(GENERAL) ELECTRIC DREAMS: RESTORING THE GE-120

A MILESTONE IN TRANSISTOR-BASED COMPUTING

MusIF- MIAI

- Two projects independently born from the south Italian hacker counter-culture, grown so close to become single entity
- Thousands of artefacts: mainframes, workstations, gaming consoles, peripherals
- A library of thousands of books, technical manuals, papers, officially part of the Italian national library service
- Currently at the end of a years-long move, inauguration of the new location coming soon

Electric Dreams

- Museums and their members are geographically distributed
- A yearly weekender event to meet each other and work on the machine
- Relatively slow progress but very focused sessions
- Part of the rich calendar of Italian summer hack events

ELECTRIC DREAMS 1

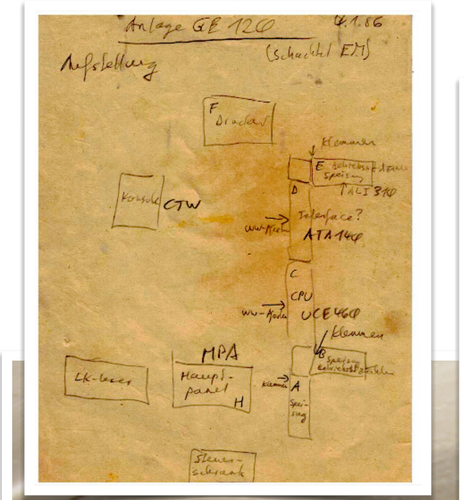
2021

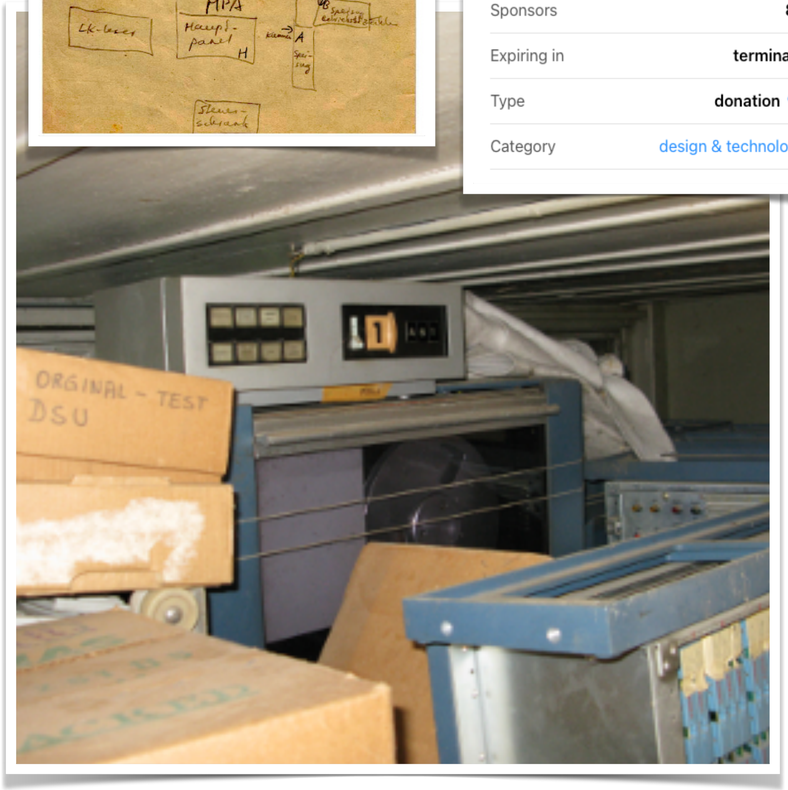
Unload & Lay of the Land

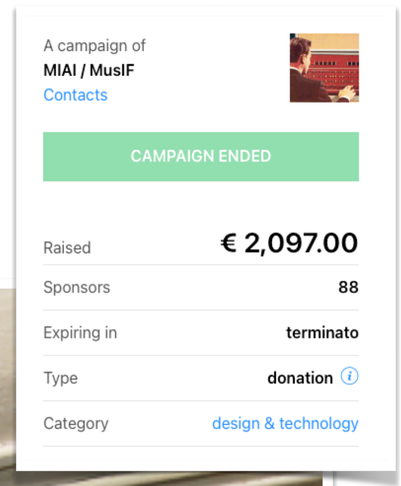
- Machine found by the friend organization ESoCoP - European society for computer preservation (esocop.org)

- Barn find
  - Commissioned at the Zurich airport until 1984
  - "Saved" by and obtained from one of its original operators, Markus

- Successful crowdfunding campaign
  - 88 sponsors and ~ 2000EUR raised.







OLIVETTI
GENERAL ELECTRIC
Product Service

DENOMINAZIONE U.E. Pannello asservimento alternate

S.U. DESCRIPTION A.C DISTRIBUTION CONTROL ASSY.

Honeywell
Honeywell Information Systems Italia

SOTTOSISTEMA PRT 142-

TECH SPECS

Honeywell Series 100

CHARACTERISTICS OF THE SERIES 100 SYSTEMS

	G-105	Model 5	Model 10	G-115	G-120	Model 15	G-130
DATE INTRODUCED	1969	1971	1971	1965	1969	1971	1968
MAIN STORAGE							
Cycle time, microseconds	7.5	6.5	6.5	6.5	4	4 or 2	2
Bytes fetched per cycle	1	1	1	1	1	1	1
Minimum capacity, bytes	4,096	4,096	8,192	4,096	12,288	16,384	16,384
Maximum capacity, bytes	8,192	12,288	12,288	16,384	24,576	65,536	32,768
PROCESSOR							
No. of instructions	39	39	39	39	67	67	67
No. of index registers	0	0	0	0	8	8	8
Instruction times, microseconds:							
Add (5 digits, unpacked)	120	114	114	114	88	88 or 44	44
Add (5 digits, packed)	*	*	*	*	68	68 or 34	34
Multiply (5 digits)	*	*	*	*	1020	1020 or 510	510
Divide (10 by 5 digits)	*	*	*	*	1648	1648 or 824	824
Move (5 bytes)	120	104	104	104	68	68 or 34	34
Compare (5 bytes)	120	114	114	114	88	88 or 44	44
Branch	30	26	26	26	20	20 or 10	10
INPUT/OUTPUT CONTROL							
No. of I/O channels	2	2	2	2	3	3	3
No. of peripheral connectors	—	3 or 4	3 or 4	4	4	4	4
Maximum simultaneous I/O operations (unbuffered)	2	2	2	2	3	3	3
Magnetic tape capability	No	Yes	Yes	Yes	Yes	Yes	Yes
Disc storage capability	No	No	Yes	Yes	Yes	Yes	Yes
Data communications capability	Yes	Yes	Yes	Yes	Yes	Yes	Yes
STANDARD PERIPHERALS							
Card reader speed, cpm	—	300 or 400	300 or 400	—	—	400	—
Card punch speed, cpm	—	—	60—200	—	—	60—200	—
Line printer speed, lpm	—	300 or 600	300 or 600	—	—	—	—
Disk storage, bytes	None	None	3 million	—	—	—	—
Communications controller	—	Standard	Standard	—	—	—	—

*Instruction not available.

Instructions or Bust

- The full set of technical documentation, for all devices, including, of course, complete schematics
- Compromises were made in keeping the machine, the most peripheral devices are the most damaged
- Decided to focus on the CPU ignoring the rest

ELECTRIC DREAMS 2

2022

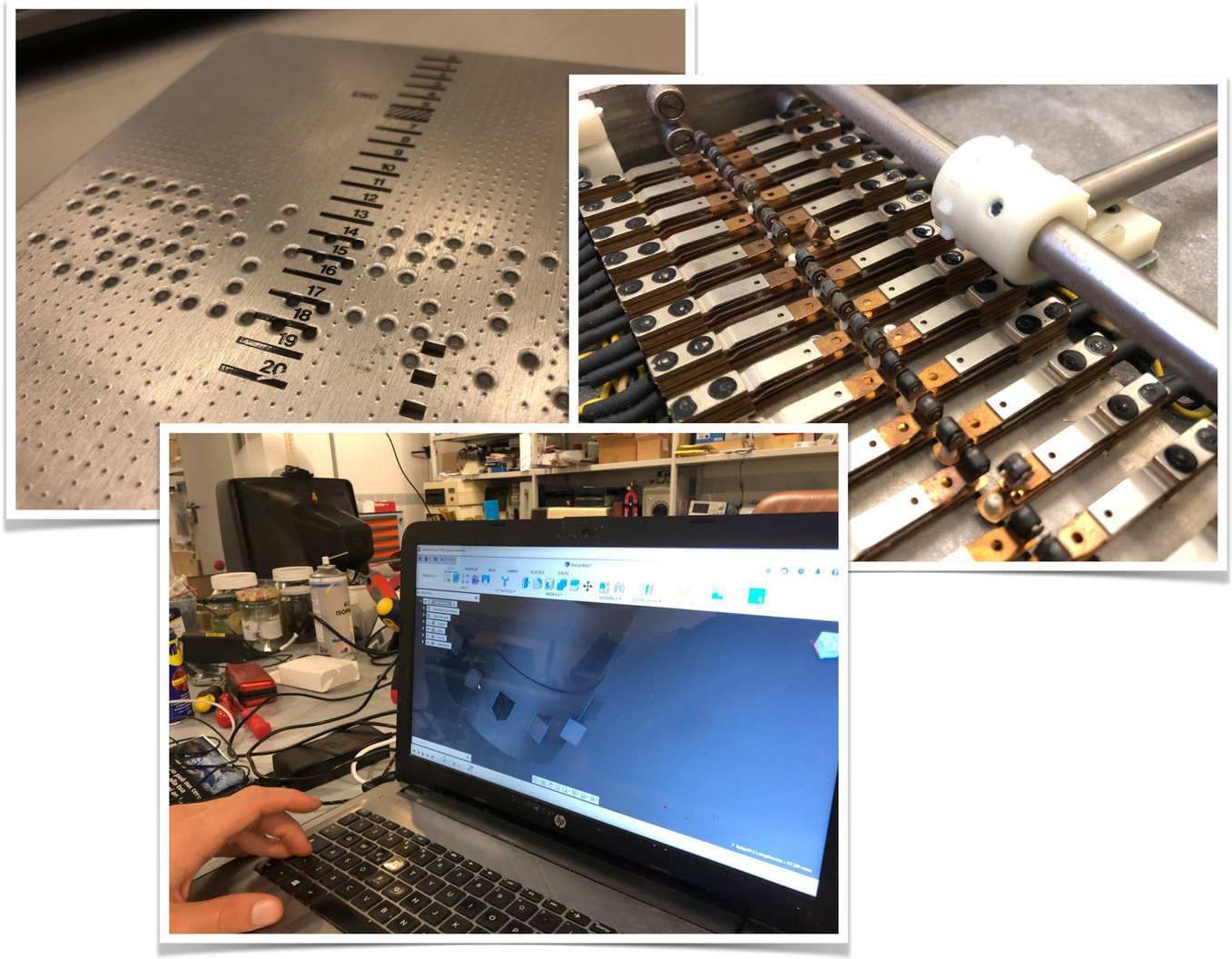
Testing and Studying

- We started studying the manuals, and found the test procedure for the CPU logic boards
  - Not confident to power up the machine so early

- We took quick mobile photos of the important materials we found.
  - Planned the digitalisation of all documentation
  - Started writing an emulator as away of further studying the machine during the year until the next event

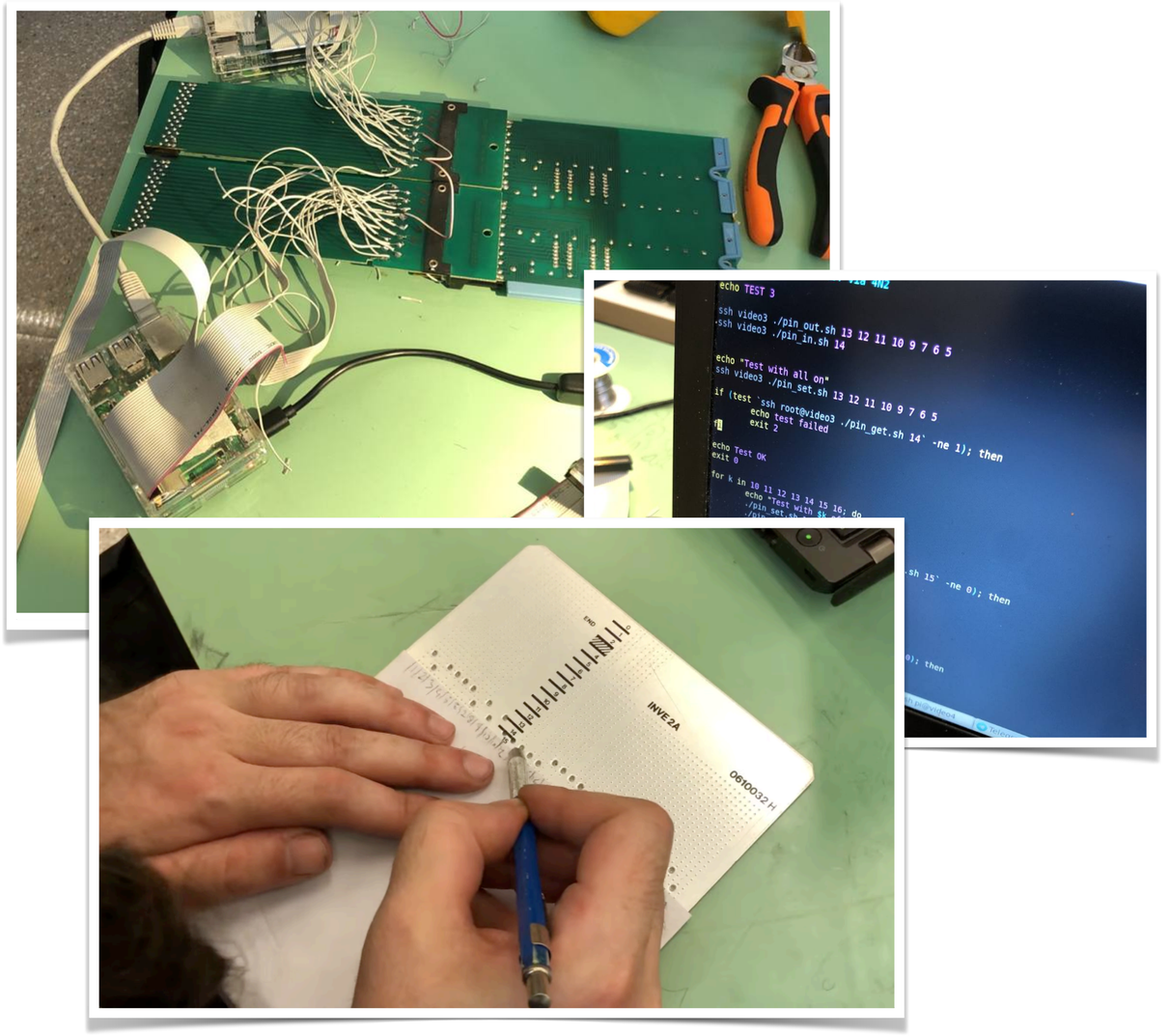
Fixing the Board Tester

- Tests are encoded in punched metal plates
  - The feeder cog was broken
- People with mechanical skills restored the mechanism and recreated the broken piece



Testing the Boards

- People with EE skills managed to reverse engineer the testing process and hacked up a testing rig using Raspberry PIs
- Even more people helped digitising the tests bit patterns "by hand"
- Finally confident to run electrons like this



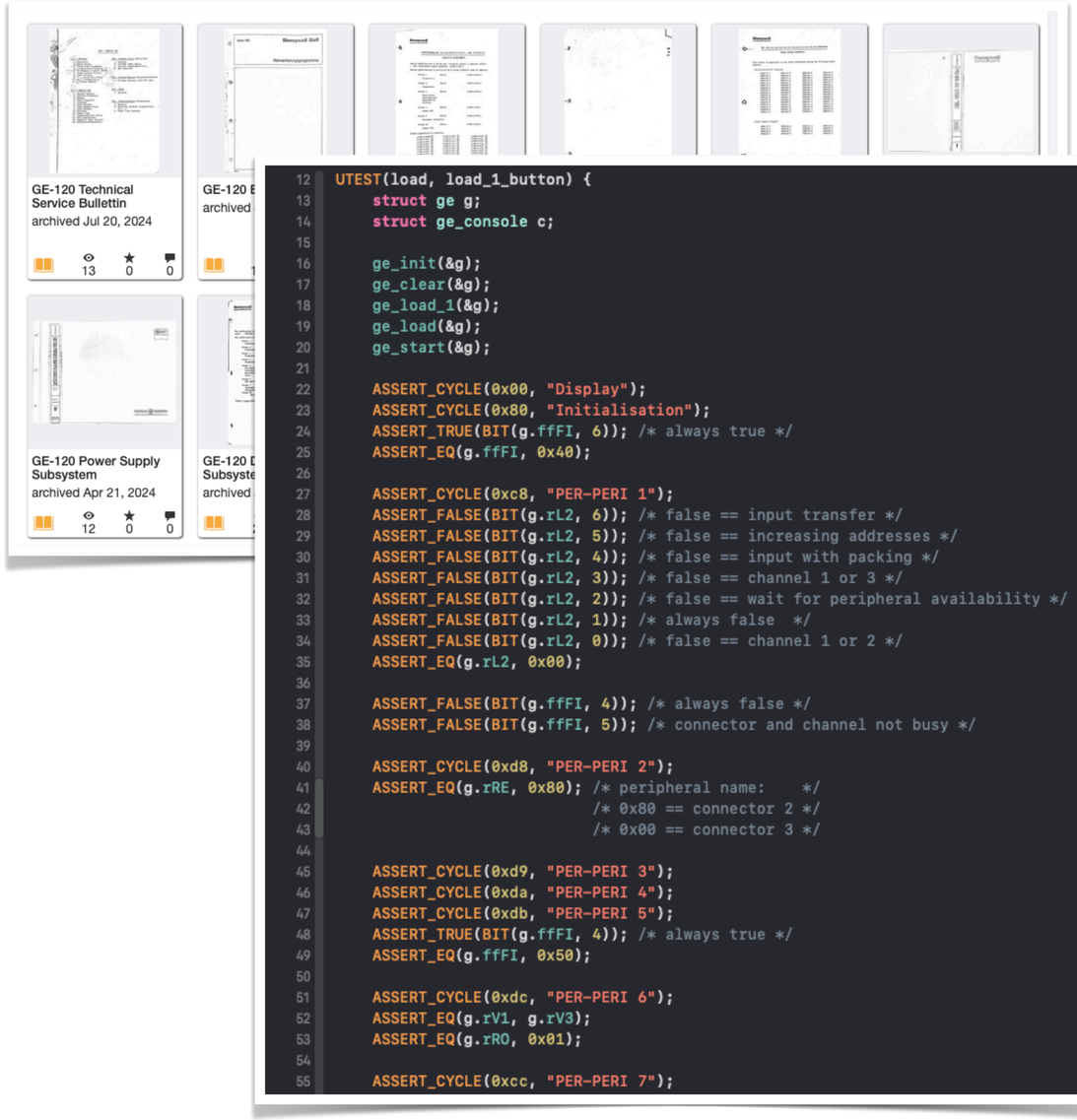
ELECTRIC DREAMS 3

2023

Documentation

- After a year the full complement of documentation is fully scanned and uploaded to archive.org
  - 57 binders or ~13.5 GB worth of schematics and all sorts of esoteric minutiae

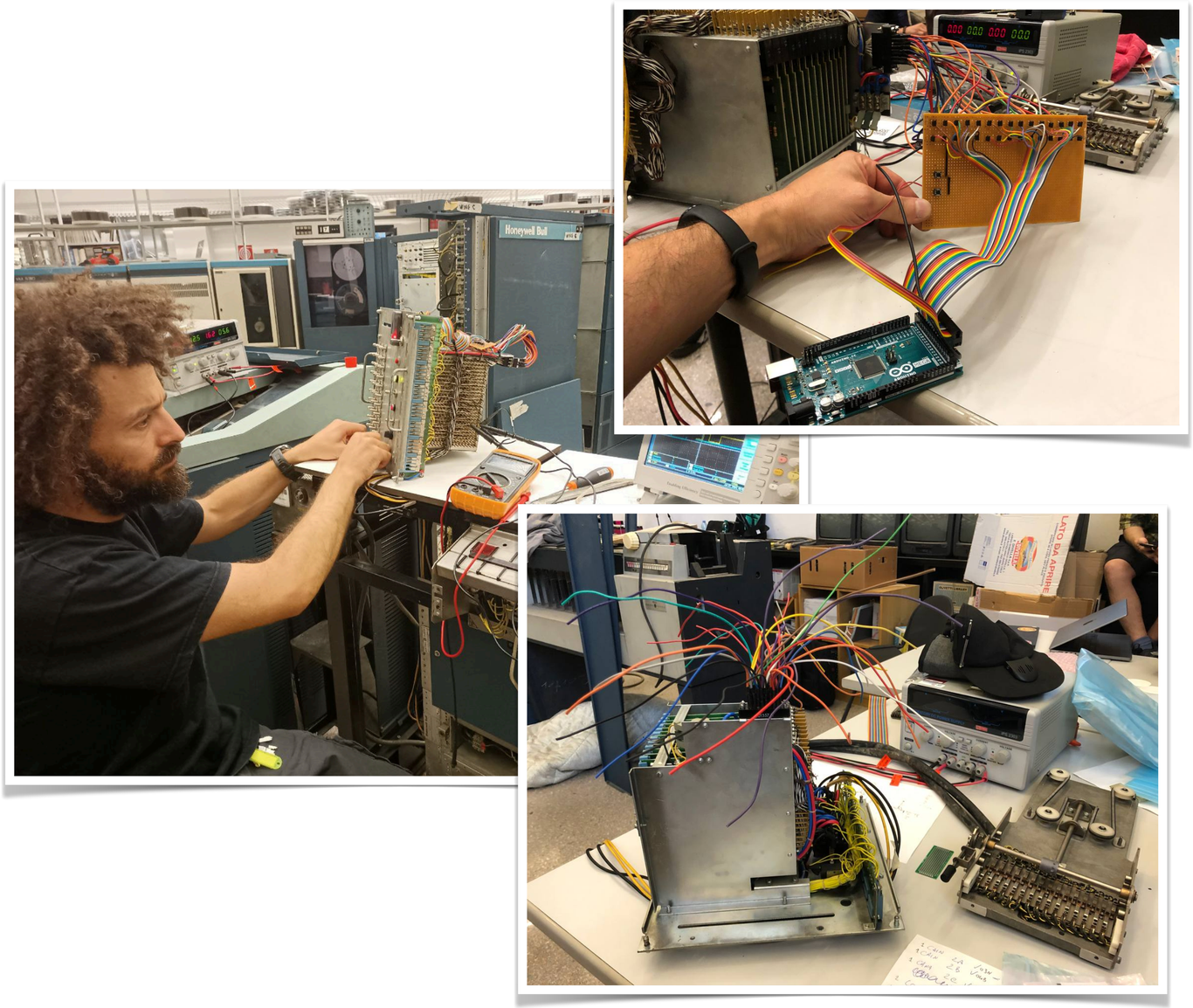
- With more documentation, the emulator has progressed up to communicate with the punched card reader peripheral




```
UTEST(load, load_1_button) {
    struct ge g;
    struct ge_console c;

    ge_init(&g);
    ge_clear(&g);
    ge_load_1(&g);
    ge_load(&g);
    ge_start(&g);

    ASSERT_CYCLE(0x00, "Display");
    ASSERT_CYCLE(0x80, "Initialisation");
    ASSERT_TRUE(BIT(g.ffFI, 6)); /* always true */
    ASSERT_EQ(g.ffFI, 0x40);

    ASSERT_CYCLE(0xc8, "PER-PERI 1");
    ASSERT_FALSE(BIT(g.rL2, 6)); /* false == input transfer */
    ASSERT_FALSE(BIT(g.rL2, 5)); /* false == increasing addresses */
    ASSERT_FALSE(BIT(g.rL2, 4)); /* false == input with packing */
    ASSERT_FALSE(BIT(g.rL2, 3)); /* false == channel 1 or 3 */
    ASSERT_FALSE(BIT(g.rL2, 2)); /* false == wait for peripheral availability */
    ASSERT_FALSE(BIT(g.rL2, 1)); /* always false  */
    ASSERT_FALSE(BIT(g.rL2, 0)); /* false == channel 1 or 2 */
    ASSERT_EQ(g.rL2, 0x00);

    ASSERT_FALSE(BIT(g.ffFI, 4)); /* always false */
    ASSERT_FALSE(BIT(g.ffFI, 5)); /* connector and channel not busy */

    ASSERT_CYCLE(0xd8, "PER-PERI 2");
    ASSERT_EQ(g.rRE, 0x80); /* peripheral name:    */
                            /* 0x80 == connector 2 */
                            /* 0x00 == connector 3 */

    ASSERT_CYCLE(0xd9, "PER-PERI 3");
    ASSERT_CYCLE(0xda, "PER-PERI 4");
    ASSERT_CYCLE(0xdb, "PER-PERI 5");
    ASSERT_TRUE(BIT(g.ffFI, 4)); /* always true */
    ASSERT_EQ(g.ffFI, 0x50);

    ASSERT_CYCLE(0xdc, "PER-PERI 6");
    ASSERT_EQ(g.rV1, g.rV3);
    ASSERT_EQ(g.rRO, 0x01);

    ASSERT_CYCLE(0xcc, "PER-PERI 7");
```

Restoring the Board Tester

- To avoid more mechanical wear and tear, we interfaced the real board tester with an Arduino that emulates the entire library of test plates
- First time running the machine as it was designed to do



Boards Tested

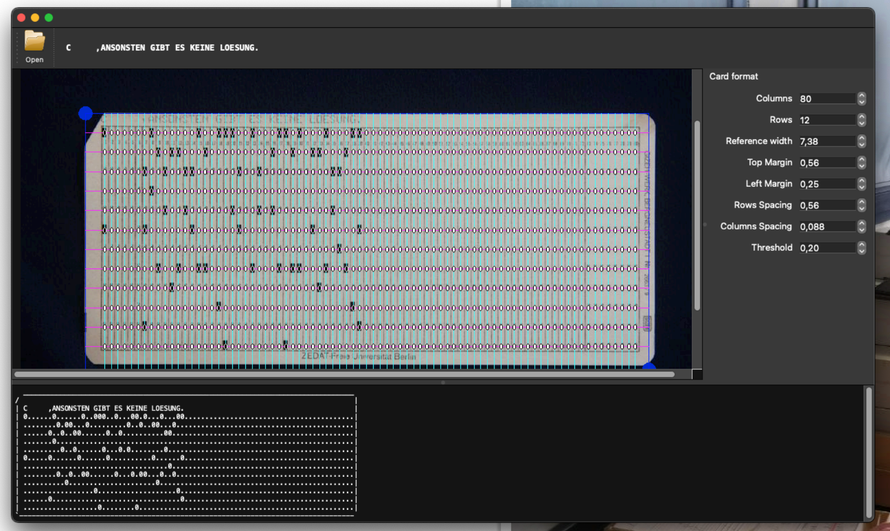
- Managed to test all logic boards of the CPU
- Had to use the disk controller as donor for some chips, but we fixed the few issues we found

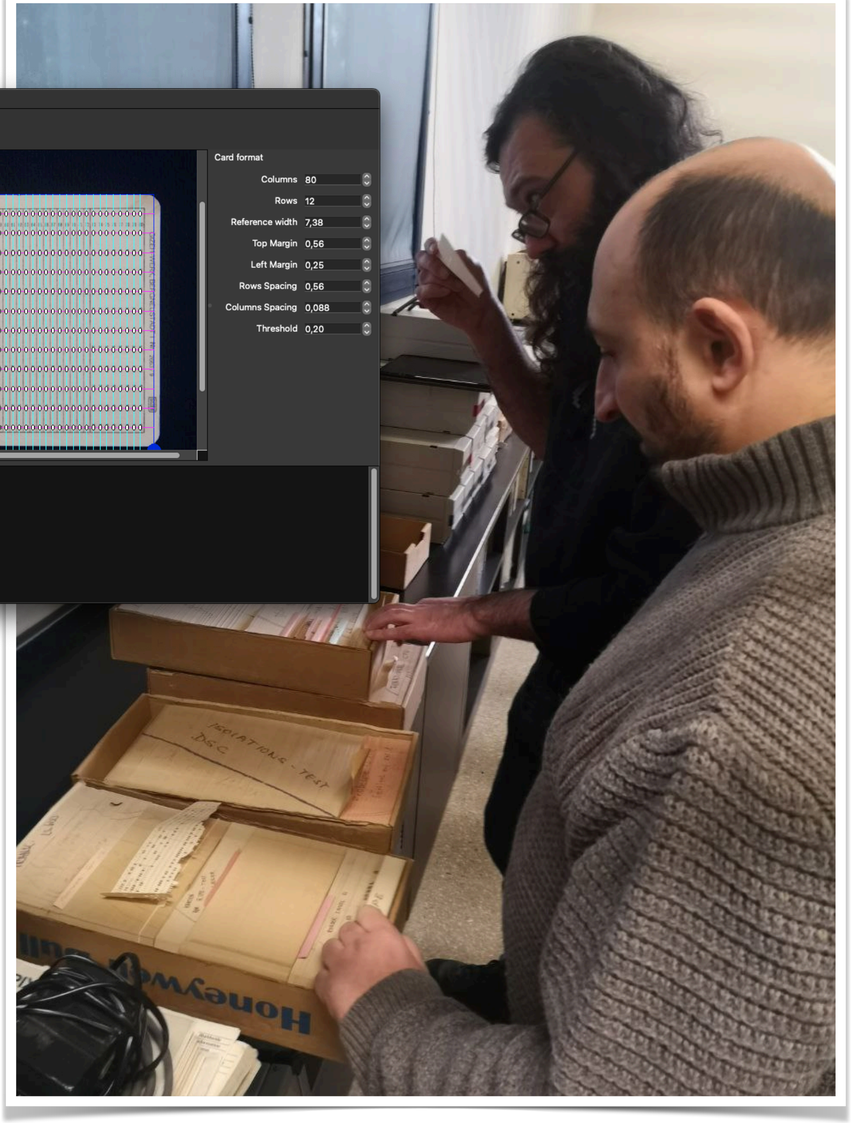
ELECTRIC DREAMS 4

2024

SOFTWARE!

- Started looking at the punch card reader
- Digitizing the punch card software we have (looks like more testing for all peripherals)
- Planning a modern device to emulate the punch card reader to the CPU

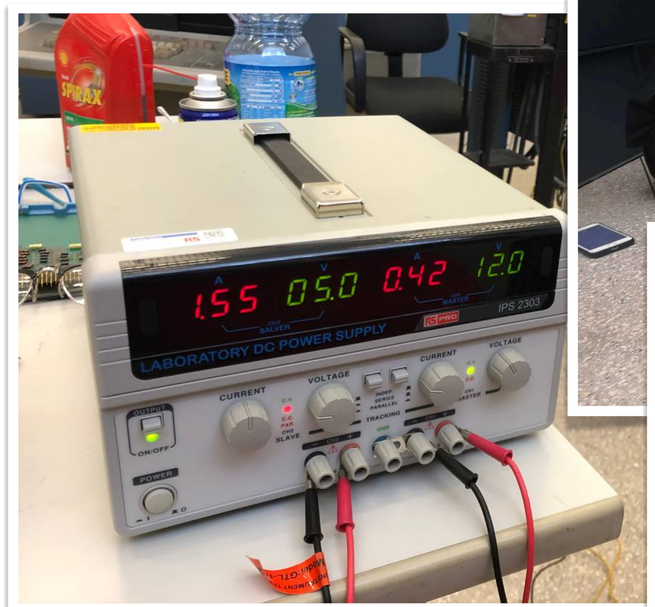


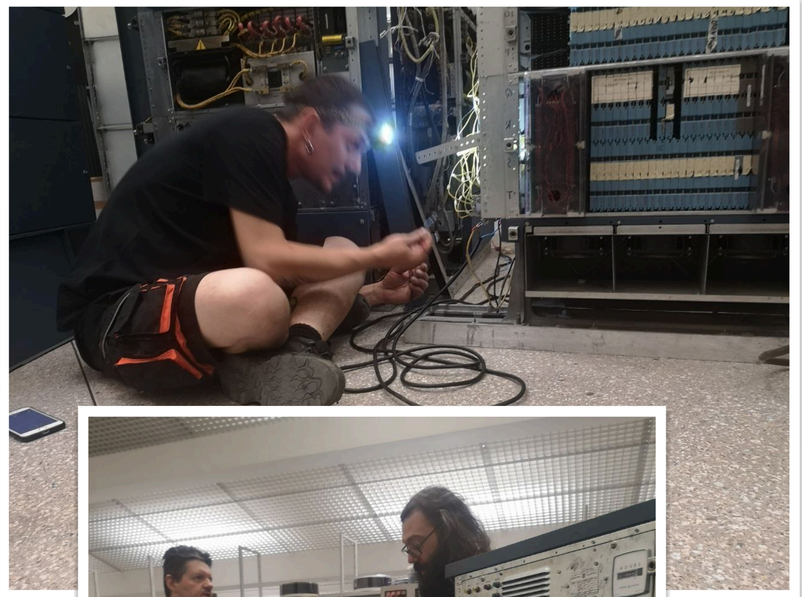


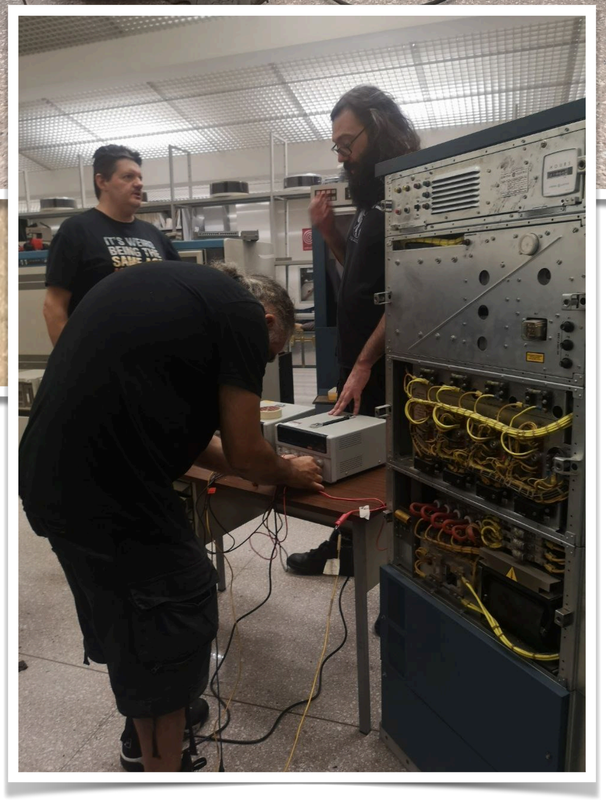
Power-up Tests

- With all boards repaired, the attention was now on the backplane
  - Cleaning, fixing shorts caused by bent metal
  - Devised a power-up strategy

- Finally power to the entire CPU, but we don't have clock generation yet







- https://miai.musif.eu
  Museums Homepage

- https://github.com/MusIF-MIAI
  Repositories of all software mentioned

- https://archive.org/details/@verdebinario
  Full digitized documentation

- March 21st, 2025
  New MIAI location opening!

- Last weekend of July, 2025
  Electric Dreams 5