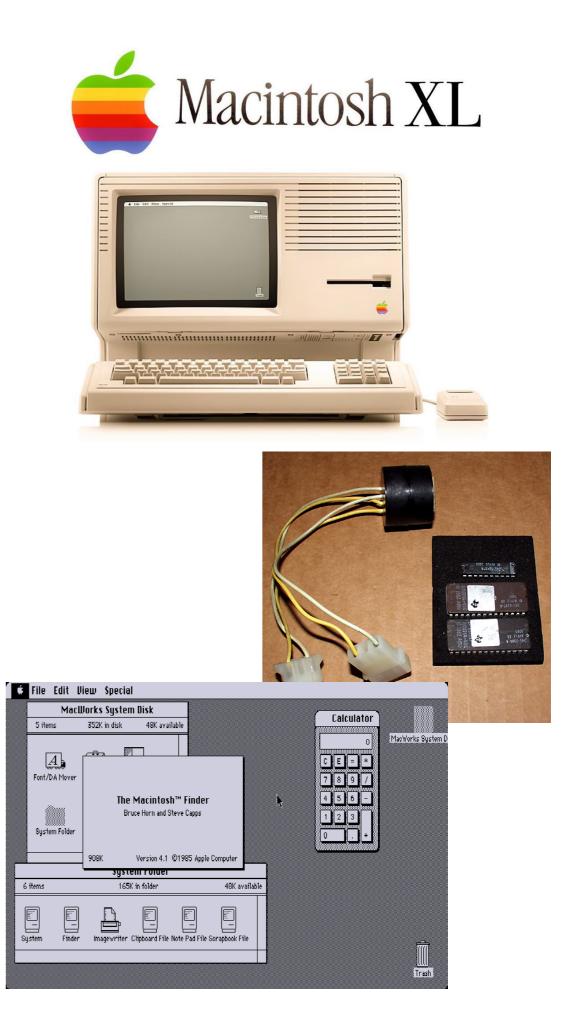
- GEM code open-sourced by Caldera/Lineo 1999
- Lisa used as example platform
  - Digital Research distributed the source code for the Lisaspecific bits of GEMDOS in their "porting kit" [10]
  - Porting kit included in the open source release [11]





#### The Fate of Lisa ...killed by the Mac?

- 1985: Lisa 2/10 → Macintosh XL
  - shipped with MacWorks XL, a Lisa program that allowed 64 K Macintosh ROM emulation
  - Hardware identical to Lisa 2/10
  - Square Pixels! (optional) [12]
    - "Screen mod kit": new firmware, video PROM, CRT transformer
    - New resolution: 608 x 431 pixels



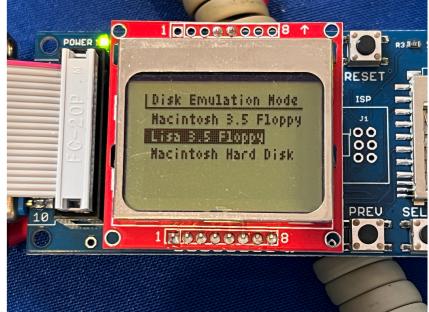
#### **Postmarket** ....Sun Remarketing

- XLerator: 12–18Mhz 68000 CPU
- 2 MB Memory card
- 800K floppy upgrade
- 20 MB SCSI HD + controller
- New MacWorks emulation
  - Support for 128 kB ROM (from Mac 512ke/Plus)
  - Runs System 6 and 7 (up to 7.5.5)!

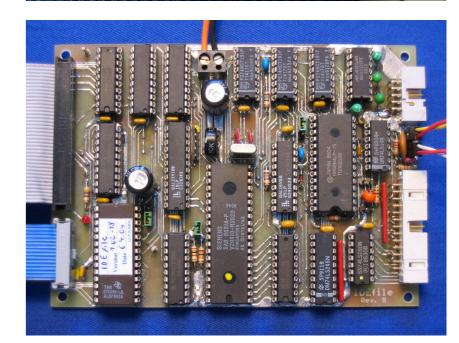


#### Useful bits ....more hardware





- Steve Chamberlain's FloppyEmu [17]
- Patrick Schäfer's IDEfile [18]
- X/ProFile disk emulator [19]
- ArduinoFile AVR [20]
- Patrick Schäfer's COP421 [21]
- Keyboard emulator [23]





# Taking Care of Your Lisa ....how to keep it alive?

- Battery on I/O board (not in 2/10) leaks, corrodes board
- RIFA capacitors in power supply rupture, release their magic smoke
- Sony Floppy stuck resin formation
- Hard disk Widgets break easily
- **Keyboard** foam in keys deteriorates
- Capacitors as in most retro systems







### The End of Lisa ....killed by the IRS?

- 1985 lots of Lisas (~5-7k) still in stock
  - Sun Remarketing acquired the rights to sell remaining Lisas
  - Consignment from Apple, not a sale
- 1989 Remaining Lisas still on Apple's books still counted as unsold inventory for tax purposes
- Sept. 1989 2,700 Lisas buries in Utah landfill
- Company could receive about \$34 for every \$100 of depreciated value as a tax break



#### The End? ...is there still hope?

Two emulators are available:

- 1997: LisaEm [14]
  - "provide as much of the experience of using an actual Lisa and several of its peripherals"
  - case view, floppy sound, power light
- 2006: **IDLE** [15]
  - "Incomplete Draft of a Lisa Emulator"
- Both run Lisa OS and MacWorks XL
  - Support for other OSes imperfect
- Some support in recent MAME



idle		
		<b>`</b>
	<b>ビジロ</b> Office System 1.0 1983 <b>(</b> apple computer inc.	(Finished)
k	This diskette is used to repair the Lisa Office System startup ProFile and to install the startup software. The ProFile is attached to the built-in parallel connector on the back of the Lisa.	( Repair )
	Click Finished if you aresfinished. Click Repair to fix a damaged ProFile. Click Install to put new startup software on the ProFile.	( Install )
	Click Restore to restore the ProFile from backup diskettes.	Restore

### Sources!

#### ...Lisa opens up

Program Preference;

{ Welcome to the ALL Create Preferences Window.



Through the extensive use of hallucenogens I have found truth and beauty. However, those same hallucenogens have also made me incapable of getting to Dodge Ridge to sell reclaimed ski wax in the parking lot.}

USES {\$U libos/SysCall } SysCall, {\$U libos/PSysCall } PSysCall, {\$U Obj:UnitStd } UnitStd, {\$U Obj:UnitHz } UnitHz,

- "Release and long-term preservation of the source code for the Apple Lisa, including its system and applications software, as part of [the CHM's] Art of Code series" [13]
- Announced 2018, realized 2023
- Apple Academic License: "for non-commercial, academic research, educational teaching, and personal study purposes only"
- Included Pascal and assembly sources:
  - Lisa OS and toolkit
  - 7/7 Office applications

Lisa\_Source/APPS/APPW/appw-prefmain.text

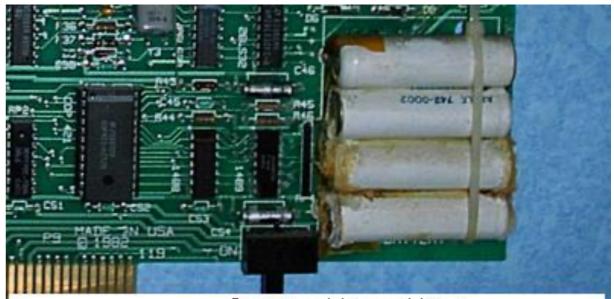
UNIT syscall; INTRINSIC;	(* system call definitions unit *)
{ Copyright 1983, 1984,	Apple Computer Inc. }
INTERFACE	
CONST	
<pre>max_ename = 32; max_pathname = 255; max_label_size = 128; len_exname = 16; size_exdata = 11;</pre>	<pre>(* maximum length of a file system object name *) (* maximum length of a file system pathname *) (* maximum size of a file label, in bytes *) (* length of exception name *) (* 48 bytes, exception data block should have the same    size as r_eventblk, received event block *)</pre>
size_etext = 9; size_waitlist = 10;	(* event text size – 40 bytes *) (* size of wait list – should be same as reqptr_list *)
<pre>call_term = 0; ended = 1; self_killed = 2; killed = 3; fthr_term = 4; bad_syscall = 5; bad_errnum = 6; swap_error = 7; stk_overflow = 8; data_overflow = 9; parity_err = 10;</pre>	<pre>(* exception kind definitions for 'SYS_TERMINATE'     exception *) (* process called terminate_process *) (* process executed 'end' statement *) (* process called kill_process on self *) (* process was killed by another process *) (* process's father is terminating *) (* process made invalid sys call - subcode bad *) (* process passed bad address for errnum parm *) (* process aborted due to code swap-in error *) (* process tried to exceed max data space size *) (* process got a parity error while executing *)</pre>

### **New Life!**

#### ... "The reports of my death are greatly exaggerated"

- Battery leakage damaged a lot of I/O and backplane boards
  - Replacement boards designed by Sapient Technologies [24]
- Rights to products developed by Sun Remarketing (SCSI board, SIMM memory board, and Sun20 hard drive controller) were transferred to Vintage Micros
  - Some spare parts still available
  - New CPU PCB, X/Profile, X/COPS
- Recreation as open source projects
  - started in 2022...



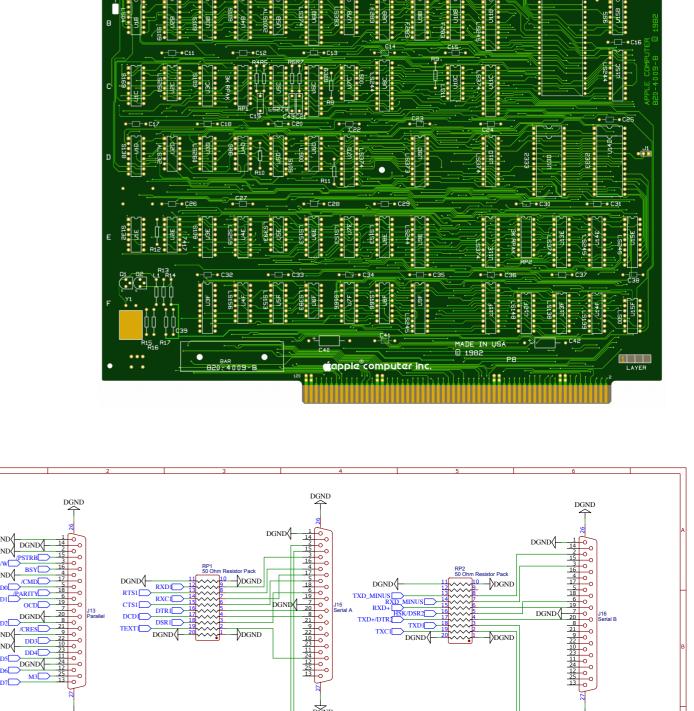


Courtesy of Jerome Vernet http://perso.orange.fr/jerome.vernet/specs/lisa.htm

### **Building a New Lisa**

#### ...parts and pieces

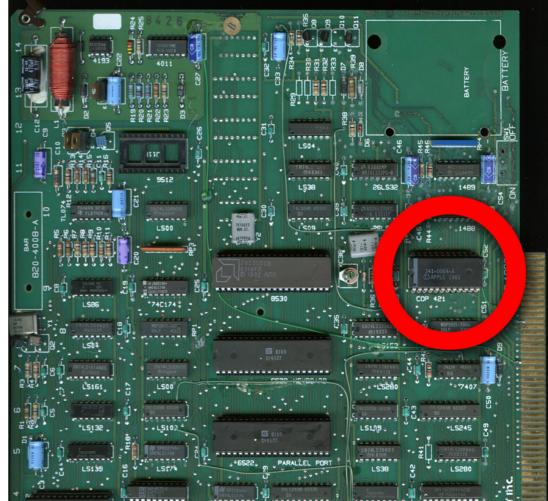
- Recreation
  - CPU board: 4 layers [25]
  - I/O, mainboard: 2 layers [26]
  - No memory board so far
- Schematics (Altium/ EasyEDA/PDF) and Gerber files available on github



## Challenges Building a New Lisa

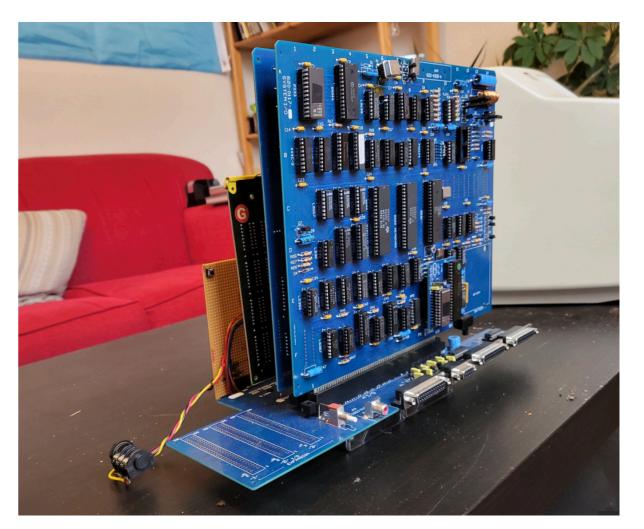
...40 year old ICs?

- "Unobtainium" ICs
  - COPS421 microcontroller [22]
  - Bipolar **PROMs**: 6309 or similar
    - Programming with modern EPROMers difficult
  - Fast SRAMs: 2148-55ns used for MMU
  - Lisa uses a strange mix of 74xx, 74LSxx, 74ALSxx, 74Cxx ICs – why?
- RAM boards not yet recreated
- Video uncommon frequencies
- Power supply replacement available



### Show me! ...first prototypes working

- Boards can easily be produced by most PCB manufacturers
  - Cost: \$12 (CPU), \$6.50 (I/O), \$4.50 (backplane)
  - Component costs vary significantly
    - Expect several US\$100
- Prototype in CNC cut plexiglass case by DosFox [27]
- Replacement power supply, keyboard adapter, I/O card PCBs also available
- RAM board has to be repurposed from existing Lisa for now...





## Work at Bamberg University





- Build our own Lisa clone (WiP) three exist in the US already
  - Also try to build CMOS SMD and FPGA versions (future)
- Replace the bipolar PROMs with GALs [28]

....Chair of Systems Programming

- Replace the COPS421 with an AVR microcontroller (WiP)
  - ...using real-time aware **binary translation** of assembler source
- Develop a **RAM board** using modern SRAM chips (future)
- Analyze, use and improve the Lisa HW and its OS in projects

# The Future? ....what will it bring?

- 1983: Frog Design Lisa concept
  - Inspiration for Portrait Display?
- 2015: Antonio de Rosa Lisa concept [29]
  - Similar aluminium Mac design idea by curved/labs





### Lisa and the Mac

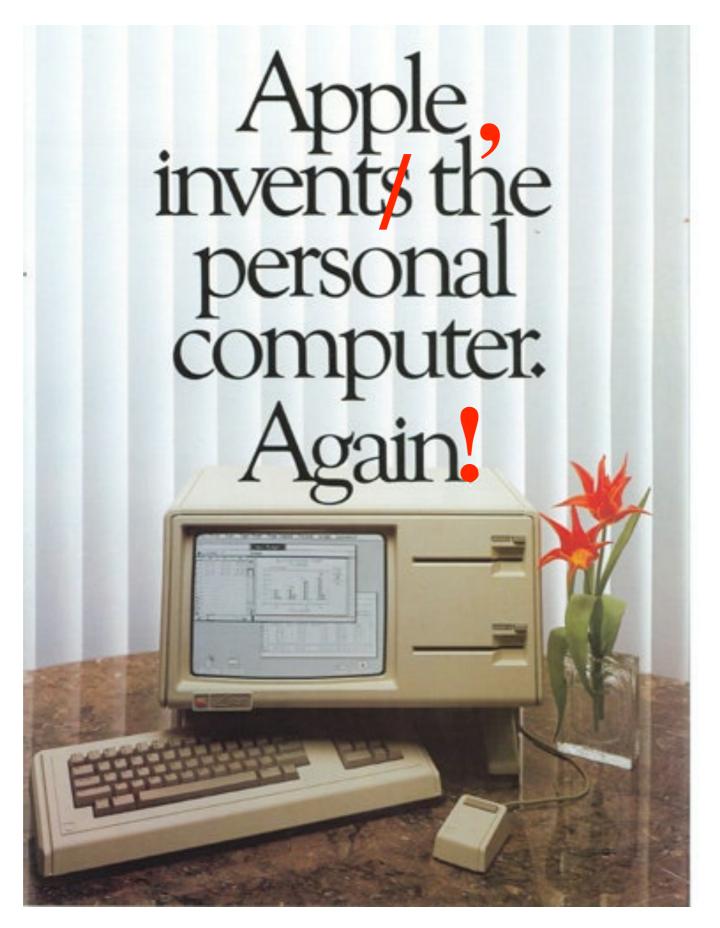
...It's complicated...

- Mac 128k introduced in 1984
  - Only cost US\$2,500 but significantly weaker hardware
    - less RAM, no HD, lower resolution higher CPU speed (7.83 MHz)
    - Mac uses a set of early programmable logic ICs (PALs)
  - Mac did more in software no I/O coprocessors
  - Initially, Mac software developers had to use a Lisa!
- QuickDraw shared between Lisa and Mac
  - Source code of QuickDraw and MacPaint published in 2010 [30]

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• Mac System: singletasking, simple FS (MFS), large parts in ROM





## References ....dig deeper!

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