

Digital Preservation during a Global Emergency

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Film Preservation and Restoration
online for India and the Subcontinent
3 September 2020

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Global Emergencies

- sanitation emergency
- climate emergency

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Sanitation Emergency

- physical distancing
- hand hygiene
- surgical masks
- stay home when feeling ill

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Climate Emergency

- embrace low-energy ...
- ... and low-energy solutions
- use less resources ...
- ... and recycle whenever possible

→ slow down

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Workflow

- prepare the source elements
- digitise the source elements
- digitally restore the files
- generate derivate files
- conserve the source elements
- conserve the files

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Source Reels

- splices repair
- perforation repair
- film cleaning
- chemical treatments
- ... and beyond

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Splices

- cement
- tape
- re-splicing

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Perforation

- tape bridges
- film bridges
- acetone
- notches
- V-cuts

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Cleaning

- PTR

- manual cleaning
- machine cleaning
- dry
- using a solvent

- re-washing

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Chemical Treatments

- drying
- humidifying
- mould fungus
- swelling the emulsion
- re-development
- hardening the gelatine

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... and Beyond

- transfer the emulsion onto a new base
- keep only the emulsion

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Equipment

- cleaning machine
- ventilation
- illumination

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Working Place

- manual rewinder with light table
- ventilation
- illumination

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Consumables

- protection masks and filters
- nitrile (and cotton) gloves
- tissues
- solvents
- film cement
- tape

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Scanner

- film transport
- light source
- camera
- image section
- wet scanning
- file format

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Film Transport

- sprocket or capstan (PTR)
- tension
- film path, guide and gate
- on cores or reels
- continuous or step-by-step

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Light Source

- | | |
|-----------|------------|
| ● diffuse | ● white |
| ● direct | ● coloured |
- illuminant

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Camera

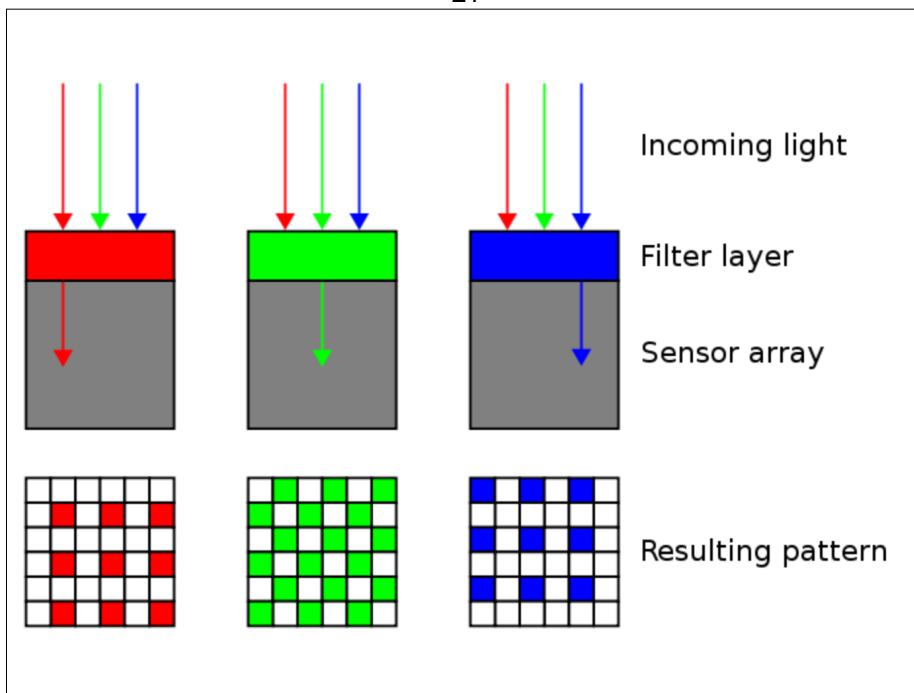
- image sensor
- resolution
- bit depth
- raw data
- lenses

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Uncomfortable Truths

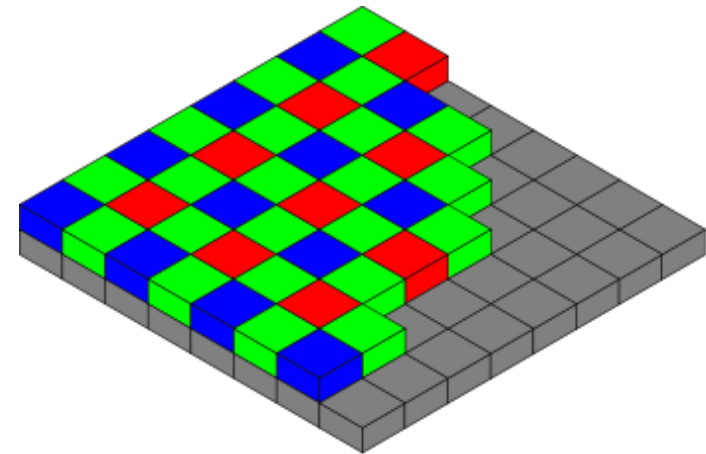
- sensors are colour blind
- Bayer sensors do not generate full RGB

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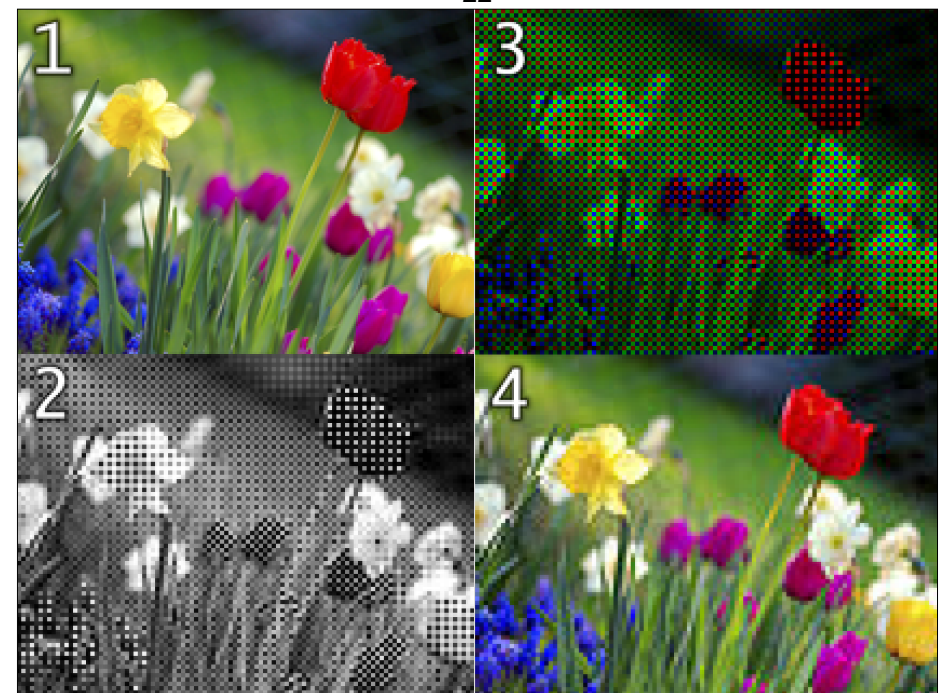


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Bayer



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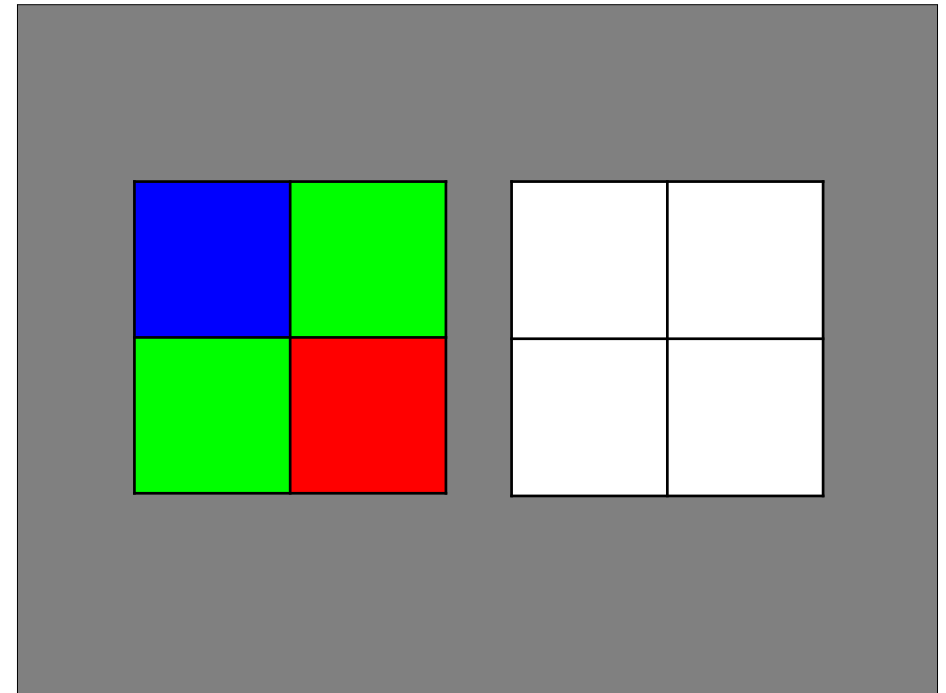
24

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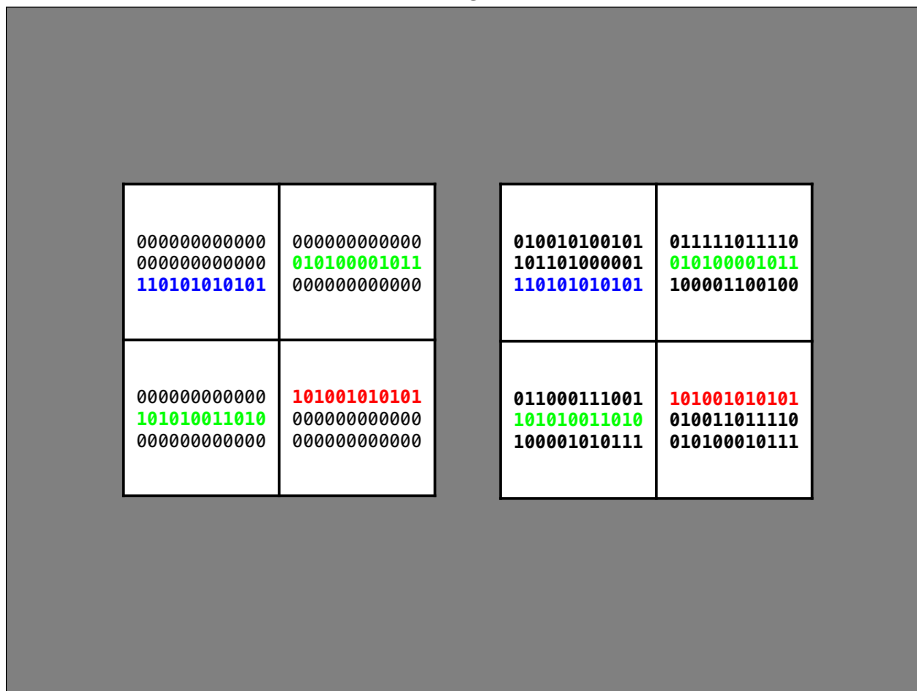
0111010100101010100010110101011110
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001010101010101010000101110101010000
011101010010101010100010110101011110
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100101110101001010101000101101010101
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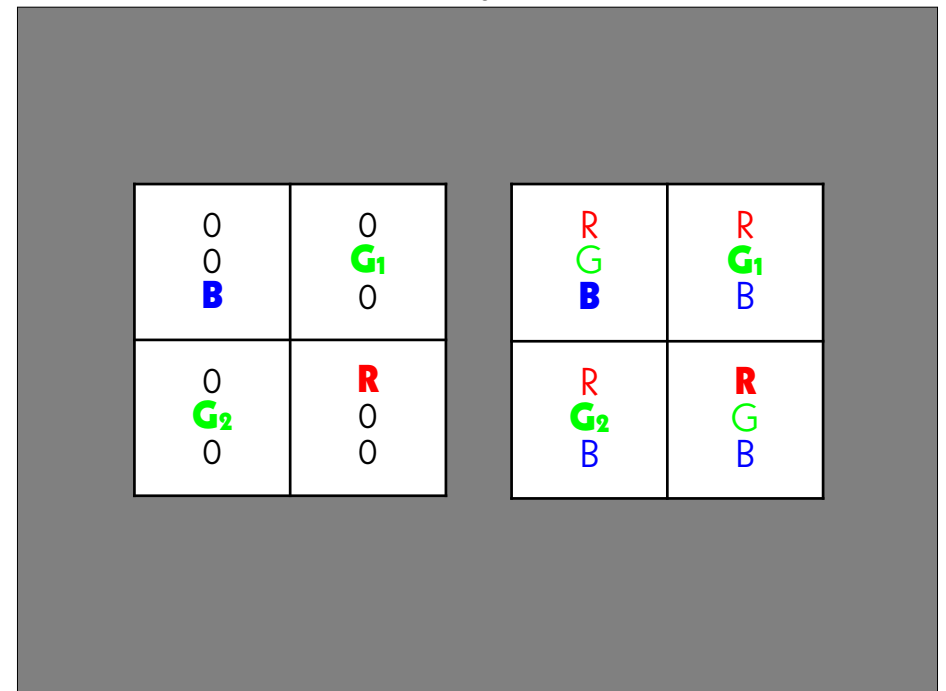
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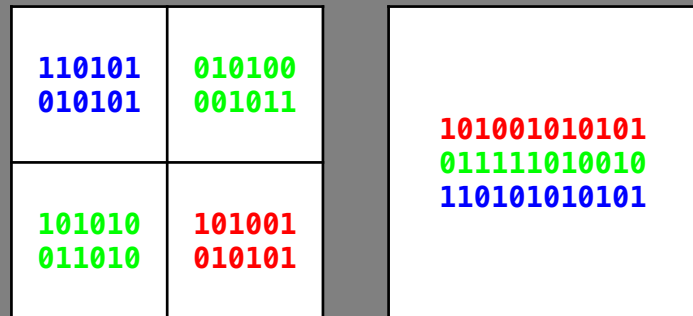
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Two ways to use Bayer data

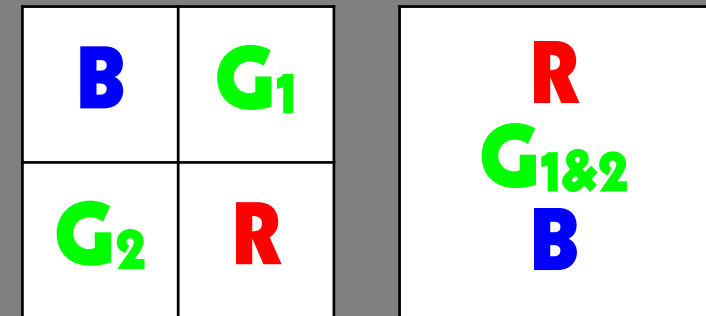
digital blow-up to RGB

- 3 times the amount of the generated data
- the file has the full sensor resolution
- only $\frac{1}{3}$ of the data are real

digital reduction to RGB

- $\frac{3}{4}$ the amount of the generated data
- the file has $\frac{1}{2}$ of the sensor resolution
- all data are real

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Image Section

- camera
- projector
- safe area
- over-scan
- edge to edge

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Wet Scanning

- wet transfer
- full immersion
- pre-wet
- solvent

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Audio Raw Data

- pcm_s16le
- pcm_s24le

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Video Raw Data

- | | |
|-----------|------------------|
| • rgb48le | • yuv444p16le |
| • rgb24 | • yuv444p12le |
| | • yuv422p10le |
| | • uyvy422 |
| | • yuv420p |
| | • bayer_bggr16le |

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Video Codecs

- | single image: | stream: |
|---------------|---|
| • DPX | • Y'C _B C _R 10-bit uncompressed |
| • TIFF | • FFV1 |
| • JPEG 2000 | |
| • OpenEXR | |

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File Formats

→ The archive must be able to handle the file formats it holds.

- open source
- simple to use and well documented
- widely used by the community

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Compression

- uncompressed
- lossless compression
- lossy compression
- chroma subsampling
- born compressed

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container:

- folder
- TAR
- ZIP
- MXF
- Matroska

codec:

- DPX
- TIFF
- JPEG 2000
- FFV1
- OpenEXR
- CineForm RAW
- ProRes RAW

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Uncompressed

- + data simpler to process
- + software runs faster
- bigger files
- slower writing, transmission and reading

Examples: DPX, TIFF, OpenEXR

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Lossless Compression

- + smaller files
- + faster writing, transmission and reading
- data processing complexer
- software runs slower

Examples: JPEG 2000, FFV1

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RAWcooked

- encoding into Matroska (.mkv) using FFV1 video codec and FLAC audio codec
- all metadata preserved
- decoding with bit-by-bit reversibility
- possibility to embed sidecar files (e.g. MD5, LUT, XML)
- compatibility with media players

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	advantages	disadvantages
TIFF DPX OpenEXR	data easier to process	bigger files
JPEG 2000 FFV1	smaller files	data complexer to process

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Data Storage

- hard disk drives (HDD)
- solid state drives (SSD)
- magnetic tapes (LTO with LTFS and/or TAR)

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LTO

- Linear Tape-Open
- answer from the IT industry to the bank and insurance sector
- in 2000 LTO-1
- currently LTO-8
- currently Hewlett Packard Enterprise, IBM, and Quantum form the LTO Consortium

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Formatting

TAR

- from LTO-1 to LTO-4 only possibility
- still possible possible today

LTFS

- possible (and recommended) since LTO-5

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TAR

- standard TAR
 - bloc size
 - number of archives per cartridge
 - archives needing more than one cartridge
- TAR with a proprietary data encoding (e.g. BRU, Retrospect)

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LTFS

- different versions
- almost one implementation per vendor, but...
- ... "ltfs" and "mklts" common commands
- lossless compression (default) or uncompressed data
- unencrypted (default) or encrypted data

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Working Space

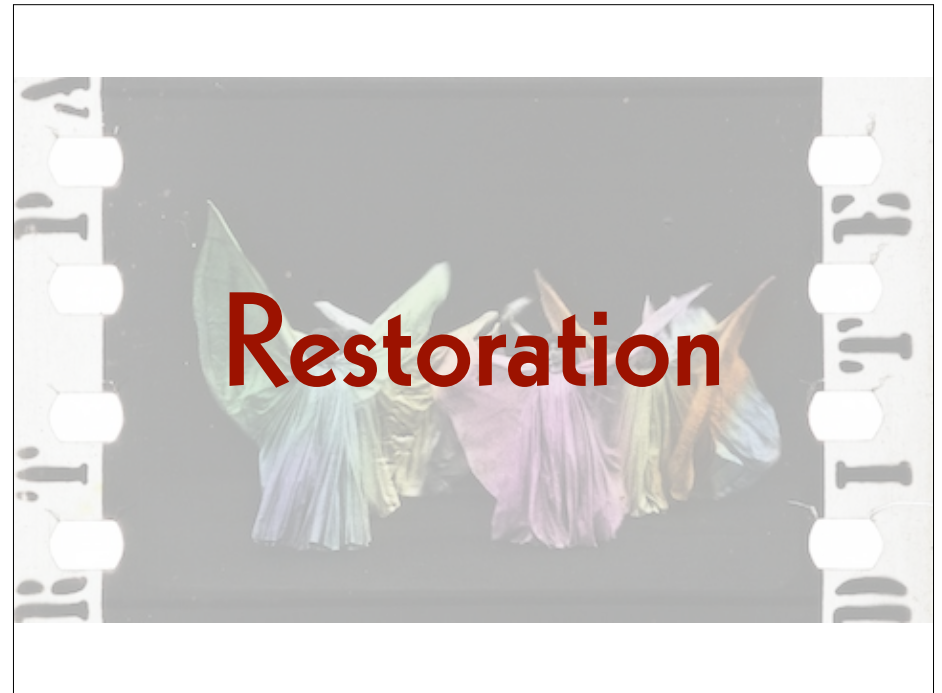
- scanner
- computer with at least one good monitor
- software
- storage: working memory and backup
- network
- illumination

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An Ounce of Ethics

- The probability that a work is available in its integrity in the future is increased.
- All the options that existed before taking an action remain open after the action.
- Every step is carefully documented.

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Equipment

- servers
- network
- storage
- ventilation (cooling)

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Working Place

- software
- computer with at least one good monitor
- storage
- illumination
- chair

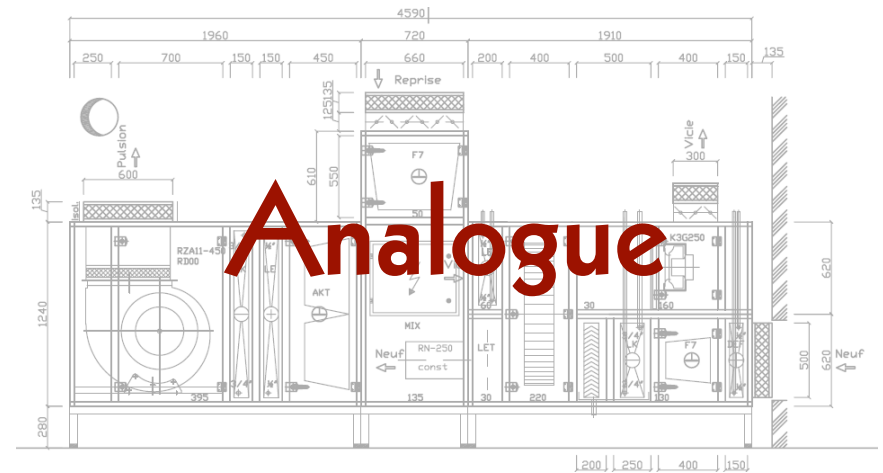
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Live in the real world!

There is only one efficient way:

- keep the analogue source elements as long as possible
- more prevention:
 - better insulation
 - more efficient air conditioning
- less handling of the source elements
- make digital masters and access copies

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Conservation

- de-restoration
- cleaning
- preparation

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Working Place

- manual rewinder
- ventilation
- illumination

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Consumables

- protection masks
- nitrile (and cotton) gloves
- tissues
- solvents
- film cement

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Infrastructure

- proper vaults with climate control

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Active measures

Air conditioning system:

- refrigerate
- dehumidify
- filter

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Air pollutant

- $\text{SO}_2 < 1 \mu\text{g}/\text{m}^3$
- $\text{NO}_x < 5 \mu\text{g}/\text{m}^3$
- $\text{O}_3 < 25 \mu\text{g}/\text{m}^3$

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Outgassed acid

- $\text{CH}_3\text{COOH} < 1 \text{ ppm}$
- $\text{HNO}_3 < 1 \text{ ppm}$

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Air flow

Outgassed acetic acid or nitric acid are heavy gases:

- air supply at the ceiling of one wall
- air exhaust at the bottom of the opposite wall
- air supply and air exhaust on the full length of the opposite longer walls

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Passive measures

- location
- orientation
- exterior paint colour
- shadow
- insulation
- humidity barrier
- apertures

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Digital

Plan the Next Migration

- file naming
- code bars
- checksums
- write the full index onto the cartridge
- technical metadata
- code to retrieve the files

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Longterm

- storage of the cartridges
- three copies ...
- ... in geographically distant locations
- data integrity check
- data migration
- availability of LTO desks

Equipment

- LTO desk or library
- software
- network

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Working Place

- small computer
- software

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Consumables

- LTO cartridges

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To do nothing
is **not** an option!

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